



STATE OIL COMPANY OF AZERBAIJAN REPUBLIC  
BAKU HIGHER OIL SCHOOL



Dedicated to the 94<sup>th</sup> Anniversary of National Leader Haydar Aliyev

# 5<sup>th</sup> Student Scientific and Technical Conference

## *Reports Thesis*



STATE OIL COMPANY OF AZERBAIJAN REPUBLIC  
BAKU HIGHER OIL SCHOOL

*Dedicated to the 94<sup>th</sup> Anniversary of National Leader Haydar Aliyev*

# 5<sup>th</sup> Student Scientific and Technical Conference

## ***Reports Thesis***

02 May 2017, Baku, Azerbaijan

## **ORGANISING COMMITTEE OF CONFERENCE**

### **CHAIRMAN**

Elmar Gasimov  
*Rector of Baku Higher Oil School*

### **DEPUTY CHAIRWOMAN**

Rena Mustafaeva  
*Dean of Life Long Learning faculty*

### **SCIENTIFIC SECRETARY**

Manafaddin Namazov  
*Associate Professor,  
Head of Process Automation Engineering Department*

### **MEMBERS**

Ramiz Humbatov  
*Vice-rector for Training, Science and International Relations*

Rashad Hasanov  
*Vice-rector for General Affairs*

Oktay Rzayev  
*Vice-rector for Administrative and Economic Affairs, Doctor of Philosophy*

Zafer Gurbanov  
*Dean of the Faculty of Engineering, Associate Professor*

Sanan Eminov  
*Director of Training and Research Center on Renewable Energy Engineering,  
Chairman of Student Scientific Communities Council*

Amir Reza Vakhshouri  
*Associate Professor of Chemical Engineering Department*

Sholakhanim Mirzayeva  
*Senior assistant of Petroleum Engineering Department*

Abbas Alili  
*Senior Lecturer of Process Automation Engineering Department*

Nijat Gasanov  
*Member of Student Scientific Communities Council,  
2<sup>nd</sup> course student, Chemical Engineering specialty*

Israfil Jabrailov  
*Member of Student Scientific Communities Council,  
3<sup>rd</sup> course student, Petroleum Engineering specialty*

Zaur Mamedzadeh  
*Member of Student Scientific Communities Council,  
4<sup>th</sup> course student, Process Automation Engineering specialty*



---

**Elmar Gasimov**  
*Rector of Baku Higher Oil School*

*To the Participants of the 5th Student Scientific and Technical Conference Dedicated to the 94th Anniversary of National Leader Haydar Aliyev*

***Dear students, the participants of the Conference!***

*Dedication of the conference to the 94th anniversary of the National Leader of Azerbaijan Haydar Aliyev is the manifestation of reverence to his personality being the founder of modern Azerbaijan and initiator of oil strategy of our country.*

*As a public higher education institution Baku Higher Oil School's primary goal is to train highly qualified prospective engineers applying up-to-date curricula and advanced technologies ensuring integration among teaching, research and businesses. To this end, we support every initiative aiming at motivating students for scientific research, and organize various events to facilitate reporting, while doing our best to create the environment and opportunities in this regard. Your obligation as a student is only to make full use of these chances and share our knowledge with your peers.*

*Such events are of utmost importance in terms of ensuring exchange of scientific information among the students, as well as present the results of their research work to the public. Eventually, participation in such conferences not only facilitates deeper understanding of the programmes courses, but also helps students to expand their world view and enrich scientific and technical knowledge.*

*I would like to congratulate all of you on this occasion and wish you success!*

***Sincerely,***

***Elmar Gasimov***

*Rector of Baku Higher Oil School*

## MODELING A RLC CIRCUIT'S CURRENT WITH DIFFERENTIAL EQUATIONS

**Aytaj Abdin**

*abdin.aytac.1609@gmail.com*

**Supervisor: Assoc. Prof. Khanum Jafarova**

### **Introduction:**

This paper explains the photovoltaic effect (solar power production process) in order to model a RLC circuit in which a photovoltaic panel is used to provide an AC output signal. The RLC circuit is the electrical circuit which has three main components: a resistor, inductor, and capacitor.

### **Applications:**

*Photovoltaic (PV) Power* is applied to transform sunlight into electricity. Then, this power can be put into a RLC circuit.

*Signal processing in an AM (amplitude modulation) radio tuner.* The tuner applies a basic rule called resonance to adjust all other signals that aren't of the frequency chosen by the radio dial. The tuner produces the resonance and amplifies specific frequency whilst neglecting all others. The RLC Circuit modeled proposes the signal processing which takes place within an AM radio tuner.

### **The mathematical model of the electric current in an RLC parallel circuit:**

In order to analyze how solar power can be used, the RLC circuit should be modeled to produce the AC signal from PV cells (about 0.5 Volts per cell) in a 12-celled solar panel. [2]

The AC signal equation can be expressed as:

$$V_{AC}(t) = V_{peak} \times \sin(\omega \times t)$$

Where,  $\omega$  is the angular frequency ( $\omega = 2 \times \pi \times f$ ) and  $V_{peak}$  can be estimated as the product of the amount of PV cells and the voltage output per cell.

To obtain the ordinary differential equation which is required to model the RLC circuit,  $V_{peak} \times \sin(\omega \times t) = L \times \frac{dI}{dt} + R \times I(t) + \frac{1}{C} \times (Q_0 + \int I(t)dt)$  should be differentiated. Taking the derivative of the equation with respect to time, the Second-Order ordinary differential equation (ODE) is represented by:

$$L \times \frac{d^2I}{dt^2} + R \times \frac{dI}{dt} + \frac{1}{C} \times I(t) = V_{peak} \times \omega \times \cos(\omega \times t)$$

With the values of resistance ( $R = 10\Omega$ ), inductance ( $L = 130nH$ ) and frequency ( $f = 105.1$  kHz), the value of capacitance can be calculated by using the following formula:  $\omega^2 = \frac{1}{C \times L}$

Putting the values in the equation gives  $C = 1/(L \times (2 \times \pi \times f)^2)$  and capacitance is calculated to be  $17.64 \times 10^{-6} F$ .

### **Solving the Ordinary Differential Equation:**

In order to solve an inhomogeneous linear ODE  $\frac{d^2I}{dt^2} + \frac{R}{L} \times \frac{dI}{dt} + \frac{1}{C \times L} \times I(t) = \frac{6\omega}{L} \times \cos(\omega \times t)$  the expressions of the complementary function and particular integral should be found.

Taking some estimation gives that  $A = 0.6$  and  $B = -8.4229 \times 10^{-8}$ . Thus the general solution is  $I(t) = C_1 e^{-5.6694 \times 10^3 \times t} + C_2 e^{-7.6917 \times 10^7 \times t} + 0.6 \sin(\omega t) - 8.4229 \times 10^{-8} \cos(\omega t)$

At  $t = 0$  seconds, the current  $I$  does not change in the circuit with time, therefore there is no initial rate of change of current. Hence,  $I(0) = 0$  and  $\frac{dI}{dt}(0) = 0$ .  $\frac{dI}{dt} = -5.6694 \times 10^3 \times C_1 e^{-5.6694 \times 10^3 \times t} - 7.6917 \times 10^7 \times C_2 e^{-7.6917 \times 10^7 \times t} + 0.6\omega \cos(\omega t) + 8.4229 \times 10^{-8} \times \omega \times \sin(\omega t)$

Using the initial conditions,

$$\begin{cases} C_1 + C_2 - 8.4229 \times 10^{-8} = 0 \\ -5.6694 \times 10^3 \times C_1 - 7.6917 \times 10^7 \times C_2 + 0.6 \times \omega = 0 \end{cases}$$

By doing so,  $C_1 = 0.0051$  and  $C_2 = -0.0051$  are obtained.

**References:**

1. Modeling a RLC Circuit's Current with Differential Equations. **Harwood, Kenny. 2011.** May 2011, pp. 3-14.
2. Principles of photovoltaic conversion of solar energy. **Trykozko, R.** Warszawa, Poland : s.n. Institute of Physics, Warsaw University of Technology.
3. The RLC Circuit. **Feldman, Joel. 2001.** 2001.

## **APPLICATION OF SECOND ORDER LINEAR DIFFERENTIAL EQUATIONS FOR SCIENCE AND MECHANICAL ENGINEERING**

**Agha Hashimov**

*hashimov.agha@gmail.com*

**Supervisor: Assoc. Prof. Khanum Jafarova**

### **Introduction**

In this scientific project, the main concept of the second order linear differential equation, its solution and its paramount applications for mechanical engineering will be considered one by one. In mathematics, a second order differential equation is an equation which involves the unknown function  $y$ , its derivatives  $y'$  and  $y''$ , and the variable  $x$ . As it is known this topic is so broad, therefore this project will only cover homogenous form of the second order linear differential equations. A second order linear differential equation has the configuration

$$M(x)\frac{d^2y}{dx^2} + N(x)\frac{dy}{dx} + T(x)y = C(x) \quad (1)$$

where  $M$ ,  $N$ ,  $T$ , and  $C$  are known as incessant functions. In this section, we will be focus on where  $C(x) = 0$  in equation (1) for all values of  $x$ . Such kind of expressions are named homogeneous linear differential equations and the general form of these equations is like indicated below.

$$P(x) \frac{dy^2}{dx^2} + Q(x) \frac{dy}{dx} + R(x)y = 0 \quad (2)$$

If the amount of  $G(x)$  is not equal to zero, then the differential equation is said to be inhomogeneous.

### **Solution**

Consider the second order linear homogeneous differential equation

$$a(t) \frac{d^2y}{dx^2} + b(t) \frac{dy}{dx} + c(t)y = 0 \quad (3)$$

where  $a(t)$ ,  $b(t)$  and  $c(t)$  are known functions. If  $y_1(t)$  and  $y_2(t)$  satisfies the equation (3), then for any two constants  $C_1$  and  $C_2$ , the Principle of Superposition says that

$$y(t) = C_1y_1(t) + C_2y_2(t) \quad (4)$$

We restrict ourselves here to the case when the coefficients  $a$ ,  $b$  and  $c$  in equation (3) are constants.

$$a \frac{d^2y}{dx^2} + b \frac{dy}{dx} + cy = 0 \quad (5)$$

There are three cases that should be analyzed.

Case 1:  $b^2 - 4ac > 0$

According to the Principle of Superposition the general solution is

$$y(t) = C_1e^{\lambda_1 t} + C_2e^{\lambda_2 t}.$$

Case 2:  $b^2 - 4ac = 0$

Thus, Principle of Superposition infers that the general solution should be

$$y(t) = (C_1 + C_2t)e^{-\frac{b}{2a}}.$$

Case 3:  $b^2 - 4ac < 0$

In this case, the general solution has to be

$$y(t) = e^{pt}(C_1 \cos(qt) + C_2 \sin(qt))$$

where  $p = -\frac{b}{2a}$  and  $q = \sqrt{\frac{|b^2 - 4ac|}{2a}}$ .

### **Application**

Actually, the equations we are talking about have a wide range of applications in science and mechanical engineering. They are applied

in chemical reactions, cooling of a body, electric circuit and mainly in the vibration of springs. In this project, one of them, the vibration of springs will be analyzed. The problem which is correlated with the vibration of springs will be solved by using the second order linear differential equations.

Sample:

The spring has a weight of  $0.2 \text{ kg}$  and a own stretch of  $0.6 \text{ m}$ . There is need a force with the value of  $2.56 \text{ N}$  for holding the spring extended to a stretch of  $0.8 \text{ m}$ . If it firstly is extended to a length of  $0.8 \text{ m}$  and after that released with the preliminary velocity of  $0 \text{ m/s}$ , determine the location of the weight at any time.

The motion is governed by  $m \frac{d^2y}{dx^2} + ky = 0$  (6)

According to the Hooke's principle, the force needed to extend the spring is  $F = 0.2k = 2.56 \text{ N}$ .

So, the spring constant  $k = \frac{2.56}{0.2} = 12.8 \frac{\text{N}}{\text{m}^2}$ .

Substituting this value of  $k$  together with  $m = 2 \text{ kg}$  into the expression (6) will give us the following equation.

$$0.2 \frac{d^2y}{dx^2} + 12.8y = 0 \quad (7)$$

We obtain the solution of the equation (7) in the form

$$y(t) = C_1 \cos 8t + C_2 \sin 8t \quad (8).$$

Taking into consideration the initial condition  $y(0) = 0.2$  in the solution (8), we get that  $C_1 = 0.2$ .

Then differentiating the expression (8), we derive the velocity function  $y'(t) = -8C_1 \sin 8t + 8C_2 \cos 8t$ .

Thus, the preliminary velocity is  $y'(0) = 0$ , knowing that  $C_2 = 0$ , we obtain that the solution is  $y(t) = \frac{1}{5} \cos 8t$ .

**References**

- <http://www.sosmath.com/diffeq/second/second.html>
- [http://elearning.utm.my/15161/pluginfile.php/241473/mod\\_resource/content/1/2nd%20Order%20ODE%20Applications.pdf](http://elearning.utm.my/15161/pluginfile.php/241473/mod_resource/content/1/2nd%20Order%20ODE%20Applications.pdf)

## TORRICELLI'S TRUMPET OR GABRIEL'S HORN

**Ahad Jafarov**

[axad.cafarov.7@gmail.com](mailto:axad.cafarov.7@gmail.com)

**Supervisor: Assoc. Prof. Khanum Jafarova**

### **Introduction**

Gabriel's horn, which is also referred as Torricelli's trumpet, is a geometrical shape which is considered as having a finite volume, but infinite surface area. The designation of the figure comes from an old custom in which Archangel Gabriel is recognized as an angel blowing the horn in order to proclaim the Judgment Day which was relating the infinite with the finite. An Italian mathematician and physicist, Evangelista Torricelli, was the first who made research on the characteristics of this figure in the seventeenth century. After the features of Torricelli's trumpet had been discovered, the fact that a figure with infinitely big surface stretching through  $xy$ -plane rotates about the  $x$ -axis was considered as paradoxical. After some calculations represented later has been done it becomes obvious that Torricelli's trumpet has a volume of  $\pi$  and a surface area equal to infinity. This incredible figure comes out with a paradoxical consequence that this trumpet may be fulfilled with  $\pi$  cubic units of paint, however infinite quantity of paint is required to cover the surface. This statement is an apparent paradox, which is called painter's paradox. Painter's paradox utters that since the trumpet has an infinite value of surface area but a finite value of volume, it seems that it could be filled up with a finite quantity of paint but that amount would not be adequate to cover the surface.

### **Mathematical definition**

Gabriel's horn is formed by rotating the following graph around the  $x$ -axis:

$$y = \frac{1}{x}$$

The values of  $x$  are situated in the interval of  $[1; \infty)$  in order to evade the asymptote at  $x=0$ .

A volume of figure is calculated through the formulae provided below:

$$V = \pi \int_a^b y^2 dx$$

Where  $a$  and  $b$  are the limits of the interval.

The surface area of the graph rotating at  $2\pi$  angle is determined by the equation given below:

$$A = 2\pi \int_a^b y \sqrt{1 + (y')^2} dx$$

So, considering  $a \rightarrow \infty$ , in Gabriel's horn case the volume and the surface area of the figure are as follows:

$$V = \pi \int_1^a y dx = \pi \int_1^a \frac{1}{x^2} dx = \pi \left[ -\frac{1}{x} \right]_1^a = \pi \left( 1 - \frac{1}{a} \right)$$

$$A = 2\pi \int_1^a \frac{1}{x} \sqrt{1 + \left( -\frac{1}{x^2} \right)^2} dx$$

As the  $x$  is in the interval of  $[1; \infty)$ , the expression  $\sqrt{1 + \left( -\frac{1}{x^2} \right)^2}$  is bigger than 1, so

$$\begin{aligned} A &= 2\pi \int_1^a \frac{1}{x} \sqrt{1 + \left( -\frac{1}{x^2} \right)^2} dx > 2\pi \int_1^a \frac{1}{x} dx = 2\pi \int_1^a \frac{1}{x} dx = \\ &= 2\pi [\ln(x)]_1^a = 2\pi \ln(a) \end{aligned}$$

So, finally the surface area is expressed by the following equation:

$$A > 2\pi \ln(a)$$

Ultimately, the equations for volume and surface area look like following:

$$\lim_{a \rightarrow \infty} V = \lim_{a \rightarrow \infty} \pi \left( 1 - \frac{1}{a} \right) = \pi \lim_{a \rightarrow \infty} \left( 1 - \frac{1}{a} \right) = \pi$$

$$\lim_{a \rightarrow \infty} A \geq \lim_{a \rightarrow \infty} (2\pi \ln(a)) = \infty$$

So,  $V = \pi$  and  $A \geq \infty$ .

## **Conclusion**

To put everything in nutshell, Torricelli's trumpet (or Gabriel's horn) is taken into account as a geometrical figure having finite value of volume, however, infinite value of surface area which is considered paradoxical. This apparent paradox called painter's paradox is proved mathematically, however a deep knowledge of quantum physics and a better understanding of molecular physics is a key to enclosure of this paradox.

## **References and Bibliography**

- <http://web.calstatela.edu/curvebank/torricelli/torricelli.htm>
- [https://en.wikipedia.org/wiki/Gabriel's\\_Horn](https://en.wikipedia.org/wiki/Gabriel's_Horn)
- "Gabriel's Horn: An Understanding of a Solid with Finite Volume and Infinite Surface Area",s by Jean S. Joseph.
- "Supersolids: Solids Having Finite Volume and Infinite Surfaces", William P. Love

# **INCREASING HYDROCARBON RECOVERY FACTOR BY NANOPARTICLES**

**Ismayil Akbarov**

[ismayilekberov96@gmail.com](mailto:ismayilekberov96@gmail.com)

**Supervisor: Farad Kamyabi**

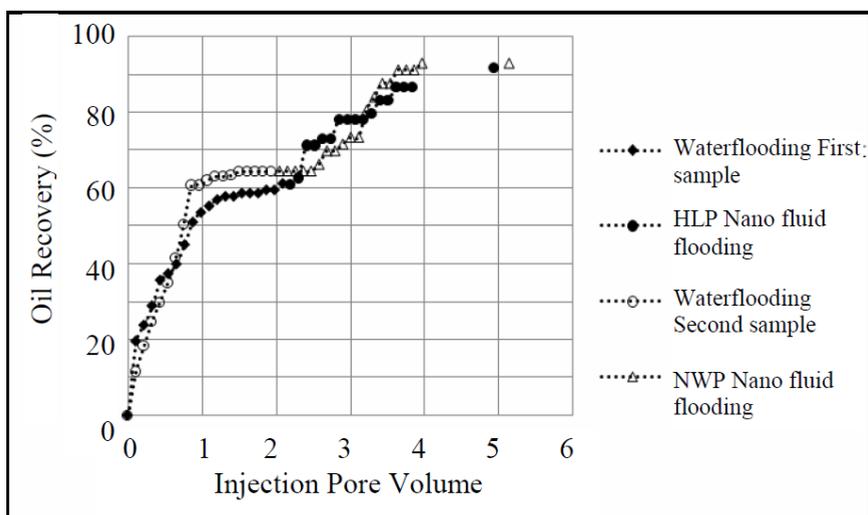
## **Introduction**

Generally, nanotechnology has a stupendous impact on petroleum industry. Its role has been highlighted in exploration, drilling as well as increasing oil recovery factor considerably. In order to replace oil from reservoir nanoparticles are added to the fluid. This alters the inner character of the solution and these obtained unique nano-solutions are rather applicable in oil fields. As an initial step for understanding the performance of nanoparticles in increasing recovery factor, oil is displaced from flooding system. After this stage, all results are

reviewed, interpreted thoroughly and compared with other recovery techniques for detecting the difference. Here, the basic goal is to make sure that further application of the nanomaterials in reservoir will bring great advantages in terms of technical and economic situations. In this thesis, the effect of silica nanoparticles in recovery factor will be manifested in detail.

### **Silica Nanoparticles**

Due to the rather low-cost manufacture and enough cost-effectiveness in surface adaptation silica nanomaterials are utilized for EOR (Enhanced Oil Recovery) operations. In order to comprehend the rheological manner of the silica nanoparticles scientists made an investigation in this field. These studies indicated that there is a stupendous dependence between the particle concentration and the viscosity of the nanoparticle dispersion. At the same time, any change in shear related to the pore morphology could have an influence in the viscosity of particle dispersion. Among silica particles, one essential type called polysilicon particles (HLP, Hydrophobic and Lipophilic Polysilicon) was defined as a strong EOR substance in the case of various water injection processes. For experiment, cored water-wet sandstone is used as sample. Increasing oil recovery can be attained with two paramount mechanisms through injection of HLP nanoparticles: Decreasing of the interfacial tension and wettability change. Injection of HLP nanoparticles consists of three scenarios. First of all, these nanoparticles are injected after waterflooding in the case of final oil saturation. Secondly, as a following step three PV water injection is carried out. Thirdly, the process continues by injecting of HLP nanoparticles from starting point. By applying HLP nano-fluid oil-water interfacial tension is reduced 10 times. Meanwhile, there becomes an observation of much less water wet situation by decreasing the contact angle from 123 up to 99 degree. The main feature of HLP nano-fluid is the ability to change the wettability from strong to less water-wet condition. Figure below depicts dependency function in different scenarios:



**Figure 1.** Oil Recovery versus Injection Pore Volume

In porous environment it is very important to analyze the retention and transport of nanoparticles. For this reason, there was an experimental study devoted to the understanding of the transport and adsorption manner of silica nanoparticles in sandstone, limestone and dolomite. Results verified that the adsorption degree of nanoparticles is acceptable to apply (1.272 mg/g, 5.501 mg/g and 0 mg/g respectively). For understanding transport behavior, coreflood test was carried out. Again the results become rather justified. Silica nanoparticles passed the sandstone without making any change in core's permeability. Nevertheless, negligibly small amount of adsorption was observed in the case of limestone, there was no any alteration in the permeability as well. Dolomite core demonstrated the same situation as limestone in terms of permeability.

### **Conclusion**

Taking all things into account, nanotechnology is very powerful tool for manipulating the recovery factor. Apart from silica nanoparticles, several additional substances including aluminum oxide, magnesium oxide, iron oxide and etc., can be used as supplementary agents in order to increase the stability and

effectiveness of nano-solutions. As it is mentioned, the basic mechanisms for increasing oil recovery factor with utilizing nanomaterials, are considerable decline in an interfacial tension and wettability alteration. Anyway nanotechnology must be studied deeply towards this direction for obtaining better results in petroleum industry.

### **References**

1. <http://www.spe.org/industry/increasing-hydrocarbon-recovery-factors.php>

### **Bibliography**

1. Investigating the Potential of Nanomaterial for Enhanced Oil Recovery: State of Art by Adel M. Salem Ragab, Article, pages 25, 35, 37.
2. Fundamentals of Reservoir Engineering by L.P. Dake, 8<sup>th</sup> Edition, page 10.

## **GRAPH COLORING AND ITS APPLICATIONS**

**Ayaz Samadli**

[samadliayaz27@gmail.com](mailto:samadliayaz27@gmail.com)

**Supervisor: Khanum Jafarova**

### **Introduction.**

The Graph Theory is the branch of mathematics which is focused on graphs and study the types of graphs, structure of them and it has a huge applied area by the help of computer science and in our century benefits of its applications are undeniable. In this report, applications of these theories will be underlined and the Five Color Theorem will be analyzed, and I will add my points of view to this theory.

The Graph Theory has some real world applications, it covers the fields from the biology to the computer science. For instance, modeling of bio-molecular networks, measurement of centrality and importance in bio-molecular networks are the main fields which have a big relationship with the graph theory. In chemistry and physics, particles are defined as node and relationship between them as vertex, so we

can handle them by the help of graph theory. Graphs are defined as directed and undirected, if we define our graph as  $G(V,E)$  if for all  $(V,W)$  and  $(W,V)$  are included our graph, it means both of edges exist in our graph it is called undirected, otherwise it is directed. In addition, graphs can be classified as weighted and un-weighted. We can represent the graphs as a matrix in computer, each element of matrix define the vertex between  $i$  and  $j$  nodes, if the element is zero there is no any connection, else there is connection between them.

**Graph coloring.** Graph coloring is one important part of graph theory, in this theory each neighborhood nodes should be in different color, and our major aim is to find the minimum color which can be satisfied us (it is called chromatic number) or the number of case if the number of color are known beforehand. It can be called senseless but it has a number of real life applications, I will try to cover all of them.

The applications of graph coloring is *Making Schedule*, *Mobile Radio Frequency Assignment*, *Sudoku*, *Register Allocation*, *Map Coloring*.

For example, we have some subjects and some students will be examined, and there is many common students, how can we calculate the minimum time slot that no any students will have two or more exam in one time. So, we can realize the exam as a vertex and the students as an edge, so in this example the chromatic number will be our minimum time slots.

The number of ways with given number of color can be calculated by the chromatic polynomial. Some polynomials have been drawn beforehand, however we can define polynomials of any graph.

- 1)  $P$  can be  $P(g, t) = t \cdot (t - 1)^{n-1}$  (For tree with  $n$  vertices)
- 2)  $P(g, t) = t \cdot (t - 1) \cdot (t - 2) \dots (t - (n - 1))$  (For complete graph)
- 3)  $P(g, t) = t \cdot (t - 1) \cdot (t - 2)(t^7 - 12t^6 + 67t^5 - 230t^4 + 529t^3 - 814t^2 + 775t - 352)$  (For Petersen graph)

Five Color Theorem. Before the Five Color Theorem, I will mention Four Color Theorem, it says that, in mapping we can draw any map with the four color, in this problem our country will be one node, and

others will be its neighbor nodes, and we can show its borders with the four colors, no more than 4. This theory have been open to researchers for 100 years, and then it was proved by the help of computer, with the brute force algorithms. Then, Five Color problem was introduced and it says that we can color any graph with five color, and its proof is not as hard as Four Color Theorem. We can easily proof it with Euler's formula and Jordan Curve Theorem.

Theorem 1. Let P be a polyhedron and note that:

- a) undirected, it means any two nodes can be connected by the edges.
- b) P can be divided two place by any loop on polyhedral

Then we can write that:

$$\sum_{s=1}^{f_L} n_s = 2 \cdot e_L (n_s \text{ is number of borderlines})$$
$$v_L \leq 2e_L$$

We can use for Euler's formula to prove below equation.

$$\sum_{s=1}^{f_L} (6 - n_s) = 6v_L - 2e_L = 6v_L - 6e_L + 4e_L$$
$$\geq 6v_L - 6e_L + 6f_L = 6 \cdot (v_L - e_L + f_L) = 12$$

After this equation we can claim that one country has at least 5 neighbors, then we can easily prove the Five Color Theorem.

#### **References:**

- [https://en.wikipedia.org/wiki/Graph\\_coloring](https://en.wikipedia.org/wiki/Graph_coloring)
- <https://www.slideshare.net/MANOJITCHAKRABORTY1/graph-coloring-project>
- <http://cgm.cs.mcgill.ca/~godfried/teaching/dm-reading-assignments/Map-Graph-Coloring.pdf>
- [https://en.wikipedia.org/wiki/Five\\_color\\_theorem](https://en.wikipedia.org/wiki/Five_color_theorem)

## **ALL-WEATHER SOLAR PANELS**

**Narmin Bakhishova**

*[narminbakhishova@gmail.com](mailto:narminbakhishova@gmail.com)*

**Supervisor: Siyavush Azakov**

It is out of the question that our life can't be imagined without energy. Nearly everything around us – homes, schools, plants, big companies need to be provided with energy. But with which difficulties do people come across during energy production process? As it is known, pollution of environment, limited quantity of natural resources such as oil and gas are one of the global problems nowadays. Scientists have been looking for environmentally friendly ways from early years. The aim is to get energy without having an adverse effect on environment and to use not only natural resources, but also unlimited sources of energy such as Sun, wind.

One of the biggest, environmentally friendly innovations was getting energy from Sun in this area via solar panels. Solar cells or in other name photovoltaic cells which consist of layers of semiconducting materials absorb energy of Sun and convert it into electricity. As a result of absorbing energy, electrons in cells will freely move and create a flow. This flow is an electric current which is used as input power for devices. Apart from, current and voltage determine solar cell capability of producing energy. The more sunshine, the more electricity will be produced. Solar panels have the lowest impact energy to fossil fuels.

Solar panels are widely used in many countries and it has been developed in Azerbaijan over last years. Their efficiency have dramatically increased by more than 20%. But the negative side is that they have limited efficiency. Since we can't get enough energy on rainy days by using solar panels, they produce approximately 25% less electricity on rainy or cloudy days. Especially, it is a big barrier for some countries, districts in which sunny days are limited in number

though, such as UK (where it rains about 42% of year) England, Cologne, Dusseldorf, Lankaran, the southern part of Caucasus.

Humans have such a potential that can solve any problem. That's why we shouldn't be satisfied with natural resources and should look for such ways that to keep our environment clean and 'healthy' for next generations. Just imagine, if we can get energy from sun or wind, why can't we do it for rain? Scientists from Ocean University and of China and Yunnan Normal University have been created solar panels which can get energy both from rain and Sun. The only needed component is graphene oxide.

According to this innovation, bottom side of solar cells should be coated with graphene oxide layer. These parts of cells are reversed upwards on rainy days. It is known that, rain is an excellent reservoir for dissolved salts which are consist of negative and positive ions. According to Lewis-Base interaction, when drops of rain touch the graphene layer, a pseudo-capacitor is formed and positive ions such as calcium, sodium, ammonium stimulate an electric current. Hundreds of millivolts worth of voltage can be generated by thick layer of graphene. Additionally, these panels can get energy on sunny days too, with the 6.53 % efficiency.

If we will talk about solar panels in terms of finance, it is known that they are not cheap. Especially, in our country, there aren't plants which produce solar cells, so we buy it from other countries and it means that much more money are spent. But just for this project no more additional money should be spent, because graphene oxide doesn't contain expensive substances and its production in laboratory doesn't take much time. Substances which are used during graphene oxide production are potassium permanganate, sulfuric acid, graphite, sodium nitrate, hydrogen peroxide, water. All of them can be easily found.

It is also possible to use graphene instead of graphene oxide. Because materials which are required should be conductive. Graphene is a great conductor, but it is not good collector for electric

current produced inside the cell. That's why scientists modify graphene to solve this problem. Although graphene oxide is less conductive, but it is a great collector and more transparent.

This new design isn't a marketable product, it is a working concept for now. Researches are still on preliminary stage, scientists try to handle with low concentrated rain. But this project created by the Chinese scientists, can guide the design of advanced all-weather solar cells.

### **Reference**

- [1] <http://www.graphene-info.com/graphene-solar-panels>
- [2] <http://www.digitaltrends.com/cool-tech/all-weather-solar-panel/>
- [3] <http://www.iflscience.com/technology/solar-panels-every-weather-condition/>

## **CARBON DIOXIDE ENHANCED OIL RECOVERY**

**Chingiz Mammadli**

*[chingiz.mammadli@gmail.com](mailto:chingiz.mammadli@gmail.com)*

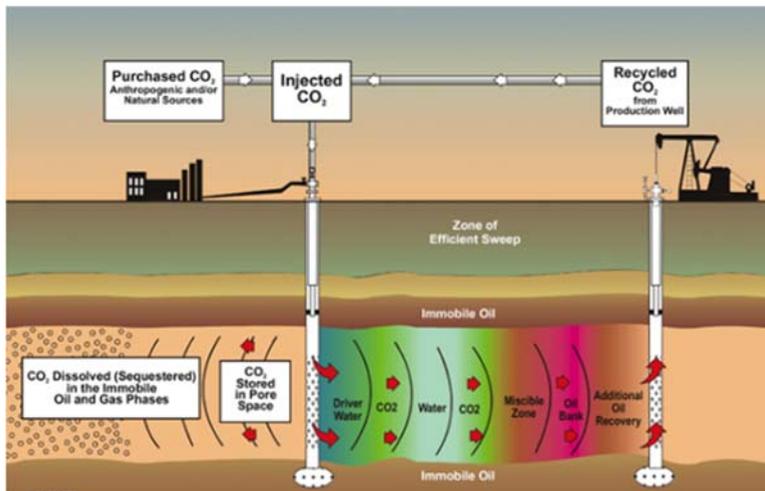
**Supervisor: Kamyabi Farad**

### **Introduction**

Primary and secondary production are generally called conventional oil production while the tertiary production is stated as unconventional production. There are several methods of operating unconventional reservoirs and CO<sub>2</sub> injection is one of the widely used method of tertiary production. This is a method to increase production by changing the physical properties of oil and provide better transmission of it between rock particles. The method is based on increasing the miscibility and thus decreasing the viscosity of oil to result in better flooding of fluid into the wellbore through reservoir pores. Each reservoir has its own requirement of CO<sub>2</sub> composition which is determined by some experiments and calculations.

## Basics of CO<sub>2</sub>-EOR

Carbon dioxide enhanced oil recovery is a most common method of tertiary oil production due to its effectiveness and relatively low cost compared to others. CO<sub>2</sub> which is almost pure (purity greater than 95%) is injected through an injection well and is extracted in production well together with oil and is re-injected to the well after separating it from formation. Following picture illustrates the process:



The vast majority of CO<sub>2</sub> used is provided by naturally occurring underground facilities however man-made CO<sub>2</sub> can also be used to escalate production which can usually reach 5-15 % of oil in place. In order to achieve the efficiency the injected CO<sub>2</sub> should be in supercritical phase in which it is denser and more mobile. This phase can be obtained above certain pressure and temperature that is 31.1 C and 7.38 Mpa for CO<sub>2</sub>. So, CO<sub>2</sub> EOR operation is suitable for over 800 m depth. However the injection process can continue up to 1 year the further production may continue up to 30 years. Today the highest proportion of CO<sub>2</sub> injection utility accounts for Permian Basin where the supercritical CO<sub>2</sub> is transported via 200 miles long pipelines. Despite this distance the cost of CO<sub>2</sub> transportation is mind drawing which has been over \$1 billion for Permian basin. The anthropogenic CO<sub>2</sub> is also used during injections which also helps to prevent and

diminish the effect of greenhouse gasses which is an annoying global concern. Utilized CO<sub>2</sub> is either gathered to re-injection or stored permanently underground which is a process known as sequestration.

### **Conclusion**

In past few decades the production of unconventional oil has been a great concern for oil industry. Due to that, tertiary production by CO<sub>2</sub> injection has established to be a great contributory to further production of reservoirs. Its reliability, environmental impact, economical advantage, accessibility and effectiveness has provided a large scale industrial application despite its high cost. The process includes changing the properties of oil by injected CO<sub>2</sub> in supercritical phase and providing better flow of fluid to the wellbore and increase the production rate. Despite some losses the formation can be separated and used further.

### **References**

- <https://pubs.usgs.gov/of/2015/1071/pdf/ofr2015-1071.pdf>
- <http://neori.org/resources-on-co2-eor/5-things-to-know-about-co2-eor/>
- <https://hub.globalccsinstitute.com/publications/technical-aspects-co2-enhanced-oil-recovery-and-associated-carbon-storage/12-how-co2-eor-works>
- [http://neori.org/Melzer\\_CO2EOR\\_CCUS\\_Feb2012.pdf](http://neori.org/Melzer_CO2EOR_CCUS_Feb2012.pdf)
- Dipietro, J et al, "The Role of Naturally-Occurring CO<sub>2</sub> Deposits in the Emergence of CO<sub>2</sub> Enhanced Oil Recovery
- Van Poolen, H.K., and Associates, 1981, Fundamentals of enhanced oil recovery

## **SOLAR ELECTROLYSIS FOR HYDROGEN FUEL PRODUCTION**

**Elmar Asgarzada**

*elmar.asgarzada@yahoo.com*

**Supervisor: Prof. Siyavush Azakov**

### **Introduction**

For many years fossil fuels have played a crucial role as a main energy resource around the world. However nowadays, for two main reasons it is not beneficial to use fossil fuel. One is detrimental effects of hydrocarbon combustion on environment and for second, statistics report that world is running out of fossil fuel sources. Therefore, modern world requires more clean and renewable energies. Use of hydrogen as a fuel can makes an opportunity to save environment as the combustion of Hydrogen gives H<sub>2</sub>O which is not harmful for environment. Therefore, hydrogen is environmentally beneficial type of fuel. In the nature more hydrogen. Another importance of hydrogen fuel is that it has low density characteristic that requires lower space storage.

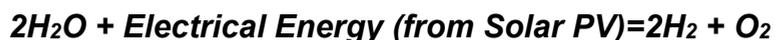
### **Solar energy characteristics**

For first examination it is required to increase maximum amount of energy from sun. Degree of arrays are investigated for better position for maximum efficiency. Each of PV solar cell requires 1.7 V from sun to begin operation. Using more cells provide more energy consumption from the sun. Use of solar energy has valuable advantages on others. Firstly, this energy type is renewable and low cost that will allow to achieve more efficiency in terms of economic and environmental aspect. In case of environmental factor using solar energy will make an opportunity to save environment as it has no harmful effects on either environmental pollution or greenhouse effect in globe. The most potential solar energy is available in north and

central Australia, north-west region of Africa and Arabian Peninsula, India and etc. These regions accept 2500 kWh/m<sup>2</sup> solar energy annually.

### **Electrolyze.**

Electrolyze is also an integral component of hydrogen production system. Solid polymer electrolyte is used in electrolyze for transfer of water and protons. When it is combined with catalyst, membrane-electrode assembly is formulated and then power from solar photovoltaic is supplied to electrolyze. When electrolyze obtains energy, it decomposes water into hydrogen gas and oxygen. Overall reaction:



For this reaction 39kWh of electricity is required to achieve 1kg of hydrogen fuel production. The main beneficial side of using electrolyze method is that it will lead to produce a very clean hydrogen fuel in comparison with other type of methods. It was proven that using high-pressure and high-temperature electrolysis would play a great role to achieve more production. Application of polymer electrolyte membrane (**PEM**) electrolyze has some important superiorities:

1. It will enable to reduce more electricity need and achieve high energy efficiency.
2. The material of electrolyze is more affordable to use that will help to cut costs.

Type of electrolyte and its concentration is also an important matter to reach high efficiency in hydrogen fuel production.

### **Conclusion**

To sum up, investigating solar electrolysis for hydrogen production makes an opportunity to harness more clean and regenerating source of fuel. Hydrogen fuel could be used as a harmlessness energy storage and transport in near future. Hydrogen which is obtained from water by using solar electrolysis is a sustainable and regenerating transport and home energy supply. By using this method it is possible to produce clean hydrogen production at many parts of the world.

## References

1. Jeremiah F. Wilson and Lamont Henderson. Journal of research in physics. Hydrogen production using solar energy. 17.03.2013
2. UK National Academy of Science and Engineering (2005), "The Hydrogen Economy" National Academies Press.
3. Ryan Mayfield. Solar PV installation and design "Wiley publishing Inc. 2007

## EULER'S BUCKLING THEORY

**Esmira Jafarova**

*jeferovaesmira@gmail.com*

**Supervisor: Assoc. Prof. Khanum Jafarova**

### Abstract

In engineering, column buckling is observed when compressive axial loads are applied, it is a contributing factor to a failure mode. Amount of maximum critical load which a column can stand prior to collapsing is determined via a special method called "Column buckling analysis". For accomplishing the very analysis, Euler's buckling theory is applied in the deformed state. Euler's theory serves to find the maximum load (Euler load) which an ideal column can carry without buckling. Euler's critical load formula was derived by the Swiss mathematician Leonhard Euler in 1757.

$$P_{cr} = \frac{\pi^2 EI}{(KL)^2}$$

### Theory

In order to find the critical load via Euler's formula moment equilibrium is written according to free body diagram of a column:

$$\sum M_z = 0, M(x) + Pv(x) = 0, M(x) = EIk(x) = EI \frac{d^2v(x)}{dx^2}$$

(Moment/curvature)

Linear 2<sup>nd</sup> order ODE:

$$EI \frac{d^2 v(x)}{dx^2} + P v(x) = 0, \quad \frac{d^2 v(x)}{dx^2} + \frac{P}{EI} v(x) = 0,$$

Where,  $k^2 = P/EI$  is a parameter and there is a phenomenon called eigenvalues of the problem which are critical values of it, eigenfunctions are corresponding non-zero solutions of  $v(x)$ .

$$\frac{d^2 v(x)}{dx^2} + k^2 v(x) = 0$$

General solution of ODE is:

$$v(x) = C_1 \sin(kx) + C_2 \cos(kx)$$

Boundary conditions:

$$v(0) = 0 \Rightarrow C_2 = 0$$

$$v(L) = 0 \Rightarrow C_1 \sin(kL) = 0 \Rightarrow \sin(kL) = 0$$

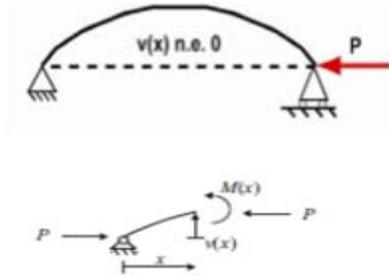


Figure 1. Free-body diagram (general and in one end)

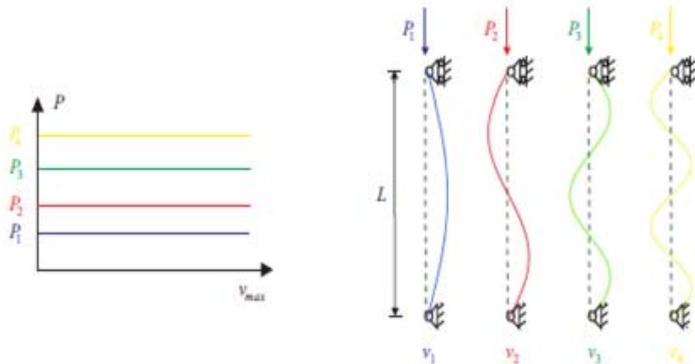


Figure 2. At left is shown the critical loads as function of maximum transverse displacement and at right the corresponding deformation shapes

The only non-trivial solution:

$$\sin(kL) = 0 \Rightarrow kL = n\pi, n = 1, 2, \dots$$

$$P_n = EI k^2 = \frac{n^2 EI \pi^2}{L^2}, v_n(x) = c_1 \sin \frac{n\pi x}{L}, n = 1, 2, \dots$$

The  $P_n$  are so-called critical loads in which an equilibrium state is observed in the deformed state determined before. The column will buckle when  $P_1$  is reached:  $P_e = P_1 = \pi^2 \frac{EI}{L^2}$

The column will retain its straightness with gradual applying of the load until the Euler load is reached. Conclusion

Determination of equilibrium of a column or beam which is loaded in axial compression is implemented via an ordinary homogenous second-order differential equation. Euler's buckling theory has a crucial role in many sectors (structural engineering) in order to determine the suitable circumstances for required duty.

**References:**

- <https://ocw.mit.edu/courses/mechanical-engineering/2-002-mechanics-and-materials-ii-spring-2004/lecture-notes/lec2.pdf>
- <http://first.math.aau.dk/dan/ressources/applications/?file=applications-ses-eng.pdf>

## **NATURALLY FRACTURED RESERVOIRS**

**Gullu Ahmadova**

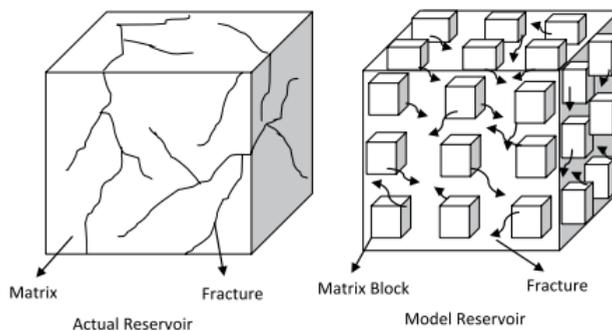
[gullu.ahmadova9999@gmail.com](mailto:gullu.ahmadova9999@gmail.com)

**Supervisor: Farad Kamyabi**

Naturally Fractured Reservoirs are significantly important contributors to the oil and gas reserves of the world. A great amount of the world's oil reserves is located in carbonate reservoirs which are naturally fractured. According to the researches, roughly one-fifth of oil reserves is contained in NFRs. The thesis focuses on investigation production individualities, the flow fluid and specific features of NFRs.

Naturally Fractured Reservoir contains a continuous fracture network distribution that affects considerably the flow of fluid. Generally, basic components of that reservoirs is an existence of

matrix and connected fracture network. The fracture has high permeability and low porosity and it is responsible for fluid flow throughout production. In contrast, matrix is highly porous block with low permeability and it is considered as storage capacity of the reservoir (See Figure 1). Rock properties of the NFR, to be exact porosity and permeability vary substantially from matrix to fracture, thus owing to variation in conductive characteristics of fracture and matrix and storage, NFR is considered as dual-porosity reservoirs.



**Figure 1.** Actual and ideal matrix - fracture system

Apropos to the many dual-porosity assumption, the oil or gas moves from porous matrix to the permeable fracture and afterwards into the wellbore, not directly from matrix to the wellbore. Additionally, mainly two major dual-porosity parameters are utilized to obtain sufficient data. First one is Interporosity flow coefficient that defines how easily fluid moves from matrix to the fracture. As regards second parameter, storativity ratio determines fraction of the whole pore volume relating with one of the porosities. It is important to develop fluid flow models, to do this two kinds of flow regimes are considered. Pseudo-steady and transient flow (also called unsteady flow) regimes are prevailing in NFRs and both of them are overriding in the matrix. In accordance with pseudo-steady flow assumption, pressure through the matrix diminishing in a linear way. For that reason, flow from matrix to fracture is proportionate to pressure variation between matrix and nearby fracture pressures. With regard to transient flow regime, it

assumes that starting from matrix-fracture borderline the increasing pressure drop is observed and continues into the matrix.

Production features and mechanisms in NFRs differ from the conventional reservoirs due to mutual interactions between matrix blocks and fractures. The main specific features of NFRs are punctuated below:

- Gas oil ratio (GOR) is lower in a NFR than conventional reservoirs. It is associated with liberated gas to segregate via fracture towards top of reservoirs.
- The rate of pressure decline per unit oil produced is lower. It is linked with higher fluid supply from matrix to fracture as a consequence of gravity, imbibition and fluid expansion.
- Fractures with high permeability lead to lower pressure drop around the producing well. Therefore, pressure gradient does not play a vital role on the production.
- PVT properties and bubble point pressure do not vary with depth as a result of convection process that caused by thermal expansion and gravitational compression.
- Due to the absence of the transition zone GOC and WOC are sharp and horizontal. Equilibrium of two phases in fracture network is controlled by gravity forces and capillary pressure is ignored.

Contrasting to the conventional reservoir, in NFRs it is challenging to forecast the production from certain reservoir parameters, additionally it is required to comprehend fracture and matrix interactions. As fracture and matrix behavior in each reservoir is dissimilar, thus there is no dominant single flow regime. Therefore, in NFRs for forecasting the production performance, transient and pseudo-steady flow regimes are used together.

#### **Bibliography**

- Nelson, R. A., 2001. *Geologic analysis of Naturally Fractured Reservoirs*. 2nd ed. United State of America: Gulf Professional Publishing .
- NTNU, n.d. Fractured Reservoir Description and Geometry. First part.

## **MEASUREMENT WHILE DRILLING (MWD) AND LOGGING WHILE DRILLING (LWD) SYSTEMS**

**Israfil Jabrayilov**

*Israfil.jabrayilov97@gmail.com*

**Supervisor: Elnur Amirov**

### **Introduction**

Nowadays, Petroleum Engineering is considered to be one of the most important engineering fields in the world. As petroleum is vitally important energy resource and is used as a feed for more than 6000 materials<sup>1</sup>, our life cannot be imagined without it. However, extracting the petroleum is as very difficult as importance of it. First of all, the place of hydrocarbons have to be determined during geological and geophysical stages. In fact, although these stages help to get information about petroleum places, the only way to make sure about presence of hydrocarbon is drilling<sup>2</sup>. When a well is drilled, layers can be studied to get required information. In turn, it requires high technology.

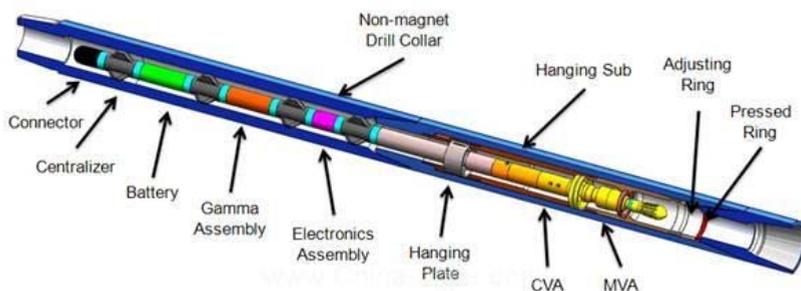
In 1927, Marcel and Conrad Schlumberger invented the first well log which was used in Pechelbronn field in Alsace, France<sup>3</sup>. Today, well logging became one of the major parts of Drilling Engineering. Therefore, there is regular upgradation in this system. This system is used for gaining information in drilling process. First logging tools were used as separate system which required pause in drilling process to be run. In fact, after the mid-twentieth century, new period began for logging and measurement system, when Measurement While Drilling (MWD) and Logging While Drilling (LWD) tools were introduced to Petroleum Industry. Schematic view of MWD tool has been shown below:

---

<sup>1</sup> <http://www.ranken-energy.com/products%20from%20petroleum.htm>

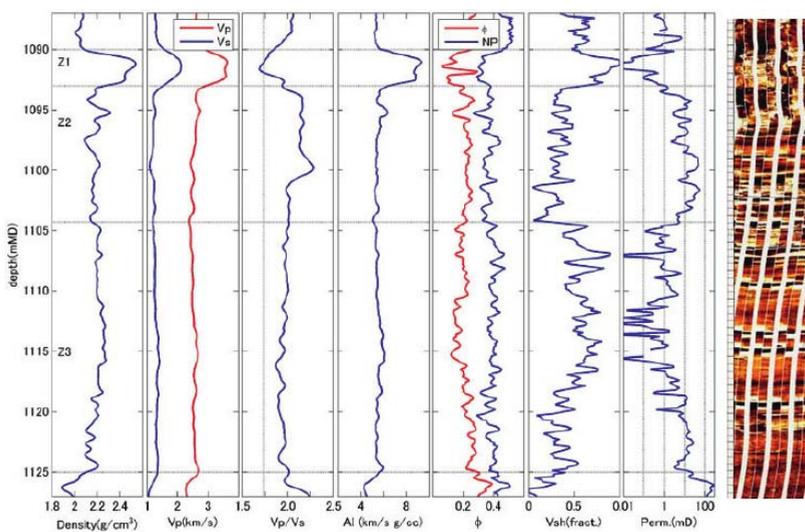
<sup>2</sup> Introduction to Petroleum Engineering, Heriot Watt University

<sup>3</sup> Introduction to Wireline Logging, Mark A. Anderson



## Working Principles

Special magnetometers and accelerometers are used in MWD system for measuring orientation of tool where magnetic and gravitational effects of the Earth are used for this operation. Gained information is changed to wellbore direction and inclination by a surface system<sup>4</sup>. In LWD system, measurement results can be sent to the surface with special systems, usually with drilling mud pulser. As it happens when the tool is in the well, this information is mentioned as real time data<sup>5</sup>. Finally, observed data is presented in special graphical form:



Taken from: [http://logging-tool.en.china-ogpe.com/html/product\\_Measurement\\_While\\_Drilling\\_12\\_21824.html](http://logging-tool.en.china-ogpe.com/html/product_Measurement_While_Drilling_12_21824.html)

<sup>4</sup> Formation Evaluation, Heriot Watt University

<sup>5</sup> [https://en.wikipedia.org/wiki/Logging\\_while\\_drilling](https://en.wikipedia.org/wiki/Logging_while_drilling)

Logging tools can give number of parameters including porosity, density, resistivity and other depth measurements. Each trend on picture shown above, demonstrates different parameters.

### **Advantages**

- Real time Data;
- Time reduction;
- Capability of working in inclined wells;
- Information about deflection tool;
- Availability when it is difficult to gain information via wireline logging;

Generally, LWD and MWD systems are called Formation Evaluation While Drilling (FEWD) systems<sup>6</sup> and are considered to be vitally important for Petroleum Engineering Industry.

## **DYNAMIC REACTIONS ON THE AXIS OF A ROTATING BODY. DYNAMIC BALANCING OF MASSES**

**Mahsati Hasanova**

*engineer.hasanova@gmail.com*

**Supervisor: prof. Fuad Veliyev**

In this scientific topic, Dynamic Reactions on supports of rotational body are going to be analyzed in-depth. It is important to focus on because if the rotational rigid body is not designed in accordance with the requirements, there would exist destructive reaction forces on supports that are much greater than body's weight. First of all, the body's center of mass must lie on its axis of rotation, and secondly, the axis of rotation should be the principal axis of inertia of the body.

---

<sup>6</sup> Formation Evaluation, Heriot Watt University

Let's consider a rigid body rotating uniformly with an angular velocity  $\omega$  about an axle mounted in bearing A and B (see Figure 1). Let us determine the dynamic pressures  $X_A, Y_A, Z_A, X_B, Y_B$  exerted by the bearing on the axle. Let a set of given forces  $p_1^{ext}, p_2^{ext}, \dots, p_n^{ext}$  be acting on the body, and denote the projections of their principal vector on the coordinate axes  $A_{xyz}$  rotating together with the body by the symbols  $R_x^{ext}, R_y^{ext}, R_z^{ext}$  and their principal moments with respect to the axes by the symbols  $M_x^{ext}, M_y^{ext}, M_z^{ext}$ . As the body is rotating uniformly,  $M_z^{ext} = 0$ . To determine the required reactions, apply D'Alembert's principle and, adding the respective inertia forces to the forces acting on all the points of the body. As a result, five equations arise.

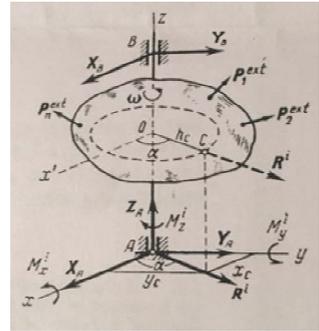


Figure 1

$$\left. \begin{aligned} X_A + X_B + R_x^{ext} + R_x^i &= 0, \\ Y_A + Y_B + R_y^{ext} + R_y^i &= 0, \\ Z_A + R_z^{ext} + R_z^i &= 0, \\ -Y_B b + M_x^{ext} + M_x^i &= 0, \\ X_B b + M_y^{ext} + M_y^i &= 0. \end{aligned} \right\} \quad (1)$$

By considering five above equations, as a consequence, these equations are obtained:

$$\left. \begin{aligned} X_A + X_B &= -R_x^{ext} - M_x c \omega^2, & Y_A + Y_B &= -R_y^{ext} - M_y c \omega^2, \\ Z_A &= -R_z^{ext}, & X_B b &= -M_y^{ext} - J_{xy} \omega^2, & Y_B b &= M_x^{ext} - J_{yz} \omega^2. \end{aligned} \right\} \quad (2)$$

Above equations (2) specify the *dynamic reactions* acting on the axle of a uniformly rotating rigid body, when axis  $O_z$  is taken coincident with the axle.

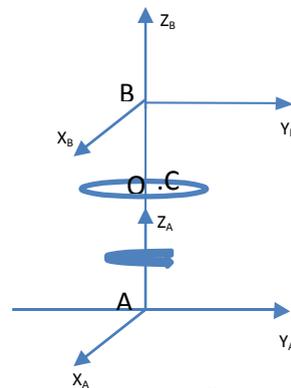
It is apparent from equations (2) that in below conditions, the rotation does not affect the reactions of bearings A and B.

$$\begin{aligned} x_c &= 0, & y_c &= 0, \\ J_{xz} &= 0, & J_{yz} &= 0. \end{aligned}$$

The *dynamic balancing of masses* is an important engineering problem that involves the determination of the principal central axes of inertia of a body. Any axis passing through a body can be made a principal central axis of inertia by adding two point masses to the body. This method is widely used in engineering for balancing crank-shafts, cranks, coupling rods. Final balancing is done on special balancing machines. (Targ, 1976)

There were solved next two problems to express the importance of taking into consideration the role of dynamic reactions.

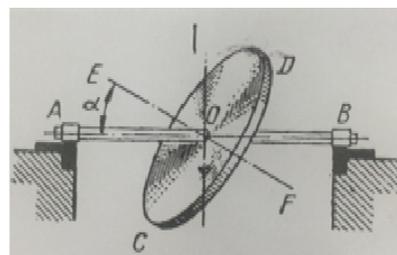
**Problem 1:** The axis of rotation of a disc is perpendicular to the plane of the disc (see Figure 2). The disc weight is 2000 N and its frequency is 6000 rpm. Determine the dynamic reactions of bearings A and B if  $OA=OB=0.5$  m, and the center of mass of the disc is located at a distance  $OC=0.5$  mm from the axis!



**Figure 2:**

**Note:** After solving the problem, it is shown that reaction forces,  $Y_B=20122$ N,  $Y_A=20120$  N, are ten times more than the weight of the disc. Therefore, only 0.5 mm distance may cause to damage supports of the body.

**Problem 2:** A thin homogenous circular disc CD of a steam turbine which rotates about the axle AB passing through the center of gravity O of the disc. Due to improper boring of the bushing the axle AB makes an angle  $AOE=0.02$  radian with the perpendicular to the plane of the disc! The other data



**Figure 3:**

are as follows: the weight of the disc is 32.7 N and its radius is 20 cm, the speed of rotation is 30,000 rpm,  $OB=30$  cm, the axle AB is absolutely rigid. Determine the pressures on the bearing A and B (see Figure 3).

**Note:** The dynamic reactions on the bearings caused by the rotation of the disc are equal value will be 8220 N – **it is 250 times greater that force of gravity!**

**Bibliography**

- Targ, S., 1976. *Theoretical Mechanics a short course*. s.l.:English Translation Mir. Publuser.

## **GYROSCOPE AND ITS APPLICATIONS**

**Allakhverdi Muradov**

[muradov.alekz@gmail.com](mailto:muradov.alekz@gmail.com)

**Supervisor: Fuad Valiyev**

### **Introduction**

A gyroscope is a turning disc or wheel in which the rotation axis doesn't need to assume any inclination. While whirling, in accordance with conservation of angular momentum, the inclination of this axis is uninfluenced by rotation or tilting of the mounting. Along these lines, gyroscopes are valuable for quantifying or preserve orientation. The working principle of a gyroscope could be most efficiently perceived by observing the front wheel of a bike. On the off chance that the wheel is inclined far from the vertical so that the highest point of the wheel moves to one side, the forward rim of the wheel likewise swings to one side. As it were, whirling on one axis of the spinning wheel causes whirling of the third axis.

### **Applications of gyroscope**

Gyroscopes play an important role in industry. They have been used in construction and improvement of a wide range of devices, for example, computer pointing devices, racing cars, motor bikes, spinning tops, gyrocompasses, robotics and etc.

There are various computer pointing devices (for example a mouse) available that have gyroscopes inside them and when the device is in the air the gyroscopes enable you to manage the mouse cursor.

Gyroscopic behavior is utilized as a part of the racing car industry. This is on account of that auto motors act simply like huge gyroscopes. In view of the of the gyroscopic forces from the motor contingent upon whether the motor is turning anti-clockwise or clockwise the autos nose will be constrained down or up. Giving the motor spins in the correct heading it can help the auto to remain on the track.

Motorbike wheels move as gyroscopes and make the bike less demanding to adjust (remain right) while moving.

One of the basic types of gyroscopes are spinning tops, because of its gyroscopic behavior as the spinning top is pivoted it can stand up correctly without falling over.

Gyrocompasses are fundamentally navigation aids. Gyroscopes don't prefer to alter course, so on the off chance that they are mounted into a gadget that permits them to act freely. At that point when the gadget is moved in various routes the gyroscope will still keep its initial direction. Gyroscopes are also utilized to help complex robots stay up right which generally fall over.

### **Ideas how to use gyroscopes in the future**

Scientists think to use gyroscopes in the construction new transportation means in the future. This futuristic transportation idea was intended to provide the urban commuter with a totally new and interesting driving experience. These transportation means will have only two wheels, a



glass-dome cabin being self-adjusting and commuters will be able to control them easily with a joystick rather than a steering wheel.

## **Conclusion**

Taking into account all considerations above, gyroscopes are one of the most important part of industry being utilized in the construction of devices and their parts from mouse to aircraft (for instance attitude and heading indicators). However, scientists should think to use gyroscopes to develop new devices which can be more advantageous for people since gyroscopes have their uniquely useful features.

## **References:**

1. <http://www.gyroscopes.org/uses.asp>
2. <http://www.yankodesign.com/2012/03/28/gyroscopic-transportation-of-the-future/>
3. <http://science.howstuffworks.com/gyroscope3.htm>

# **REDUCING MISCIBILITY PRESSURE FOR CO<sub>2</sub> FLOODING**

**Kamal Omarov**

*[kamal210797@gmail.com](mailto:kamal210797@gmail.com)*

**Supervisor: Farad Kamyabi**

## **Introduction**

Increasing amount of residual oil accelerates the development of different techniques for oil recovery. Generally, oil recovery comprises 3 main steps. Primary and secondary recovery methods can only extract 1/3 of Original Oil in Place and this is main reason why a lot of EOR projects come on stream. Nowadays, 3% of worldwide production benefits from EOR. It is divided into thermal and non-thermal recovery. In thermal recovery, heat is introduced to reservoir to reduce viscosity and mobility while in non –thermal some chemical is added to water content to optimize its property. The second non-thermal method is gas flooding. This method is appropriate for low permeability and light-hydrocarbon containing reservoir. Since its first

usage, this method manages to increase 10-20% recovery. Most common flooded gas is CO<sub>2</sub>. First reason is its abundant sources. By separating the CO<sub>2</sub> from air and applying to EOR, this method doubles its benefits and become economical to use till the oil price of even 20\$ per barrel. It is generally accepted that 80% worldwide reservoirs are qualified for CO<sub>2</sub> flooding. Additionally, this is so convenient to transport and inject to reservoir.

**CO<sub>2</sub> flooding.** This gas flooding has 2 main branches, miscible and immiscible. When two fluids mix and exist in one phase together, they are called miscible fluids. Comparing to other fluid, CO<sub>2</sub> is more soluble in the oil and this factor also explains why CO<sub>2</sub> is the best choice. Main objectives of miscible flooding are to reduce oil viscosity, condensing or vaporization some components of oil and reduce IFT. For miscible flooding, the term Minimum Miscibility Pressure is important. This a minimum value of IFT and pressure at which CO<sub>2</sub> and oil becomes completely miscible. MMP is a function of temperature and oil composition only. It directly proportional to temperature.

**Reducing MMP.** To conduct miscible CO<sub>2</sub> flooding, it is favorable to have lower miscibility pressure. The more pressure gap between reservoir fracture and miscibility the more applicable CO<sub>2</sub> flooding. There are also cases in which reservoir pressure exceeds the MMP and it can be considered as best choice for miscible gas flooding. In order for MMP to be far from fracture pressure, different kinds of techniques are used to minimize it.

First method is addition of oleophilic chemicals. Apart from oleophilic chemicals, carboxyl acid, alcohols and ketones can also be used. These chemicals are soluble with both CO<sub>2</sub> and hydrocarbons because of polar structure. The molecule of oleophilic chemicals is polar, while CO<sub>2</sub> and hydrocarbons are non-polar. To experimentally observe their effect, the method of vanishing interfacial tension and slim-tube test is conducted. In VIT, the IFT among CO<sub>2</sub>, hydrocarbon and oleophilic chemicals is measured in different pressures till it

becomes minimum. In slim-tube experiment, crude oil is pumped into core and displaced by injected CO<sub>2</sub> with different pressure measuring recovery factor for each step.

Main chemical compound of second method is Fatty Acid Methyl Ester derived from the process of fatty acid trans esterification. Injection of 10% slug of FAME lead to 15% reduction of MMP. Depletion of non-renewable chemical sources leads to increase of its usage. Also, this chemical is biodegradable, non-toxic and environmentally safe. Feedstock for FAME is rubber seed.

**References:**

1. *Carbon Capture and Storage from Fossil Fuel Use.* **Golomb, Howard Herzog and Dan.** Massachusetts Institute of Technology Laboratory for Energy and the Environment.
2. *CO2 miscible flooding application and screening criteria.* **Yin, Mingfei. 2015.** 2015. SCIENCE AND Degree MASTER OF SCIENCE PETROLEUM ENGINEERING.
3. *Reduction of MMP Using Oleophilic Chemicals .* **C. L. Voon, M. Awang. 2014.** 2014. International Scholarly and Scientific Research & Innovation.

## **MATHEMATICAL CONSTANT Π(PI)**

**Pakiza Pashayeva**

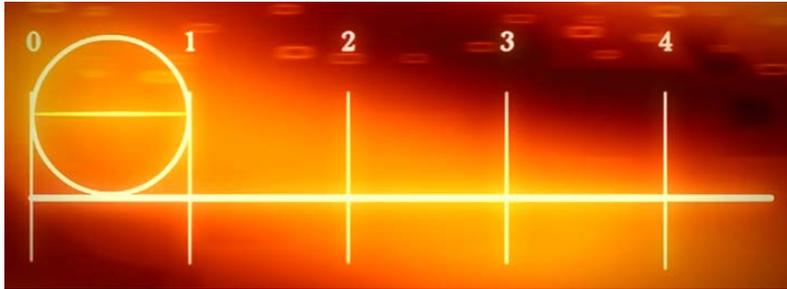
[pakizapashayeva@gmail.com](mailto:pakizapashayeva@gmail.com)

**Supervisor: Assoc. Prof. Khanum Jafarova**

π is usually shown like the ratio of a C (circle's circumference) to its d (diameter):

$$\pi = \frac{C}{d}$$

The ratio - C/d is const., regardless to circle's dimension.



$\pi$  is an irrational amount, so that it can not be written like ratio of two integers (for example, such as  $(22 / 7)$  are usually utilized to approaching  $\pi$ , but no shared fragment (ratio of total quantities) can be its precise quantity).

$\pi$  is - irrational, it has an infinite quantity of figures in its own decimal representing, and it doesnot arrange into an limitlessly repetitive model of figures. There are some substantions that,  $\pi$  is irrational; they comonly demand calculus and also lean on “reductio ad absurdum” method. The degree to that pi can be approached by rational quantities (named irrationality gauge) is not unknown; opinions have founded that the irrationality gaugement is bigger than the calculation of e or  $\ln(2)$  however little than calculation of Liouville quantities.

The ancient scienstists calculated pi via this formula,

$$A = (8*d/9)^2$$

Where **d** is the diameter and they got pi is equal to 3.16.

Sometimes pi is refered to Archimed’s constent. Archimed said that pis is the between

$$3\frac{10}{71} < \pi < 3\frac{1}{7}$$

This is the approximate value of 3.14.



Ptolemy utilized Archimed's method and improved it, so he find more clear answers for pi that was 3.1416.

Francois Viète made significant improvements to Archimed's method.

$$\frac{2}{\pi} = \frac{\sqrt{2}}{2} \cdot \frac{\sqrt{2+\sqrt{2}}}{2} \cdot \frac{\sqrt{2+\sqrt{2+\sqrt{2}}}}{2} \dots$$

It was first analatical expression for pi: involving infinite submissions and products. Finding calculus, it improved mathematical issueses about pi. So it improved infinite series in a way of pi.

Sir Isaac Newton derived the formula

In 1965, John Wallis published Opera Mathematica which first intoruced continued fraction.

$$\pi = \frac{4}{1 + \frac{1^2}{2 + \frac{3^2}{2 + \frac{5^2}{2 + \frac{7^2}{2 + \frac{9^2}{2 + \dots}}}}}} = 3 + \frac{1^2}{6 + \frac{3^2}{6 + \frac{5^2}{6 + \frac{7^2}{6 + \frac{9^2}{6 + \dots}}}}} = \frac{4}{1 + \frac{1^2}{3 + \frac{2^2}{5 + \frac{3^2}{7 + \frac{4^2}{9 + \dots}}}}}$$

He also showed that:

$$\frac{\pi}{2} = \frac{2}{1} \cdot \frac{2}{3} \cdot \frac{4}{3} \cdot \frac{4}{5} \cdot \frac{6}{5} \cdot \frac{6}{7} \cdot \frac{8}{7} \cdot \frac{8}{9} \dots$$

In 1949, Jon von Neuman dissueded that put his knowledge in computer to a test for the first time history. He was the first person compute pi using the computer. This was a complished in ENIAC computer, whic approximated 2037 digits of pi.

The decimal expression of pi is

$$\pi = 3.141592653589793238462643383279502884197 \dots$$

In today's world the best computers have calculated only 13,3 trillion numbers after comma. Till now the exact value of pi is unknown. In below picture I will show the 12.1 trillion digits of pi after comma (3, ...)

3.									
1415926535	8979323846	2643383279	5028841971	6939937510	: 50				
5820974944	5923078164	0628620899	8628034825	3421170679	: 100				
2597691971	6538537682	7963082950	0909387733	3987211875	: 4,999,999,999,950				
6399906735	0873400641	7497120374	4023826421	9484283852	: 5,000,000,000,000				
0874753286	1800417105	0417234177	3440660835	6303291247	: 5,000,000,000,050				
0494788787	3350953767	0283816394	7603993291	8259328455	: 5,000,000,000,100				
9544408882	6291921295	9268257225	1615742394	7483010753	: 9,999,999,999,950				
9804871001	5982157822	2070871138	6966940952	1989228675	: 10,000,000,000,000				
4392476662	7656619000	2124460557	5531593458	4820611421	: 10,000,000,000,050				
7774158802	8607364081	0882791485	3424578359	2017915623	: 10,999,999,999,950				
9022892022	4547999448	8759918307	1538211154	9129857424	: 11,000,000,000,000				
8850838032	0621312483	8327044318	1257233570	9958940293	: 11,000,000,000,050				
0225990312	0715120901	2625933350	2113726804	5410547637	: 11,999,999,999,950				
9229203002	7190437071	4461941152	9088219512	2780551965	: 12,000,000,000,000				
6281443745	8325315851	4346900240	7029751021	5197388736	: 12,000,000,000,050				
2323632519	7260136778	4244176022	7323590892	5620919959	: 12,099,999,999,950				
6850993485	4514351158	7381100302	4015062599	1743930275	: 12,100,000,000,000				
2840983997	4140672353	4319030217	7521257272	1740258075	: 12,100,000,000,050				

### Reference:

- <https://en.wikipedia.org/wiki/Pi>
- [https://en.wikipedia.org/wiki/Mathematical\\_constant](https://en.wikipedia.org/wiki/Mathematical_constant)
- <http://www.livescience.com/29197-what-is-pi.html>
- <http://mathworld.wolfram.com/Pi.html>
- <https://www.angio.net/pi/whypi.html>

## RESONANT VIBRATION ANALYSIS

Humay Hamidli

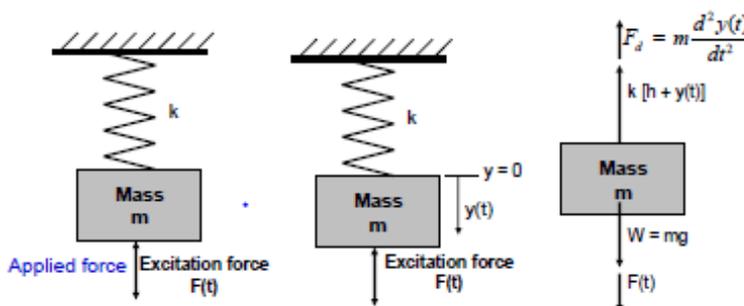
[humayhamidli@gmail.com](mailto:humayhamidli@gmail.com)

Supervisor: Assoc. Prof. Khanum Jafarova

### 1. Introduction

In this work, resonant vibration analysis which is crucial engineering analysis will be studied. Mechanical resonance is the phenomenon occurs when an external force vibrates similarly to the natural frequency of vibrating system at the same frequency. As a result of the resonance vibration of structure, the amplitudes of the oscillating motion enlarge in brief time, leading to the failure of overall structure. The phenomenon was first analyzed in acoustical systems. Resonance analysis is utilized for rising the intensity of sounds. One of the main concerns in the construction of buildings, bridges and towers is to prevent resonance catastrophes. The destruction of the Tacoma Narrows Bridge was caused by resonance phenomenon in USA in 1940. Devices such as motors and compressors can create vibrations during operation. In order to reduce vibration, these are equipped with products which work with natural frequency close their running speed. Electric resonance analysis finds its application in tuning of radios and television.

### 2. Theory



Picture 2.1 Simple string-mass model

The differential equation of the amplitudes of the mass affected by  $F(t)$  force:

$$\frac{d^2y(t)}{dt^2} + \omega_0^2 y(t) = \frac{F_0}{m} \cos(\omega t) \quad (2.1)$$

Mathematical part of the analysis:

(2.1) equation is a non-homogeneous second order DE.

$$y(t) = y_{cf}(t) + y_{pi}(t) \quad (2.2)$$

Complementary solution:

$$y_{cf}(t) = c_1 \cos(\omega_0 t) + c_2 \sin(\omega_0 t)$$

Particular solution:

$$y_{pi}(t) = \frac{F_0}{m(-\omega^2 + \omega_0^2)} \cos(\omega t)$$

The general solution of DE:

$$y(t) = c_1 \cos(\omega_0 t) + c_2 \sin(\omega_0 t) + \frac{F_0}{m(-\omega^2 + \omega_0^2)} \quad (2.3)$$

The resonance vibration is encountered when  $\omega = \omega_0$

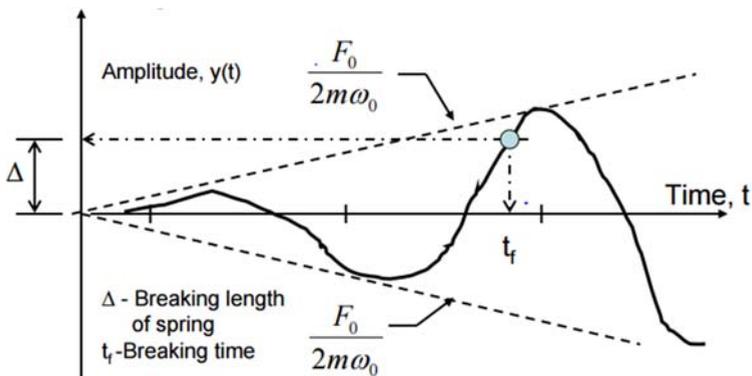
Non-homogeneous DE is solved by assuming:

$$y_{pi}(t) = (A_1 \cos(\omega_0 t) + A_2 \sin(\omega_0 t))t$$

$$A_1=0; \quad A_2 = \frac{F_0}{2m\omega_0}; \quad y_{pi}(t) = \frac{F_0}{2m\omega_0} t \sin(\omega_0 t)$$

Finally, the amplitude of the mass under resonance vibration is expressed as:

$$y(t) = c_1 \cos(\omega_0 t) + c_2 \sin(\omega_0 t) + \frac{F_0}{2m\omega_0} t \sin(\omega_0 t) \quad (2.4)$$



**Picture 2.2.** Graphical demonstration of the amplitude change.

As it is shown on the picture below, the amplitude of resonant vibration increases significantly with time.

### 3. Conclusion

Studying resonant vibrations has a great importance in engineering designing, construction and creating acoustic systems and so on. In this work, resonance phenomenon and the mathematical method of understanding the theory of resonances will be examined, its calamitous causes, precautions and methods for avoiding hazardous resonances will be emphasized.

### References

1. "Application of second order differential equations in mechanical engineering analysis", Tai-Ran Hsu
2. "Theory of vibration with applications", William T Thomson, 2008.

## **NEWTON'S LAW OF COOLING**

**Javid Zeynalov**

*[cavidzeynalov7@mail.ru](mailto:cavidzeynalov7@mail.ru)*

**Supervisor: Assoc. Prof. Khanum Jafarova**

### Introduction

The famous English mathematician Sir Isaac Newton made an equation to compute the temperature of an object as it loses heat. He created the heat-transfer version of the law which is known as Newton's Law of Cooling and this regulation declares that the rate of change of temperature has to be corresponding to distinction in the range of its own and ambient temperature. Thus, Newton's law of cooling is defined in mathematical terms as following.

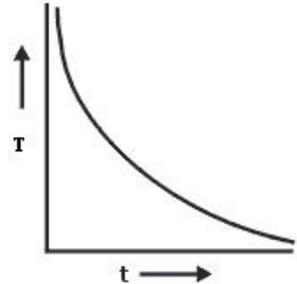
$$\frac{dT}{dt} = -k(T - T_a), \quad T(0) = T_0$$

### **Main body**

In above formula a positive proportionality constant,  $k$  and the ambient temperature of the environment,  $T_a$ , are constants. By using the separation of variables and integrating factor method the initial value problem is solved and obtained under formulae.

$$T = T_a + (T_0 - T_a)e^{-kt}$$

From the equation it is apparent that when time increases, temperature of the body declines correspondingly and the appropriate portion of graph is represented below and is called “cooling curve”.



This module of law is the main prerequisite for the vast decrease after some time which might be connected with numerous trend known for the release of the rot in radioactivity and a capacitor, which are widely relevant for science and engineering. Also, Newton's Law of Cooling is valuable for examining water warming since it is able to reveal to us how quick the boiling point water in funnels chills. One of the major known application of it is correlated with about how quick a dilute radiator chills if you switch off the breaker when you leave for holiday.

To better comprehend Newton's law of cooling, the simple experiment was carried out and applied to the hot tea.

### **Example of Newton's law of cooling:**

The experiment was conducted and as it observed the initial temperature of hot tea was  $T_0 = 65^\circ\text{C}$ . After 7 minutes the temperature of the tea constituted  $52^\circ\text{C}$  merely, also it was defined the temperature of environment was  $23^\circ\text{C}$ . Compute the required time, when hot tea is assumed that to be drinkable. It is liked the tea is drunk at  $40^\circ\text{C}$ .

The above problem according to Newton's law of cooling can be solved easily.

$$52 = 23 + (65 - 23)e^{-7k}$$

$$e^{-7k} = 0.69$$

Taking logarithm of both sides

$$-7k = \ln 0.69 \Rightarrow k = 0.053$$

After finding the value of k our equation becomes

$$T = 23 + (65 - 23)e^{-0.053t}$$

Substituting  $T = 40^{\circ}\text{C}$  into the formula above I get that  $t = 17 \text{ min.}$

Now, we say that at  $23^{\circ}\text{C}$  room temperature the hot tea can be drunk after 17 minutes in that its temperature will decrease to  $40^{\circ}\text{C}$  within this period.

### Conclusion

By way of conclusion, Newton's Law of Cooling has made huge impact on heat transfer, it allows us to estimate to what extent it takes a hot body chill off at a specific temperature.

### References

- <http://www.ugrad.math.ubc.ca/coursedoc/math100/notes/diffeqs/cool.html>
- <http://vlab.amrita.edu/?sub=1&brch=194&sim=354&cnt=1>

## BERNOULLI'S PRINCIPLE

**Amir Namazov**

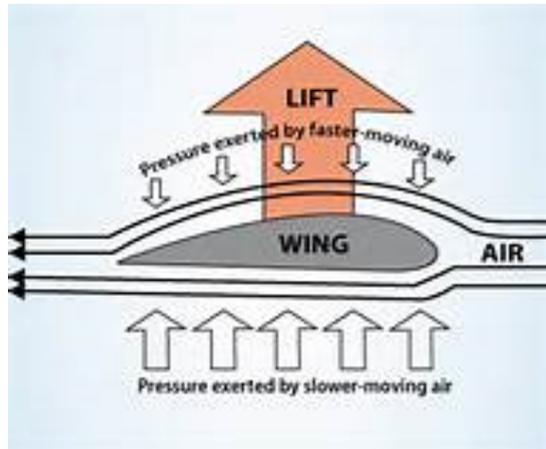
[amirnamazov3@gmail.com](mailto:amirnamazov3@gmail.com)

**Supervisor: Fuad Valiyev**

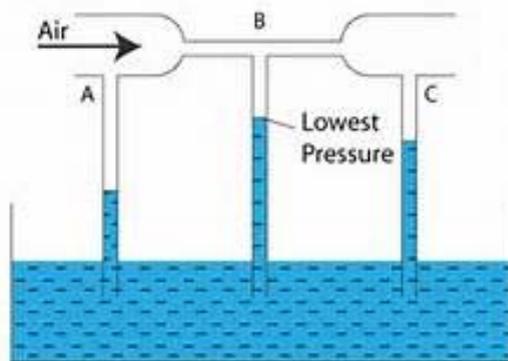
Generally, mechanics plays a great part in our life, and applications of different branches of mechanics may be observed in our daily life, such as working principle of many mechanisms. Frequently, many types of motions are come across in nature, and there are adequate factors causing those motions. Changes occurring in nature are based on diverse principles, and one of the most *common* principles of interest is **Bernoulli's law**.

What is the concept of Bernoulli's principle? What makes it so imperative for our life? This principle states that in motion of a fluid, there is an inverse relationship between its velocity and pressure. It is meant that the faster a fluid, the lower it exerts pressure. Bernoulli's law is applied in some areas, such as flight. The figure below explains this phenomenon more clearly. As the top of the wing is curved and the bottom is flat, air moves a longer distance at the top rather than the bottom at the same time. Therefore, air moves faster at the top

than at the bottom, and since it generates higher pressure at the bottom than at the top, the wing is able to fly up. Another sample to demonstrate Bernoulli's law can be flow through a pipeline as described in the figure below. So, as a fluid flows faster through narrow tubes rather than wide tubes, the



pressure is exerted less strongly in narrow parts than in wide parts. Bernoulli's principle can be compared with conservation of energy law as well. As we know, in many systems, the total energy is comprised of potential and kinetic energy, and as one of them decreases, the other increases or vice versa, but the total energy is conserved (small energy conversions are theoretically ignored).



As mentioned before, the application of Bernoulli's principle is sufficiently great, such as flying machines, flow of fluids within piping,

atomizers, chimneys etc. It would be a worth to mention the working principle of atomizers and chimneys. So, inside atomizers (sprayers or perfume cans) there are liquid and gas (normally air), and since air moves more slowly than liquid inside a can, it possesses stronger pressure than the liquid. That's why air is capable of lifting the liquid up through a narrow tube whose one end is near the bottom of the can and another end is combined with a small squeeze pump which is at the top of the can. Once the pump has been pushed, immediately a small amount of air compressed between the pump and liquid and a certain amount of liquid itself is quickly sprayed out just for a moment. The difference that the perfume gives an instant spray while the aerosol is able to give a permanent spray is due to the fact that air of relatively high pressure is pumped into an aerosol can. As regards chimneys, since air outside is faster than that inside a home, air inside has greater pressure again according to Bernoulli's law. Hence, air inside a home tends to move up outside where pressure is comparatively lower, and this is why air inside the home is sucked outside faster in windy days.

In short, the essence and major applications of Bernoulli's principle were mentioned above. A couple of small experiments related to Bernoulli's principle are going to be demonstrated during the conference.

### **References**

1. <http://www.scienceclarified.com/everyday/Real-Life-Chemistry-Vol-3/Bernoullis-Principle.html>
2. <https://www.britannica.com/science/Bernoullis-theorem>
3. <http://mitchellscience.net/Physics/BernoulliPrinciple>

## **HARNESSING HIGH-ALTITUDE WIND POWER**

**Huseyn Aliyev**

*aliyevhuseyn6@gmail.com*

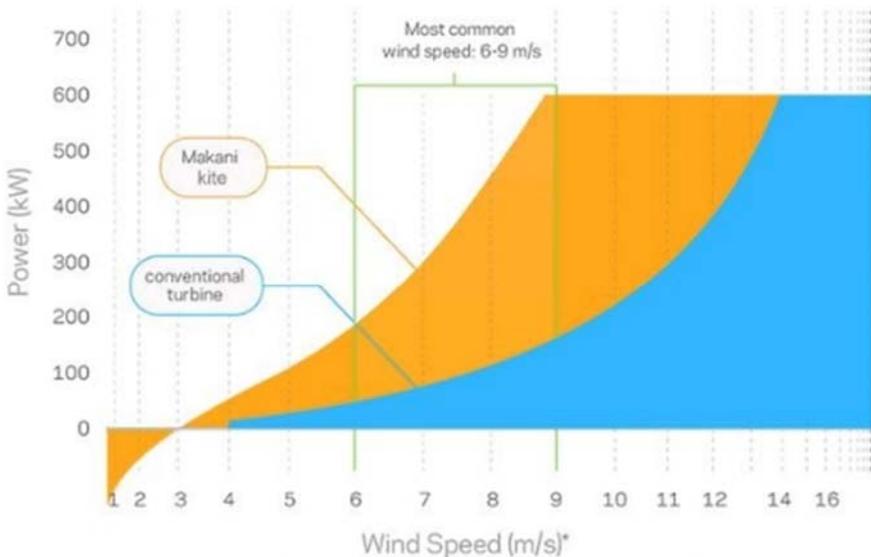
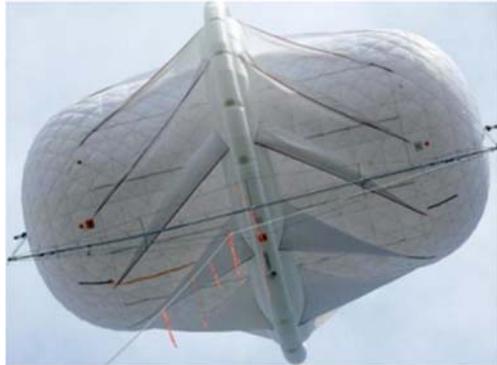
**Supervisor: Prof. Siyavush Azakov**

Nowadays, there is one of the global issues related with the rising energy demands of the developing countries. Subsequently, our mankind can confront with unavoidable climate change, which can be considered as one of the main results of fossil fuel (oil, gas, coal) usage. Thus, the application of renewable sources of energy is one of the possible ways to reduce the usage of fossil fuels and concentration of greenhouse gases in the atmosphere. According to the observations, wind energy can be considered as one of the main type of renewable energy sources which can somehow fulfil current energy demands. However, convenient wind turbines that are widely applied in the various countries have its own economical and technological limits. Consequently, new design of wind generator can be observed in order to get more energy from high altitude. This thesis is written in order to describe the design of the new generation wind turbines and to observe its working principle. Different possible concepts for innovative type of wind power generator were proposed throughout several years. However, the kite power system was considered as one of the most suitable for generator's design.

### **Concept for extracting high altitude wind energy.**

First of all, new generation wind turbines are categorized according to the location of the electrical generator. Thus, there are two main concepts for wind turbines known as "flygen" concept and "groundgen" concept.

In the “flygen” concept electrical energy is being transmitted to the ground via conductive tethers. Magenn Air Rotor System is one of the best examples of “flygen” concept<sup>[1]</sup>. According to this concept helium filled balloon is rotating around horizontal axis at the height of approximately 200 m to 350 m. One of the main differences of this concept is “Magnus effect”, due to which the whole system is stabilized and its position is restricted within defined location. Moreover, another outstanding example of the “flygen” concept was proposed by Joby Energy and Makani Power. Due to the high tangential speed of the blade, suggested model is responsible for approximately 80% of the accumulated energy. These turbines are proceeding mostly at the height of about 250 and 600 meters where wind is more powerful.



According to the “groundgen” concept, the electric generator is located at the ground level and connected to the relevant rotating

mechanism. The main advantage of this mechanism is that main heavy components such as generator and others are located on the ground and enable the kite power to rotate more freely and achieve high performance. Furthermore, the flight is regulated by means of the advanced computer technology. This system manipulates over the aerodynamic surfaces on the wings and controls the speed of the rotor.

### **Costs and material of high altitude wind power.**

Abovementioned technology has some difficulties related with the material properties which should be appropriate in order to enable kite to proceed at high altitude. Generally, it is deduced that material should be ultra-light type and also have high strength with being corrosion-resistant<sup>[2]</sup>. Taking into account the costs for the new generation wind turbines, it is preferable to make a comparison in the following way: a medium sized kite generates approximately maximum power of 21 kW. For comparison, convenient wind turbine, accumulating the same power, weighs about 6 tons and costs in the range of 70,000-90,000 euro, while the mass and the cost of the objected flying wind turbine is approximately 1 ton and 20,000 euro respectively<sup>[3]</sup>.

All in all, described technology for harnessing of the high altitude wind power can be successfully applied in developing countries, especially in farms, remote areas, oil and gas wells etc. New technology is a mobile power generating system which creates a reliable medium of getting wind energy in effective way at high altitude.

### **References:**

- [1] Lorenzo Fagiano. "Control of Tethered Airfoils for High-Altitude Wind Energy Generation". PhD dissertation, Politecnico di Torino, Italy, February 2009.
- [2] Imran Aziz "Design high altitude wind power generation system" (2013).
- [3] Dr. Roland Schmehl. "Kiting for Wind Power". Wind Systems, No. 7, pp. 36-43, 2012

## VIBRATIONS IN CO<sub>2</sub> MOLECULES: COUPLED OSCILLATORS

Ellada Isazade

[elladaisazade1997@mail.ru](mailto:elladaisazade1997@mail.ru)

Supervisor: Assoc. Dr. Khanum Ceferova

### 1. Introduction

[1] The vibrations in molecules are known as a crucial fingerprints which have a great importance in the identification of liquid and gas content by means of spectroscopy. The electromagnetic radiation in another words light is absorbed in the cases when oscillation frequency of molecular vibration of any substance or compound matches with that of electromagnetic radiation. In order to determine the frequency of electromagnetic radiation absorbed, this parameter is found for molecules which are present in the atmosphere. Due to specific structure and properties water and carbon dioxide molecules have capacity to absorb the main part of electromagnetic spectrum, they are known as a good absorbers of the infrared radiation, especially around 15  $\mu\text{m}$ . In fact, the main contributing factor to the global warming is increasing the concentration of carbon dioxide in the atmosphere which causes the increase in the absorption of electromagnetic radiation (light). Therefore, it is important to investigate and determine characteristic frequencies in the vibration of CO<sub>2</sub> molecules.

### 2. Theory

[2] To describe the vibrational motion and evaluate vibration frequencies the general model of molecule must

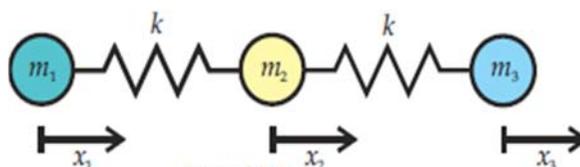


Figure 2.1.

be considered. Obviously, the figure 2.1 illustrates the three masses (indicated as  $m_1$ ,  $m_2$  and  $m_3$ ) which are connected by means of two

identical springs with constant  $k$ . The masses are stretched only along the  $x$ -axis, this motion is known as a stretch vibration. By applying the Newton's second law and Hooke's law to the system the equations for the motions of masses can be found.

$$m_1 \frac{d^2x_1}{dt^2} = -k(x_1 - x_2) \quad m_3 \frac{d^2x_3}{dt^2} = -k(x_3 - x_2)$$

$$m_2 \frac{d^2x_2}{dt^2} = -k(x_2 - x_1) - k(x_2 - x_3)$$

$\frac{d^2x}{dt^2}$  indicates the acceleration of moving object. If all masses oscillate with the same frequency the equations for displacement of objects can be represented as:

$$x_i(t) = A_i \cos(\omega t) + B_i \sin(\omega t) \quad \frac{d^2x_i}{dt^2} = -\omega^2 x_i$$

By dividing the both sides by mass ( $m$ ) and substituting obtained equations for acceleration the system of equations can be represented in the matrix form in the following way.

$$\omega^2 \begin{bmatrix} x_1 \\ x_2 \\ x_3 \end{bmatrix} = k \begin{bmatrix} \frac{1}{m_1} & -\frac{1}{m_1} & 0 \\ -\frac{1}{m_2} & \frac{2}{m_2} & -\frac{1}{m_2} \\ 0 & -\frac{1}{m_3} & \frac{1}{m_3} \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \\ x_3 \end{bmatrix}$$

For CO<sub>2</sub>  $m_1=m_3= m_o$  (oxygen),  $m_2=m_c$  (carbon), by simplifying and replacing  $\lambda = \frac{\omega^2}{k}$  the characteristic parameters are determined as an eigenvalues matrix with mass and spring constant.

$$\begin{bmatrix} \frac{1}{m_o} - \lambda & -\frac{1}{m_o} & 0 \\ -\frac{1}{m_c} & \frac{2}{m_c} - \lambda & -\frac{1}{m_c} \\ 0 & -\frac{1}{m_o} & \frac{1}{m_o} - \lambda \end{bmatrix} = 0$$

By evaluating the determinant of matrix:

$$\lambda(1 - m_o\lambda)(2 * m_o + m_c - \lambda m_c m_o) = 0$$

$$\omega_1 = 0, \omega_2 = \sqrt{\frac{k}{m_o}} \quad \omega_3 = \sqrt{\frac{k(2m_o + m_c)}{m_o m_c}}$$

### 3. Conclusion

Obviously, zero frequency indicates that molecule does not vibrate, it moves to the left or right. The eigenvectors corresponding the second and third frequencies are  $\vec{v}_2 = (1, 0, -1)$ , which depicts that the second mode is symmetric stretch mode (carbon atom is in the fixed position, whereas oxygen atoms move in the opposite directions),  $\vec{v}_3 = (1, -2m_o/m_c, 1)$ , which indicates that the third one is an asymmetric stretch mode in which oxygen atoms moves in the same direction and carbon atom in the opposite direction .

### 4. Reference

- [1] Peter W. Atkins, J.de Paula, Atkins' Physical Chemistry, Chapter 16,7 "Vibrational spectroscopy", Oxford (2002).
- [2] Michel Moller Bech, Morten Lykkegaard Christensen, "Application of Mathematics in Engineering and Science". Aalborg University (2012).

## STUDY OF MODERN METHODS OF CALCULATING THE BASIC CATEGORIES OF WIND POTENTIAL IN AZERBAIJAN

**Ismat Aghayev**

*[ismathaghavev98@gmail.com](mailto:ismathaghavev98@gmail.com)*

**Supervisor: Prof. Siyavush Azakov**

### Introduction

During the 21<sup>st</sup> century, energy consumption of the world has reached its peak and it is increasing at an alarming rate, therefore there should be infinite amount of energy in order to sustain life on our planet in the future. Nowadays, huge amount of energy consumed in the world is not renewable energy thus, we cannot rely on non-renewable energy because it has finite resources. Furthermore, energy produced from fossil fuels is not environmentally friendly

because it leads more CO<sub>2</sub> production which consequently results in environmental problems such as Global Warming or Air Pollution.

What is the Renewable Energy? Energy from the fossils, for example, coal, oil or characteristic gas, is limited – it can't be renewed once it is depleted. However, renewable energy is basically limitless – it does not depend on the amount of energy that is consumed or extracted, the resource of the energy will be maintained. Wind Energy, Solar Energy are well-known examples of renewable energy.

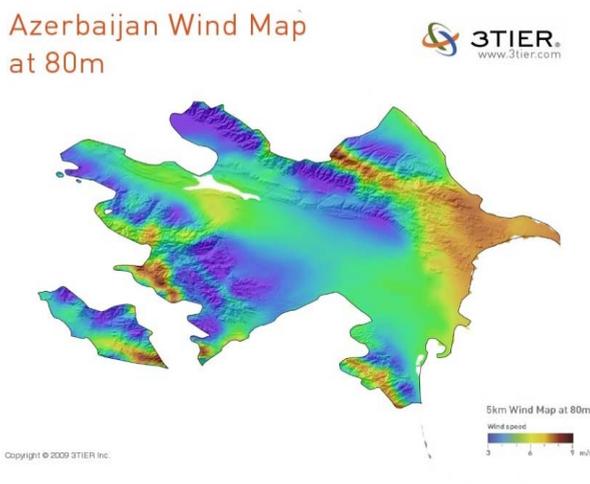
### **Wind Energy**

For identifying the technical resource (electrical energy) which can be generated by the natural wind resource of Azerbaijan or any region, it is important to calculate or find the frequency distribution of the speed of the wind. This data makes it easy to estimate the magnitude of electricity created or produced by a wind turbine throughout a time interval, in most cases annually, therefore, it can be identified whether the project is efficient or not

### **Basic Categories of Wind Potential in Azerbaijan**

Wind is the more suitable energy source among the other types of renewable energy for its cost, being environmentally friendly and having boundless accessibility. Practices demonstrate that many regions in Azerbaijan have very high potential for construction of wind power plants. Evaluations illustrate that Azerbaijan Republic has approximately 800 MW wind power potential because of its geographical position, nature and monetary foundation. This save implies 2.4 billion kilowatt-hours, as per harsh computations. This would suggest the setting aside 1 million tons of restrictive fuel, more vitally, aversion of transmitting huge amount of squanders together with breaking of ozone as a result of production of CO<sub>2</sub>. Long-term researches have demonstrated that appropriate windy condition is highest in Absheron Peninsula, Caspian coasts and islands that are located on the north-west of Caspian. It is attainable to utilize wind power plants with the normal capacitance in Ganja-Dahskesen area, Sharur-Julfa region of Nakhchivan Republic due to fact that the

average speed of wind throughout a single year in those regions ranges from 3 to 5 meter/seconds. Japanese organization Tomen, together with Azerbaijan Scientific-Research Energy and Power Design Institute, had constructed two twist towers with 30 and 40 meter altitudes and confirmed that yearly normal wind speed fluctuates between 7.9 and 8.1 meter/seconds in Absheron. These three organizations had additionally arranged a Feasibility Study for portion of 30 MW wind control plant near Gobustan. Evaluations of renewable energy sources of Azerbaijan was conducted in 2002, it was resolved that Absheron Peninsula has considerably high level of wind power capacity. The mean speed of wind which lasts longer is above the 6 meter/seconds which demonstrates the advantageous specialized monetary potential and requirement for utilizing wind control. According to conducted research, the displayed indicators on Gobustan region is incorporated with fourth category of wind energy potential, that is taken into account as a higher potential.



**Figure 1.** Average Speed of Wind in Azerbaijan.

### References

- <http://www.azpromo.az/3/en/141#.WKgLCaq0nIU>
- <http://www.lahistoriaconmapas.com/atlas/country-map01/azerbaijan-wind-map.htm>
- <http://www.osce.org/baku/41338?download=true>

## **INVESTIGATION OF WIND ENERGY IN AZERBAIJAN**

**Parvin Guliyeva**

*pervin.q098@gmail.com*

**Supervisor: Prof. Siyavus Azakov**

### **1. Wind Energy and Wind Power**

Nowadays, wind energy is predominant among the types of renewable energy sources all over the world. Wind energy portrays the procedure by which wind is utilized to produce electrical energy. Also, wind turbines are utilized to transfer the kinetic energy of the wind into the mechanical energy. On the other side, generator can be used to convert the mechanical power into electricity.

As we know, winds emerge as a result of the warming of the air by the sun, abnormalities on the surface of earth and earth's rotation. Therefore, the terms "wind energy" or "wind power" illustrate the procedure of generating mechanical electricity or power from the blowing or flow of wind.

### **2. Wind Energy sources in Azerbaijan**

It is evident that Azerbaijan has been likely exploring places of option where the renewable energy can be produced since 2004, when it is appeared in the declaration of a decade's plan, which was aimed for the satisfactory energy. Then, in 2009, "SAARES" which stands for the State Agency of Alternative and Renewable Energy Sources, established in Azerbaijan.

Azerbaijan, the country which has places with the high level of natural recourses, has started to construct the first wind plant (turbine) of the "Yeni Yashma" wind farm and is planning to produce more and more energy. The development of wind energy sources is made a priority with the help of Azeri authorities because it was quite cheap, it has considerably low level of ecological impact and boundless accessibility. There is high potential for development of wind power

plants in Azerbaijan, because it is evident that there are approximately 250 days when the wind strength can be considered as normal-to- high throughout a year, and it means that with the help of the wind power plants, more than 2.4 billion kilowatt-hours of electricity can be generated annually. There are regions where the application of wind power can be considered as efficient, such as Absheron Peninsula. In Absheron the strength of wind starts from 3 to 27 meters per second, therefore putting into operation the wind powers in this peninsula can benefit more.



**Figure 1.** The wind turbines

Until 2009, few attempts had been made in order to grow the wind energy potential of Azerbaijan, and our country have just three wind plants that are still working, one in the regions of Khizi, and other two in Sitalcaj and Yashma. By contrast, wind power has been attracting many organization's interests, and in the year 2009 with the assistance of USAID, preferential tariff to encourage the application of wind power plants was crated. Furthermore, a new wind farm is currently under

construction in Guba and it is expected that this wind farm will have 16 turbines which will be able to provide a total power of 4800 kilowatt-hours.

### **References**

- [http://accessdl.state.al.us/AventaCourses/access\\_courses/envi\\_sci\\_ua\\_v16/05\\_unit/05-04/05-04\\_learn.htm](http://accessdl.state.al.us/AventaCourses/access_courses/envi_sci_ua_v16/05_unit/05-04/05-04_learn.htm)
- <http://www.caspianinfo.com/wp-content/uploads/2013/05/Azerbaijan-Alternative-and-Renewable-Energy.pdf>
- <http://www.azernews.az/business/82792.html>

## **ARCTIC OIL DRILLING**

**Mahammad Aliyev**

*[mehemmedaliyev97@gmail.com](mailto:mehemmedaliyev97@gmail.com)*

**Supervisor: Farad Kamyabi**

Oil is the most widely used source of energy. It is the cornerstone of variety of industries including pharmacy, machinery, material manufacturing and etc. However, recent studies reveal that oil cannot be considered as sustainable energy source for the future, because worldwide production of conventional oil is declining and this situation pushes the major oil companies to seek more advanced oil recovery methods and ways to extract oil from unconventional reserves. One of those unconventional reserves is arctic oil and it is considered that ice cap of the North Pole conceals a third of the world's oil reserves. This writing aims to investigate pros and cons of arctic oil drilling from different aspects and finally conclude if it is worth to drill through the ice or not.

It is considered that millions of years ago, there were no ice caps on Earth; vast majority of its surface was covered by oceans. Some of the atmospheric carbon dissolved in the warm oceans and this

triggered the flourishing of planktons because they were consuming carbon. When they died, they actually buried plentiful amounts of carbon with themselves at the bottom of stagnant sea where there was hardly any oxygen. Over the centuries, sediment accumulation on the debris contributed to the deeper burial of them, 'cooked' the early hydrocarbon accumulations and today's fossil fuel reserves were formed. Due to the loss of excessive energy, the planet started to cool down and ocean levels dropped as a result of formation of ice caps. This is why we usually find oil fields under the modern deserts and remote icy places.

Drilling exploration wells through the permafrost lands is a costly and dangerous wish. The word 'dangerous' can be defined in two ways: it endangers human life and it endangers the local ecosystem. However, the most evident reason why arctic drilling is not spread worldwide is an unanswered question: is it really worth-drilling? To formulate a better answer to the question both advantages and disadvantages of arctic oil drilling should be considered.

Let us start with the negative aspects. Firstly, harsh conditions of arctic environment put the life of workers in danger. In any case, human safety should be the main priority. Especially, off-shore drilling is the most dangerous one, because it is evident that human organism cannot resist cold water for more than 4-5 minutes. Another unsolicited outcome is the increase of anthropological noise pollution in the seas. Studies showed that anthropogenic noise could cause auditory masking, changes in individual and social behavior, altered metabolisms. (Chao Peng, 2015) Arctic waters are habitat to polar bears, walruses, ice seals, and other marine animals. Extinction of at least one of the rings of food chain can lead to catastrophic consequences. And thirdly, there is no effective method of cleaning up a major oil spill in water. Deep-water Horizon blowout and Exxon Valdez disaster have shown the severity of the oil spills and their catastrophic effect on marine life and ecosystem.

Turning to the benefits that arctic drilling can offer us, the main gain will be energy. A third of world's oil reservoirs is quite huge amount of hydrocarbons. According to 'Shell' company, arctic reservoirs have 27 billion barrels of oil and 132 trillion cubic feet of gas capacity. Moreover, flourishing of the oil industry will probably enhance the local businesses and indigenous people can upgrade to better life standards. Which means higher salaries and more available jobs. Another positive aspect of arctic fields is that they are not located as deep as other reservoirs, which means that it is easier to control a well.

There are several oil companies which are more willing to produce arctic oil than others. Namely, Shell, Exxon Mobil, Gazprom, Chevron and etc. They are potentially and financially ready to extract the fossil fuels.

To sum up, arctic ecosystem is fragile and encompasses some of the rarest animals. Any devastating event can wipe several species away from the existence. The Arctic Ocean is prone to severe conditions which can complicate and hamper drilling and response to problems risking oil spills, human lives and wildlife. (diversity, 2015) Despite all the positive aspects we have to protect our planet and it does not matter whatever it costs or whatever have to be sacrificed.

#### **References**

- Chao Peng, X. Z. a. G. L., 2015. *Noise in the Sea and Its Impacts on Marine Organisms. International Journal of Environmental Research and Public Health*, p. 1.
- diversity, C. f. b., 2015. *Center for biological diversity. [Online] Available at: [www.BiologicalDiversity.org/ArcticOilDevelopment](http://www.BiologicalDiversity.org/ArcticOilDevelopment) [Accessed 5 January 2017].*

## SMART FLOATING FARMS

**Toghrul Karimov**

[kerimovtogrul96@gmail.com](mailto:kerimovtogrul96@gmail.com)

**Supervisor: Siyavush Azakov**

### Introduction

According to statistics revealed by the United States, the population of the world in 2016 was 7.4 billion people. However, the world population forecast predicts that in 2030 the number of people living on earth will grow to 8.3 billion. The more people will live on earth, the more food will be required. Thus, by 2030, the demand for food is expected to rise by 50%. The agricultural sector will face some serious challenges as a result of this increasing demand. The main issue for the farming sector is not growing 50% more food, but making 50% more nourishment available for people. One feasible solution for this problem is the smart floating farm which uses less area and produces more organic and fresh food. Smart floating farming is a completely new method of farming that will connect people directly with food and meet the agricultural need of ever-growing population.

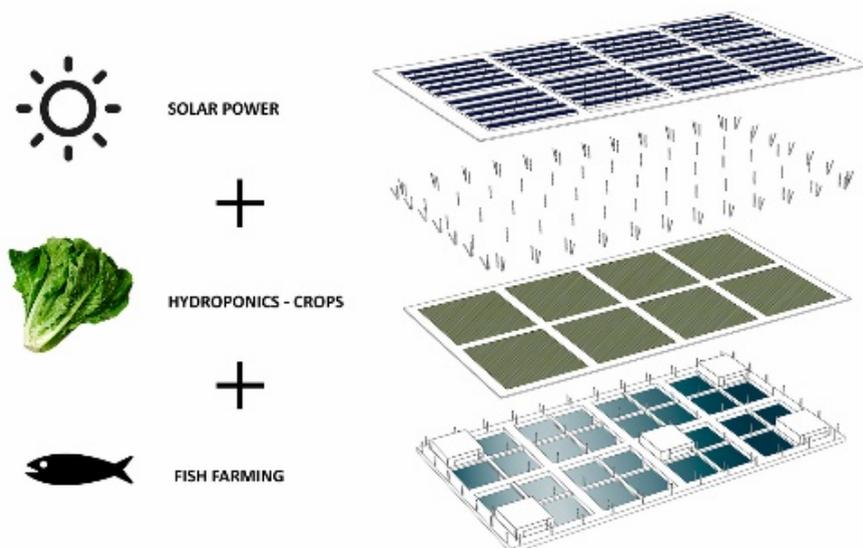


## General Information

Smart floating farming is a farming method which functions via hydroponic agricultural system. By the term hydroponic agricultural system it is meant that instead of growing crops conventionally in soil, they are grown in water by using solutions of mineral nutrients. In fact, plants would not be able to live on saltwater, thereby they are provided with freshwater from specific pumps. In order to protect the farm from waves inflated cylinders are built in front of the farm. The farm can also be stacked or adjusted in various ways in order to be directed towards the perspective location.

## Working principle

The farm is composed of 3 levels and it includes cutting-edge agricultural technologies which are already used all over the world. The top part will be equipped with solar panels and it will also incorporate skylights to provide plants with natural light. Moreover, in order to meet the irrigation needs rainwater collectors will also be supplied.



When it comes to the second level, it will feature hydroponic systems and a greenhouse. Hydroponic method will help to grow

plants without soil and the solar energy for growing them will be provided from the first level. Finally, the ground level is appointed for offshore aquafarming. This cage fishing technique happens in the open sea. The fish in the bottom level will be fed with waste products from the crops in the second level while these crops will in turn be fertilized with the waste from the fish.

### **Advantages**

First of all, smart floating farm (SFF) requires less space for growing crops. This happens due to two main factors: the multi-level strategy of the farm and the hydroponic system's higher food production rate per meter squared. Secondly, smart floating farm can produce fruits and vegetables without using chemicals which have detrimental impacts on both people and the environment. Next, smart floating farm is useful for managing water. Unlike the conventional farming, smart floating farms have lower rate of water consumption, hence no pipes are required to be built. Next, as no shipping and machinery are used in SFF, the use of fossil fuel is dramatically reduced thanks to smart floating farming. Additionally, SFF reduces the food preservation and storage needs, thereby the number of vermin such as rats and mice on food reserves are minimized.

Generally, smart floating farm is one of the most useful and cost-effective innovations that will play an intense role in dealing with the demand for more food all around the globe in the near future.

## **ENHANCED OIL RECOVERY USING POLYMER NANOCOMPOSITIES**

**Gulay Ibrahimova**

*gulay.ibrahimova.b0260@bhos.edu.az*

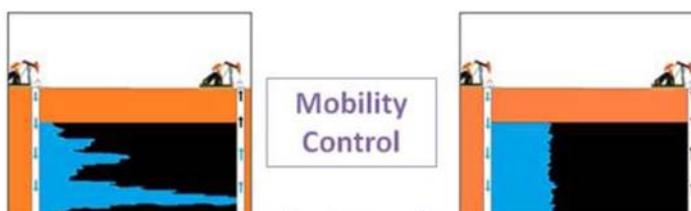
**Supervisor: Dos. Amir Reza Vakhshouri**

### **Introduction**

The growing demand for energy makes oil more important and for this reason, it becomes necessary to try to recover the trapped oil in reservoirs more as much as possible. After primary and secondary recover methods, tertiary recovery which is also called enhanced oil recovery (EOR) method is carried out to recover trapped oil in the reservoir. Nanoparticles are widely studied to be used in enhanced oil recovery. In enhanced oil recovery, polymer-coated nanoparticles are applied which is, in fact, nanoparticles with polymer chains grafted to the surface. Polymer-coated nanoparticles are used due to some advantages including their solubility, greater stabilization of foams and emulsions, stability, and easy transport through pore spaces with rocks. This work covers the use of polymer-coated nanoparticles for having mobility control, and changing wettability where they increase the recovery of trapped oil left in reservoirs in the range of 5-20% additionally.

### **Polymer-coated nanoparticles for mobility control.**

Mobility of a fluid is characterized with mobility ratio which is the ratio of mobility of injected displacing fluid to that of fluid being displaced in enhanced oil recovery, and good mobility control is created when the viscosity of fluid injected is greater than that of oil in the reservoir. Thus, it can contribute to displacement of oil from the injection well to the production well like piston which is illustrated in figure 1.



**Figure 1:** Description of mobility control [1]

In general, the mobility control is a matter of viscosity which is due to the generation of emulsions and foams that form owing to the presence of nanoparticles or surfactants.

### **Foams and emulsions**

Emulsions and foams are diffusions of a fluid in another immiscible fluid and as a result, they typically show shear thinning behaviors and relatively high viscosity. Foams and emulsions have shear thinning behaviors which is benefit to obtain high injection rate going to the reservoir. As it was mentioned above, like surfactants, nanoparticles are also used to produce emulsions and foams in order to have injected fluid at higher viscosity.

### **Polymer-coated nanoparticles for surface wettability alteration**

It is the fact that oil can be more easily recovered from water-wet rock than oil-wet rock, so another main way to increase the recovery of oil is changing the wettability of the rock from oil wet to water-wet. When the water contact angle is greater than 90, it is called water-wet, but if the water contact angle is less than 90, it is called oil-wet. And this work is going to cover how nanoparticles do the alternation of wettability which increase the recovery of oil.



**Figure 2.** Illustration of how it works [1]

The wettability alteration can contribute to up to 20% recovery of oil when high concentration of nanoparticles are used, on the other hand, the high concentration of nanoparticles can cause reduction in permeability, so an optimum concentration of nanoparticles is suggested to be injected into the core.

### **References**

1. ShamsiJazeyi H. Clarence A. M. et al. J. Appl. Polymer Sci., v. 131, 15, 2014.
2. Singh R., Mahto V., Journal of Macromolecular Science, Part B, Physics, 2016, v. 55, 11.
3. Downs H. H.; Hoover P. D. ACS Symp. Ser. 1989, 396, 577.
4. Buckley, J. S.; Liu, Y.; Monsterleet, S. Soc. Pet. Eng. J. 1998, 3, 54.

## **REMOVAL OF TOXIC MATERIALS BY NANOPARTICLES IN DRILLING FLUIDS**

**Gulshan Jabbarzadeh**

[gulshan.jabbarzade.b0242@bhos.edu.az](mailto:gulshan.jabbarzade.b0242@bhos.edu.az)

**Supervisor: Assoc. Prof. Amir Reza Vakhshouri**

### **Introduction**

In drilling process, drilling fluid play significant role like removal of cuttings from borehole, providing the constancy of hole and precluding any unbalanced flows between formation and borehole, and reducing temperature of drill bit. Recently, the production rate of oil and gas has increased exponentially, especially the interest in working and development of non-conventional reservoirs in conditions with high temperature and pressure (HTHP) has risen. This in turn increased demand for the improvement of conventional drilling fluids in the way that increasing stability and efficiency. Traditional drilling fluids are muds composed of mainly water (WBM), oil (OBM), or gas (GBM). Relatively new phenomenon nanotechnology proposes innovations in

oil and gas production. In this work, effective role of nanoparticles during removal of toxic and dangerous substances from drilling fluids is the subject of investigation. Especially we study the case in which the hazardous gas hydrogen sulfide is removed from drilling fluid via utilizing zinc oxide nanoparticles.

### **Brief History and Definition**

First design of drilling fluid, the mixture of water and plastic materials, was developed by the Chapman in 1890. Further development was mixing clay and water while drilling in 1901. The bentonite clay was introduced 34 years later by Harth and the base of recent drilling fluids was founded. The drilling fluid is defined as the composites or mixtures of different materials those can be utilized to get rid of cuttings from borehole.

### **Advantages of Using Nanoparticles**

There are many positive sides relating to usage of nanoparticles in drilling fluids both economically and technically. For instance, nanomaterials are cost-effective, environmentally friendly, and they allow us to recover the formations with high challenging depths. They are used for different purposes in drilling processes, such as ensuring wellbore stability, preventing the drilling fluid losses to the formation, reducing the friction forces between borehole and pipe, and finally removing toxic materials especially gases from drilling fluids.

### **Removing H<sub>2</sub>S Using ZnO Nanoparticles**

One of the hazardous, corrosive, and toxic gases emerging in drilling fluid is hydrogen sulfide (H<sub>2</sub>S). As it creates considerable danger for environment, the drilling devices, pipes, and stuff working there, it has to be removed in all costs. This gas may emerge in the form of H<sub>2</sub>S, HS<sup>-</sup>, and S<sup>-2</sup> in drilling fluids and its concentration must be decreased till safe level. Generally, zinc compounds such as zinc oxide and zinc carbonate are used as scavengers. Zinc oxide is very efficient considering its high zinc content and H<sub>2</sub>S is decontaminated by ZnO by the following reaction:



Nano zinc oxide particles have the size of 14 – 25 nm and this small size allow them to be highly active on large surface area of 44 – 56 m<sup>2</sup>/g. Nanoparticles remove all hydrogen sulfide content after 15 minute, while bulk ZnO able to clean only about 2.5 percent during 90 minute. The superiority of nanoparticles is obvious, the usage of them is going to solve the problem relating to the removal of highly toxic materials from drilling fluids efficiently.

#### **References**

1. Al-Yasiri M. S., Al-Sallami W. T. American Journal of Nano Research and Applications, 2015, v.3, 3, p: 41-45
2. Abdo, J. and Danish, M. Nanoparticles: Promising solution to overcome stern drilling problems. (2010). Nanotech Conference and Exhibition, Anaheim, California.
3. Sayyadnejad M. A. Ghaffari H. R. Saeidi M. International Journal of Environment Science and Technology, 2008, Vol. 5, 4, p. 565-569.

## **ENHANCEMENT OF MECHANICAL AND GAS BARRIER PROPERTIES OF HDPE NANOCOMPOSITES FOR PIPING AND PACKAGING INDUSTRY**

**Kamran Aliyev**

*ka286@hw.ac.uk*

**Supervisor: Amir Reza Vakhshouri**

#### **Introduction**

The main drawback in application of polymers in a wider engineering ambience is their lacking mechanical, thermal and physical properties compared to metals. Accordingly, number of methods has been contrived for enhancing polymer properties throughout last decades. However, the addition of nanoparticles into polymers to form polymer nanocomposites is the main trend among the coined methods for improving neat polymer properties. The main upside of exploiting polymer nanocomposites is their ability to offer

similar or enhanced properties at considerably lower filling content than would be the case with traditional micro-composites. Moreover, particularly in applications where constructive integrity is of high importance, polymer nanocomposites do illustrate substantial improvements in tensile strength, stiffness, and toughness (Manolis Sherman, 1999). Besides, nanocomposites are capable of hindering the permeability of gases as an outcome of their excessively large surface area-to-volume ratio.

Among the large number of commercially available thermoplastic polymers, high-density polyethylene (HDPE) has been universally used in various applications. This is mainly attributed to bountiful supply of HDPE and its low processing cost. Moreover, the reasonable mechanical properties of HDPE have made it pertinent for many industrial applications including piping and packaging. Considering mechanical properties, HDPE, in comparison with the other kinds of polyethylene, has high tensile strength caused by its highly crystalline structure. However, for usage of HDPE pipes in wider engineering fields, the mechanical properties of latter still need improvement in order to stand high pressure processes. On the other hand, gas permeability is one of the most crucial properties to be contemplated and enhanced, for wider usage of HDPE pipes in gas transportation as well as for food and drug packaging. Although, HDPE propounds a fine barrier for water vapor, it is yet easily permeated by oxygen. In fact, some of these mechanical and gas barrier properties can be ameliorated by the addition of either inorganic or organic particles into matrix of polymer. Accordingly, this notion has given a rise to investigations for enhancing the mechanical and barrier properties of HDPE using organic and inorganic nano-fillers in the recent decade. The purpose of this study is to detect the main factors influencing on enhancement of mechanical and gas barrier properties of HDPE nanocomposites, and comment on enhanced properties exhibited by HDPE/Montmorillonite (Bentonite) nano-composites having the highest potential for being commercially utilized in the closest future.

## **Experiments**

To investigate the influence of polymer & nano-filler interaction on mechanical properties of polymer nanocomposite, the study conducted by Abdul Wahid Al-Hajjaj et.al (2010) is considered. The original purpose of this study was to enhance the design stresses of high density polyethylene pipes & vessels by addition of organically modified MMT into commercially available HDPE grade TR-401 hexene copolymer. Consequently, mechanical properties of HDPE/org-MMT nano-composites were scrutinized and optimal conditions were detected. The MFI and density of the used polymer were 0.12 g/10 min. and 0.945 g/cm<sup>3</sup> respectively. For better dispersion of filler in the polymer matrix, surfaces of nano-fillers were modified via alkyl ammonium to achieve the desired filler-matrix compatibility. All nanocomposite samples were prepared via melt compounding in a Haake rheomix 600. The results show that in the presence of org-MMT, tensile strength at break and Young's Modulus of polymer increase up to 50% and 300% respectively, whereas, elongation at break decreases around 15%.

## **Discussion & Conclusion**

It was ratified that optimal enhancement of both mechanical and permeability properties of HDPE nanocomposites is dependent on nanofiller type, filler-matrix interaction, content nanoparticle, the type of the observed polymer matrix, and the polymer nanocomposite processing method. Although, selection of pertinent filler with reasonable properties is of high importance, the maximum improvement of properties can be only obtained by amelioration of filler-matrix interaction and subsequently sufficient dispersion. The samples of nanocomposites with organically modified MMT or MMT + compatibilizer corroborated the aforementioned concept with significantly improved mechanical and permeability properties compared to neat HDPE. It also was revealed that an increase in content of nanofiller would facilitate modification of mechanical and permeability properties until certain threshold. Beyond this limit, addition of nanofillers ends up with either similar or worsened

properties caused by formation of agglomerations. HDPE/org-MMT or HDPE/MMT + E/MMA are strongly believed to have high potential for being widely utilized in engineering industry (for piping and packaging). Preparation of the pointed out nanocomposites under suitable conditions might allow wide-scale manufacture as a result of high demand for the investigated properties.

### **References**

- 1- Al-Hajjaj A. et al. *Journal of Saudi Chemical Society*, 2010, v 14, p. 251–256.
- 2- Sherman M. et al. *Nanocomposites - a little goes a long way*. (<http://www.ptonline.com/articles/199906fa4.html>)
- 3- Bhattacharya M. 2016. Polymer Nanocomposites - A Comparison between Carbon Nanotubes, Graphene, and Clay as Nanofillers. *MDPI*, 9(4), p. 262.

## **NITRATE AND PHOSPHATE REMOVAL FROM WATER AND WASTEWATER USING NOVEL ION-EXCHANGERS**

**Sanam Amirli**

[sanam.amirli.b0300@bhos.edu.az](mailto:sanam.amirli.b0300@bhos.edu.az)

**Supervisor: Amir Reza Vakhshouri**

Widespread use of water in different industrial, municipal, agricultural fields like manufacturing, farming makes the contamination and degradation of water inevitable. These activities impairs the balance of species in water which endangers marine life. One of the main consequences of active use of water is accumulation of nitrate and phosphate ions in water. These ions are fatal to marine animals after certain concentration in terms of reduction of oxygen content of water which is called hypoxia. One of the causes of hypoxia is eutrophication which results from excess amount of nutrients in water. Phosphates and nitrates are the main constituents of these nutrients.

They mainly comes from the fertilizers left from agricultural activities and nourishes algae and promotes increase of oxygen producing phytoplankton in water which consequently leads to accumulation of waste in the water shell. The overproduction of algae leads to algal blooms and formation of dead zones where oxygen consuming marine animals cannot live. Decomposition of algae remnants and wastes requires oxygen which leads to oxygen deficiency in water. Once these nitrate polluted water are drunk it oxidizes the iron in hemoglobin and deteriorates its function as oxygen carrier. These poses great threat for children and pregnant women as baby bodies are unable to reconvert the oxidized hemoglobin back to its original form.

There are different methods developed to treat wastewater leaving agricultural processes. A range of chemical, physiochemical and biochemical methods are implemented to remove nitrogen and phosphorus containing compounds from wastewater such as MAP precipitation, electrocoagulation, application of hydrogels, crystallization process, electrochemical denitrification etc. [1]. The method described in this paper removes nitrates and phosphates from water and wastewater by absorption via modified zeolites. Activated alumina and bauxite, activated carbon, chitin are also used as absorbent [2]. As there are 40 naturally occurring zeolites and they are abundant in nature, their use is considered favorable. Zeolites can absorb phosphates and nitrates from the wastewater by its selective absorptivity. Their pores of different sizes gives them this property. Clinoptilolite mainly is constituted of Al, Si, O which are arranged in three dimensional frameworks with open-ended channels with  $K^+$ ,  $Na^+$ ,  $Ca^{2+}$  and  $Mg^{2+}$  within them. The positive ions situated in the channels are exchangeable with external ions which is what makes the zeolite a good absorbent. The general formula of clinoptilolite is  $(Na, K, Ca)_4Al_6Si_{30}O_{72} \cdot x24H_2O$  [3].

An experiment was conducted in order to examine its ability to absorb anion  $NO_3^-$ . The experiment was carried out with both activated and non-activated clinoptilolite zeolite which belongs to heulandite-

type framework. The zeolite was first activated using acid of 0.1 M concentration. The activation was intended to increase the surface area of the zeolite which will promote the absorption. The grinded zeolite particles was put into the acid solution and left for 24 hours. After 24 hours the suspension was filtered and washed with water (several times) and ethanol in order to get neutral pH. After that the zeolite was dehydrated by heating in order to remove water in its pores to a certain extent so that its absorption capacity increases. The structures of zeolites were investigated by using X-ray Diffraction (XRD) spectrum.  $FeNO_3 \cdot 9H_2O$  (or any other nitrate source could be used) was used to generate  $NO_3^-$  ions in the water. Solutions were prepared at three different concentrations. The modified zeolites were added to nitrate containing solutions. After 2-4 hours stirring, the concentration was measured using UV spectrometer and was compared with that of zeolite-free solution. After the comparison of the results, sufficient amount of absorption was observed. In conclusion, the clinoptilolite zeolite was confirmed to be effective absorbent for removal of nitrates and can be applied in water-treatment as a cheap and economical alternative.

### **References**

1. Hoon, C. H. (2011/2012). The Removal Methods of Phosphorus/Phosphate and Nitrogen/ Nitrate from Water and Wastewater.
2. Minocha, A. B. Indian Journal of Chemical Technology, (2006). 203-217.
3. Andreyev M. K. Zeolites Syntesis, Chemistry and Applications. New York (2012) Nova Science Publishers.

## **BIODEGRADABLE POLYMERS AND BIODEGRADABLE PLASTICS**

**Subhana Allahverdiyeva**

*subhana.allahverdiyeva@gmail.com*

**Supervisor: Assoc. Prof. Amir Reza Vakhshouri**

### **Introduction**

Plastic has become one of the most essential substances in use, but it is also one of the main threats that stands in front of the environment. One of the best solutions to this global problem is production of biodegradable polymers, which could decrease the environmental threat, as well as dependency on petroleum. Although some polymers are naturally biodegradable, the synthetic polymers, such as widely-used LDPE, need addition of some additives in order to achieve biodegradation. In this experiment the starch was used to get biodegradable LDPE. Its effect on biodegradation and properties of the polymer was investigated.

### **Experimental result**

The experiment was carried out by blending of starch and LDPE with different concentration in the differing amount of water. Before and after extrusion the mechanical strength, water and gas permeability and biodegradability of the polymer was studied. It was unclosed that as the starch content exceed the 30% (w/w) the mechanical properties of the polymer decreased, and it was accompanied by increase of water and gas permeability. However, the biodegradability rate enhanced when the starch content exceled 10% (w/w).

The increase in water/gas permeability was related to the fact that LDPE itself does not absorb a significant amount of water, so the higher starch content of the blend results in higher WVTR because of its hydrophilic character. The significant increase in water permeability

specially observed at higher content of starch approximately above the 15% (w/w).

Another drawback of the addition of the starch was found that the particles of starch were bound to protrude which affected the form of the product and made a need for further measurements of mechanical properties.

Gas transition was found to be tend to energy availability for chain separation and loosening in polymer structure which was followed by decrease in starch molecule introduction within the LDPE network. Higher temperature resulted in more formation of cavities and interconnecting of channels, and further diffusivity and permeability, which followed by lower activation energy.

The gas permeability of the blend was found by using Salame's equation:

$$N * \pi = \Pi = \sum (N_i * \pi_i)$$

Where,  $\Pi$ , additive molar function of permeability

$N$ , number of additive groups per structural units

$i$ , Increment of the group  $i$

$\pi$ , permeability at the ambient temperature

In order to find out the diffusivity and permeability relation with temperature the Arrhenius logarithmic relationships were used:

$$D = D_0 \exp (-E_D/RT)$$

Where,  $D_0$  - diffusion coefficient

$E_D$ , activation energy of diffusion

$R$ , universal gas constant.

Similarly, for permeability

$$P = P_0 \exp (-E_p/RT)$$

Where,  $E_p$  - apparent activation energy of permeation

To sum up, the experiment result was that the higher starch content in LDPE/starch blend resulted in higher brittleness and lower tensile strength and promoted to higher gas and water permeability.

Increased water content in blend itself, exhibited increased percentage of elongation due to water plasticization of the mixed matrix.

#### **Reference**

- 1- Hoque M. E., Jie T. Y., et al. Journal of Materials Volume 2013, (2013), Article ID 365380
- 2- Borghei M., Karbassi A. et al. African Journal of Biotechnology (2010) Vol. 9(26), pp. 4075-4080

## **OPTIMISATION OF CENTRIFUGAL PUMPS BY CHANGING THE FREQUENCY**

**Jamil Ismayilzada**

*[jamil.ismayilzade6@gmail.com](mailto:jamil.ismayilzade6@gmail.com)*

**Supervisor: Ass. Prof. Azizaga Azizov**

In practice, currently one of perspective methods of optimization of centrifugal pump is to regulate the number of revolutions of the pump shaft using a special frequency converters supply pump or use of adjustable fluid converters. Terristor current frequency converters are more low-cost than adjustable fluid converters and they it is more preferable at rather small powers to 500kW.

Take an example, when to pick up the pump which provides maximum flow rate  $Q = 6,0 \text{ m}^3/h$  for a given hydraulic system, which has the following analytical characteristics:

$$H_{sys} = H_{st} + AQ^2 = 10 + 0.15Q^2 \quad (1)$$

There is a type of centrifugal pump console brand X50-32-125, the number of revolutions which  $n_1 = 2900 \text{ min}^{-1}$ . When this number of revolutions of the pump optimum flow  $Q_{op} = 12.5 \text{ m}^3/h$  with a head  $H_{op} = 20 \text{ m}$ , ie the pump feed is more than 2 times the desired.

Analytically, the pump characteristic  $H = f(Q)$  according to the passport of the pump represented in the form of a parabola of the second order:

$$y = ax^2 + bx + c \quad (2)$$

where  $x = Q$ , and  $y = H$ .

For determination the coefficients of the equation used mathematical method of least squares, a built-in program for Excel 2013.

The analytical expression for the characteristic  $H_{p1} = f(Q)$  with the number,  $n_1$  of the pump speed will be:

$$H_{p1} = -0.0183Q^2 - 0.1259Q + 24.441 \quad (3)$$

When the pump is to this feed pump hydraulic pressure  $Q_1$  and  $H_1$  will be (Fig.1.) Are determined by the system of equations:

$$\begin{cases} H = -0.0183Q^2 - 0.1259Q + 24.441 \\ H = 10 + 0.15Q^2 \end{cases} \quad (4)$$

We find that at the operating point  $N_1$  flowrate  $Q_1 = 8.90 \text{ m}^3/\text{h}$ , head  $H_1 = 21.87 \text{ m}$ , and power consumption  $P_1 = 1.27 \text{ kW}$ , ie feed pump longer given to  $2.9 \text{ m}^3/\text{h}$ . Using the valve at the pump outlet can reduce consumption, but the pump is running continuously this will lead to a large loss of electricity consumed.

It is known that when the number of revolutions,  $n$  of the pump shaft, observe the following relations for the parameters (flowrate, head and power) of the pump:

$$\frac{n_1}{n_2} = \frac{Q_1}{Q_2}; \quad \frac{H_1}{H_2} = \left(\frac{n_1}{n_2}\right)^2; \quad \frac{P_1}{P_2} = \left(\frac{n_1}{n_2}\right)^3 \quad (5)$$

When the number of revolutions of pump varies pump parameters change in a parabola, which is called the curve of such regimes or regimes similarity curve.

To find the pump modes similarity line equation  $H_2 = K_{sim} * Q_2^2$ , passing through the point  $N_2$  (Fig.1), it is necessary to determine the coefficient of similarity curve:

$$K_{ox} = \frac{H_2}{Q_2^2} = \frac{15.4}{6.0^2} = 0.4278 \quad (6)$$

In the coordinates  $y - x$  equation similarity curve is:

$$H_{ox} = 0.4278Q^2 \quad (7)$$

Let us feed pump  $Q_3$  at the point  $N_3$  for this similarity line with the number of wheel revolutions  $n_1 = 2900 \text{ rpm}$ . To do this, find the intersection of the two curves at the point  $N_3$  (Fig.1)

$$\begin{cases} H = -0.0183Q^2 - 0.1259Q + 24.441 \\ H = 0.4278Q^2 \end{cases} \quad (8)$$

From:  $Q_3 = 7.15 \text{ m}^3/\text{h}$ ,  $H_3 = 22.61 \text{ m}$

The required new speed  $n_2$  of the impeller is determined from the relation (5):

$$n_2 = \frac{6.00}{7.15} * 2900 = 2434 \text{ rpm} \quad (9)$$

The degree of reduction in the number of revolutions:

$$S = \frac{n_1 - n_2}{n_2} 100\% = \frac{2900 - 2434}{2900} 100\% = 16.10\% \quad (10)$$

which is quite acceptable and the efficiency of the pump will not change.

Equation characteristic  $H = f(Q)$  for the new speed  $n_2$  will:

$$y = -0.0183x^2 - 0.1061x + 17.344 \quad (11)$$

At  $Q_2 = 6.0 \text{ m}^3/\text{h}$  in operating point  $N_2$ , the pressure head will be  $(H_2)_2 = 15.89 \text{ m}$ .

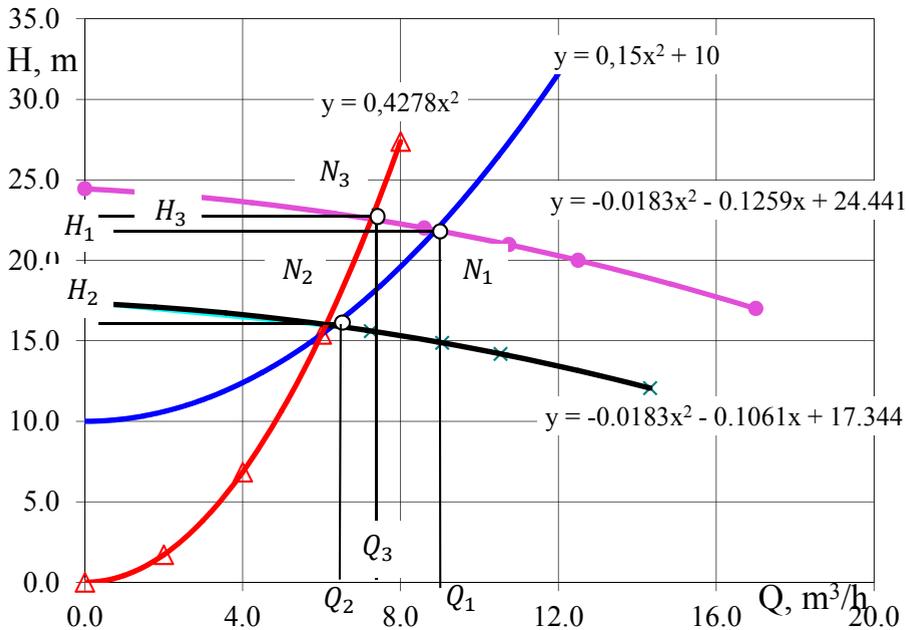


Figure 1

According to the factory characteristic of the pump, power input at the operating point will be  $N_3$  is  $P_3 = 1.20 \text{ kW}$ .

Then, the pump power input at the operating point  $N_2$  in accordance with relation (5) becomes  $P_2 = 0.71 \text{ kW}$

The economy of an input in kW makes:

$$\Delta P = P_3 - P_2 = 1.20 - 0.71 = 0.49 \quad (12)$$

or in %

$$\Delta P\% = \frac{P_3 - P_2}{P_3} 100\% = \frac{0.49}{1.20} 100\% = 39.4\% \quad (13)$$

#### **Reference**

1. Qarayev M.A., Əzizov Ə.H. Mərkəzdənqaçma nasosların özlü mayelərlə işləməsi. Dərs vəsaiti («Hidravlik maşınlar. Hidravlik intiqallar və hidropnevmoavtomatika» ixtisaslı tələbələr üçün). Bakı, ADNA, 2008 il, 196 c.
2. GRUNDFOS. Research and Technology. The Centrifugal Pump. 2010.
3. Ron Darby. Chemical Engineering Fluid Mechanics. Second Edition, Revised and Expanded, 2001.

## **SELECTION OF CENTRIFUGAL PUMPS OPERATING IN PARALLEL**

**Narmin Abdullazade**

[abdullazadenarmin@gmail.com](mailto:abdullazadenarmin@gmail.com)

**Supervisor: Ass. Prof. Azizaga Azizov**

One of methods to regulate the centrifugal pumps is to operate them in parallel by switching on and off. However switching to the parallel working of two pumps doesn't double the flow rate. This results from the fact that the output of parallel working pumps is influenced by the characteristic of system and the characteristic of pumps which can be flat or steep. Centrifugal pumps are switched on in parallel when output of one pump is insufficient for requirements of hydraulic system.

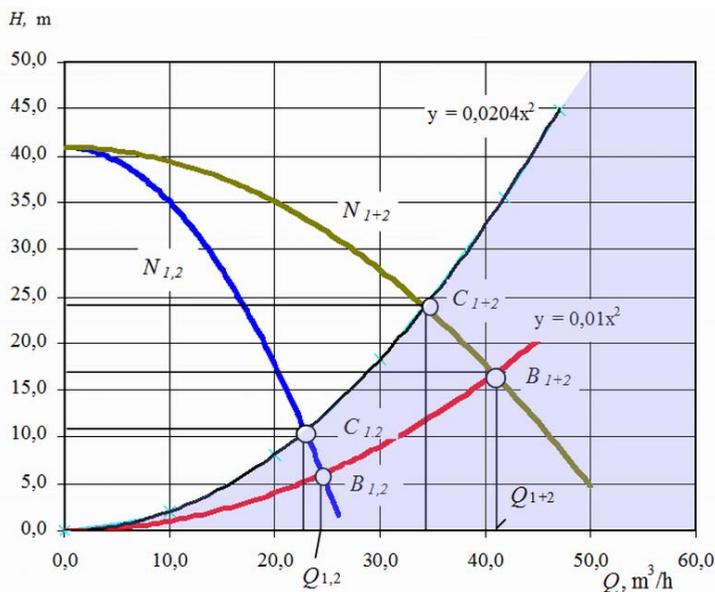
For the construction of resulting  $H - Q$  characteristic in parallel working of two identical pumps the flow rate is twice of the flow rate delivered by single pump at the same pressure.

The operating point of parallel working pumps at a given system is defined by finding solution of system of the equation (1) of the resulting characteristic of pumps  $H_{1+2}$  and system  $H_{sys}$  characteristics (operating point  $B_{1+2}$ , fig. 1):

$$\begin{cases} H_{1+2} = 0,25 \cdot aQ^2 + 0,5 \cdot bQ + c \\ H_{sys} = H_{1+2} = AQ^2 \end{cases} \quad (1)$$

The operating flow rate of joint pumps is defined by formula:

$$Q_{1+2} = \frac{-0,5b \pm \sqrt{(0,5b)^2 - 4(0,25a - A)c}}{2(0,25a - A)} \quad (2)$$



**Figure 1.** Representation of parameters defining possibility of parallel operation of pumps

In parallel connection of pumps it is possible to achieve at least 50% increase in flow rate:

$$m = \frac{Q_{1+2}}{Q_{1,2}} \geq 1,5 \quad (3)$$

Thus the pressure developed by each pump increases as well:

$$\frac{H_{1+2}}{H_{1,2}} = \left( \frac{Q_{1+2}}{Q_{1,2}} \right)^2 \geq 1,5^2 = 2,25, \quad (4)$$

Substituting (2) and (4) in equation (5) yields following:

$$\frac{Q_{1+2}}{Q_{1,2}} = \frac{2(a - A)(-0,5b \pm \sqrt{(0,5b)^2 - 4(0,25a - A)c})}{2(0,25a - A)(-b \pm \sqrt{b^2 - 4(a - A)c})} \quad (5)$$

$$\text{or } \frac{(a - A)(-0,5b \pm \sqrt{(0,5b)^2 - 4(0,25a - A)c})}{(0,25a - A)(-b \pm \sqrt{b^2 - 4(a - A)c})} \geq 1,5 \quad (6)$$

Derived inequality allows to define analytically whether it is possible to operate pumps in parallel or not, also to find out how system characteristic has to be changed to get at least 1.5 times increase in flow rate.

The analysis shows that it is impossible to achieve essential increase in flow rate in parallel operation when system characteristic is steeper.

Using an inequality (6) for known polynomial coefficients of pump characteristic ( $a$ ,  $b$  and  $c$ ) it is possible to define the characteristic of hydraulic system at which flow rate delivered by pumps increases at least by 1.5 times (50%). It can be accomplished by using Goal Seek function of MS. Excel. It has been found that as a result of scalings it has been found that in the equation of the characteristic of hydrosystem the factor  $A$  for the given pumps should be less than 0,0204, i.e.  $A \leq 0,0204$ . Shaded area in fig. 1 shows the region at which system characteristic can be arranged.

### **Conclusions**

1. The analytical method to determine the effectiveness in the application of parallel operation of identical pumps is developed.
2. The analytical method to define the parameters of system

characteristic at which pumps effectively operate in parallel is introduced.

3. The parallel operation of pumps is efficient when system characteristic curve is flatter.

**References:**

1. Qarayev M.A., Əzizov Ə.H. Mərkəzdənqaçma nasosların özlü mayelərlə işləməsi. Dərs vəsaiti Bakı, ADNA, 2008 il, 196 s.
2. Grundfos. Research and Technology. The Centrifugal Pump. 2010.
3. Ron Darby. Chemical Engineering Fluid Mechanics. Revised and Expanded, 2001.

## **DETERMINATION THE OPERATING MODE OF HYDRAULIC MACHINES BY MEANS OF THERMODYNAMICAL METHOD**

**Saida Alasgarova**

[alasgarovasaida@gmail.com](mailto:alasgarovasaida@gmail.com)

**Supervisor: Dr. Azizagha Azizov**

The thermodynamic method of the determination and research of hydraulic machines is based on the temperature change of working fluid in the system. As the temperature difference is observed when some amount of power of hydrosystem turns to heat, this method can be applied to the whole system.

According to the definition of rotodynamic pump, it gives the mechanical energy to the fluid via a disk and this determines the main parameter of the pump which is efficiency. It defines the general condition of the pump and effectiveness in all points of the pump has an impact on the efficiency of the pump.

It is clear from theoretical and practical measurements that overall temperature decrease is situated between 1.5...6 °C and it could be measured accurately enough with diagnostic method.

In this thesis it will be looked at pump in series model which is constituted of pump and throttling valve (fig.1).

The efficiency of the pump is

$$\eta_p = \frac{P_p}{P_{ps}} = \frac{\Delta p \dot{V}_p}{M_p \omega_p} \quad (1)$$

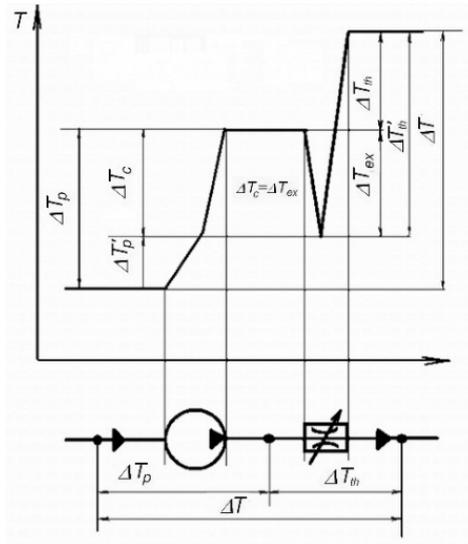
Here,  $\eta_p$  – efficiency of pump,  $P_p$  – power of pump,  $P_{ps}$  – power of the shaft of pump,  $\Delta p$  – pressure difference of pump,  $\dot{V}_p$  – flowrate of the pump,  $M_p$  – momentum in the shaft of the shaft of pump,  $\omega_p$  – angular velocity of the shaft of pump.

If it is assumed that pressure in the suction and after valve is the, the heat exchange with environment will be negligible and the mechanical energy of the pump will completely be converted to the heat, and it will be utilized to heat of fluid. After this process, the fluid could be taken to vessel.

$$P_{ps} = M_p \omega_p = \rho c_p \Delta T \dot{V}_p \quad (2)$$

After substitution, the final formula for efficiency:

$$\eta_p = \frac{\Delta p \dot{V}_p}{\rho c_p \Delta T \dot{V}_p} = \frac{\Delta p}{\rho c_p \Delta T} \quad (3)$$



**Figure 1.** Pump system with the throttling valve

When the fluid passing through the pump it is heated by  $\Delta T_p$  (fig. 1). And this temperature increase is obtained on the account of heat loss from some amount of mechanical energy and compressing of fluid. That's why general temperature increase in the pump will be illustrated below:

$$\Delta T_p = \Delta T'_p + \Delta T_c \quad (4)$$

It is assumed that  $\Delta p_p = \Delta p_{th}$  and as a result  $\Delta T_c = \Delta T_{ex}$ , because of combination of pump and throttling in series. So, the heat balance is compensated and total temperature change has been affected by this. That's why:

$$\Delta T = \Delta T_p + \Delta T_{th} = \Delta T_{th}' + \Delta T_p'. \quad (5)$$

Now the total efficiency can be computed as:

$$\eta_p = \frac{\Delta T'_{th}}{\Delta T} = \frac{\Delta T_{th} + \Delta T_{ex}}{\Delta T} \quad (6)$$

So the the theoretical and practical experiments shows that the speed of the process going inside the pump is so fast, that's why it can be accepted as **adiabatic process**. When the pump passing through the valve, Joule-Thomson effect is monitored. Taking into account that, efficiency of the pump might be found that way:

$$\eta_p = \frac{\Delta T_{th}}{(1 - \alpha_{ex} T_p) \Delta T} \quad (7)$$

Here  $\alpha_{ex}$  is expansion coefficient for the fluid in the pump.

From the last experiment, that is done in the laboratory of Azerbaijan Oil and industry University, the error can be considered as  $\pm 1,5\%$ , which is very appropriate value.

### Conclusion

1. To observe the hydraulic systems especially in mobile exploitation it is advised to use thermodynamic method.

2. It is required to operate the pump at the pressure higher than 2 MPa, because of increasing pressure increase the accuracy of thermodynamic method.

**References:**

1. Азизов А.Г. Определение термодинамическим методом общего КПД гидромотора объемного гидропривода. Баки Dövlət Əmtəəşünaslıq Kommersiya İnstitutu. V Elmi-nəzəri konfransın materialları, 1999, 3 s.
2. <https://www.pumpindustry.com.au/thermodynamic-performance-testing-and-monitoring/>

## **OIL SPILLS: PREVENTION AND CLEANUP**

**Fidan Abdullayeva**

*[missis.abdullayeva@mail.ru](mailto:missis.abdullayeva@mail.ru)*

**Supervisor: Assoc. Prof. Rena Abbasova**

Oil spills have considerable impact on the marine life and resultant ecological unbalance. The problems generated as a result of this phenomenon last in the long-term spoiling the aquatic ecosystems. The loss of the fauna and flora at the corresponding areas urge the governments to take precautions in the decreasing process of the environmental contamination. *(Figure)* Particular regulations are governed in the implementation of the Spill Prevention and Control program. The responsible organizations have the objective of providing specific preventions in a number of different ways throughout this issue. Those schemes include building double hulls (double-hulling), constructing blowout preventers, casting of the well and etc. Besides, cleaning of the oil spills through the water zones is carried out strictly as well. Additional to the use of sophisticated technologies in the cleanup of water, the movement of the oil to the onshore is prevented in a rapid way. There are different ways of removing the extreme consequences of the oil spills at the oceans as well as seas. The applicable methods include dispersion, burning and skimming processes with the help of the professional employees and modern equipment [1].

Dispersants are the detergents cleaning the water from the oil via separating them into droplets. In the burning method, the booms are used to constraint the harmed area and prevent further spread as a preliminary step. Afterwards, the floating oil is burned together with the monitoring of the air conditions. Another widely used way is called skimming in which particular devices – boats - are utilized to pick up the oil from the surface of the water [4].

Azerbaijan also has the groups working against the oil spills in Caspian Sea after certain offshore field accidents. Different seminars hosted in Baku give valuable information about oil spill combat, development of technologies used in offshore activity and oil well drillings [2]. Norwegian experience also reveals its branches in the conducted prevention and cleanup programs of Azerbaijan and with the help of the innovative devices the emission to the atmosphere is precluded in the long term [3].



**Figure:** *The bitter affect of oil spill on living organisms*

### **References**

1. Beaudry, F. (2016, April 6). Retrieved from [http://environment.about.com/od/petroleum/a/oil\\_spills\\_and\\_environment.htm](http://environment.about.com/od/petroleum/a/oil_spills_and_environment.htm)
2. M. Fingas, *The Basics of Oil Spill Cleanup*, Canada CRC Press, 3-rd edition 2012. 286 p.
3. Mirzayev, E. (2014, January 29). Retrieved from <http://www.azernews.az/nation/63866.html>
4. NOAA. (2015, June 17). Retrieved from <http://response.restoration.noaa.gov/about/media/how-do-oil-spills-out-sea-typically-get-cleaned.html>

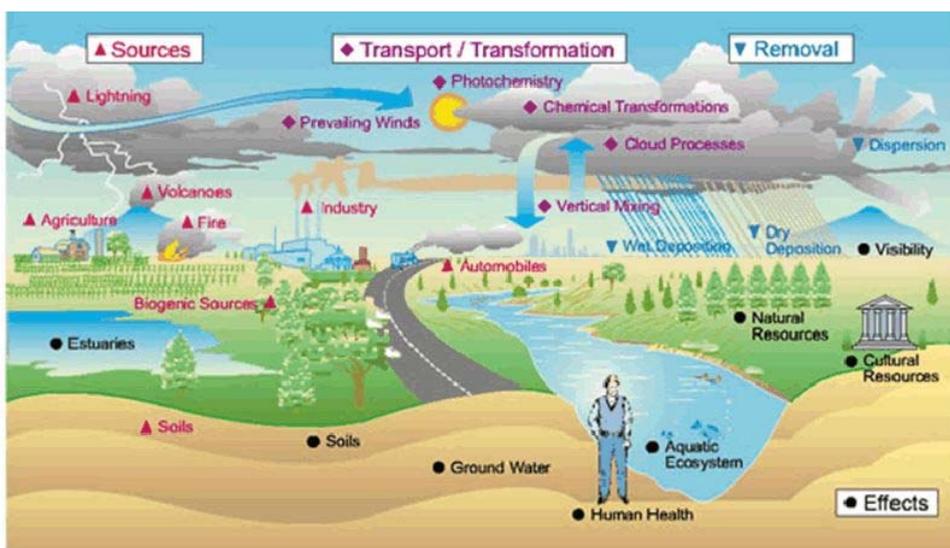
## HEAVY METALS AND THE INFLUENCE THAT HEAVY METAL CONTAMINATION HAS ON ECOSYSTEM

**Sabina Mammadova**

*Mammadova.sabine@gmail.com*

**Supervisor: Assoc. Prof. Rena Abbasova**

In recent years monitoring of ecosystem showed that heavy metal pollution has a drastic impact on the Earth's ecosystem. It already became a global problem; some parts of our planet are polluted more than the other ones. Some geological and human activities caused the growth of harmful elements' concentration; their high concentration, especially of heavy metals, in the surrounding environment, can be toxic and can have a negative impact on the flora, fauna, marine life, as well as, human health. If the soil is enriched with heavy metals, it is quite complicated to be remediated. The main factors that cause the accumulation of high amount of heavy metals are wastes from industry activity, emission gases from the vehicles, different kinds of paints, lead acid batteries and etc. Metals are entering human tissues, plants and animals via air, diet or can be transported manually.



- Sources, transport, removal and effects of heavy metals

One of the commonly known heavy metals is mercury (Hg). It is liquid in standard conditions, as it has low melting temperature (-38.83° C). In the Earth's crust it is infrequently found, however, there is one widely known and broadly deposited compound of mercury, called cinnabar (HgS). Pure mercury is extracted from cinnabar by heating:



In daily life and industry, mercury is widely used: in thermometers, barometers, manometers, fluorescent lamps and etc. Moreover, it is used in medicine, chlorine and caustic soda production, laboratories and etc.

Most inorganic compounds of Hg are less toxic than its organic compounds. Organic compounds are extremely toxic and hazardous for biosphere. Organomercury compounds do not react with water. The most dangerous organic family of Hg is methylmercury (CH<sub>3</sub>HgX). They are mostly found in water, due to its high pollution. This process is known as biomethylation.

Methylmercury (CH<sub>3</sub>Hg<sup>+</sup>) is very toxic, because it actively interacts with sulfide groups of ferments and inactivates them, moreover in living organisms it is fat soluble. Fishes may absorb methylmercury and consuming these fishes may cause Minamata disease. Main effects of this disease are destruction of brain cells, lungs and kidneys.

Nowadays, there is a wide range of cleaning up methods of heavy metal pollution; they can be classified as physical, chemical or biological methods. In order to reduce the amount of mercury in the environment, products, containing Hg, such as batteries, fluorescent bulbs, mercury thermometers, should be replaced with other products, which do not contain mercury. Currently, in most devices (in thermometers, bulbs) it has been replaced by alcohol or galinstan. However, in most scientific experiments, mercury filled thermometer is still used due to its high accuracy. Furthermore, the amount of mercury-containing wastes, which are ejected to the oceans, must be decreased. Despite all negative influences on biosphere and ecosystem, some of toxic heavy metals, in small portions, are vital for human health.

### **References**

1. Baldwin D.R., Marshall W.J. "Heavy metal poisoning and its laboratory investigation". *Ann Clin Biochem* 1999; 36: p.267-300
2. Bánfalvi, G ."Heavy Metals, Trace Elements and their Cellular Effects". *Cellular Effects of Heavy Metals*. Springer. 2011. pp. 3–28.
3. Duffus J.H. "Heavy Metals - A Meaningless Term?" (IUPAC Technical Report). *Pure Appl. Chem.*, Vol. 74, No. 5, pp. 793–807, 2002.
4. Mahipal Singh Sankhla , Mayuri Kumari , Manisha Nandan, Rajeev Kumar, Prashant Agrawal *International Journal of All Research Education and Scientific Methods (IJARESM)* ISSN: 2455-6211, Volume 4, Issue 10, October- 2016; p.13-19

## **CARBON FOOTPRINT MEASUREMENT**

**Gulnar Sadigova**

*[gulnarsadigovasg@gmail.com](mailto:gulnarsadigovasg@gmail.com)*

### **Supervisor: Sadaqat Farzullayeva**

Carbon Footprint represents the total amount of greenhouse gases (GHG) released to the atmosphere due to a human activity or natural processes. Most common GHG include CO<sub>2</sub>, CH<sub>4</sub>, N<sub>2</sub>O, PFC, HFC and SF<sub>6</sub>, and are expressed in the general unit of CO<sub>2</sub>e (CO<sub>2</sub>-equivalents). The most influential greenhouse gas is CO<sub>2</sub> which contributes to the well-known global warming process. The main reason for the increase in Carbon Footprint is high usage of fossil fuels such as oil, natural gas, and coal. A sudden rise has been observed in the concentration of atmospheric CO<sub>2</sub> from nearly 280 parts per million (ppm) to 370 ppm in the period since the industrial revolution (end of 18<sup>th</sup> century) till present. What is more, if the current trends of fossil fuel utilization continue, the amount of CO<sub>2</sub> released to atmosphere will probably exceed 700 ppm by the end of 21<sup>st</sup> century and may cause the further increase in the Earth's global temperature from 1.4°C to 5.8°C. This global warming has severe impacts on the weather, environment, natural ecosystems, marine life, human health, wildlife,

etc., that is why it is crucial to reduce the amount of GHG, especially CO<sub>2</sub> emissions to the atmosphere. To be aware of total amount of GHG emissions, Carbon Footprint should be measured. One of the most commonly used method to quantify these emissions is Carbon Footprint which is calculated by finding the total amount of GHG emissions caused directly or indirectly by a company or a specific product. Defining the amount, scope, and boundary of Carbon Footprint is useful in terms of prioritizing the steps taken to reduce it. Moreover, Carbon Footprint measurement helps individuals and organizations to be aware of their impact on the global warming.

Carbon footprint can be calculated using Life Cycle Assessment (LCA) technique which has been internationally approved by ISO 14000 standards [1]. The method is helpful for examining the total environmental influences of a process, activity or product through all periods of their life. Life Cycle Assessment considers energy inlets and emission outputs during the whole production chain, transportation, and final utilization. In order to reduce Carbon Footprint, types of the emissions should be defined in the first place.

There are three main scopes of emission:

*Scope 1* emissions include all *direct emission sources*. These emissions are the result of assets' emissions created by an on-site processing for instance, combustion of a natural gas, physical or chemical processing, equipment leaks, vehicle emissions, and so on.

*Scope 2* emissions contain all *indirect emissions*; these are emissions formed by the production of purchased electricity.

*Scope 3* emissions include all *other indirect emissions* that are not caused by utilization of purchased electricity such as waste, water usage, consumables, and so on.

Another method to calculate Carbon Footprint is called *Multiregional Input-Output Analysis* (MRIO); it is increasingly used now to analyze environmental consequences of consumption with the inclusion of GHG emissions. What is more, a large amount of data is required to construct input-output tables which demonstrate

interconnection between various sectors of production and consumption in an economy. The multi-regional input-output tables are becoming highly attractive for displaying the global aspects of people's consumption. For example, in 2001, 22% of CO<sub>2</sub> emissions related to production of goods traded in international frame. [2]

The following steps are taken to measure carbon footprint:

- 1) *Determine **carbon footprint boundary** to cover operational control, financial control, and equity control;*
- 2) *Define **which kind of emission** will be considered;*
- 3) *Determine the **carbon footprint duration**;*
- 4) *Take **advantage of a practical method** such as use of proxies, intelligent estimation, annualizing of partial data, and so on to collect yearly data;*
- 5) ***Calculate footprint with internationally recognized techniques.***

Currently there is a lack of consistency in methods used to calculate carbon footprint, what in fact makes comparison difficult. In order to make sure that all areas, e.g. hot water systems, compressed air systems, alternative energy supply and generation, operation, ventilation settings, and so on, work as efficient as possible, energy audit should be used that is helpful for the reduction of carbon footprint [3].

The benefits for the measuring Carbon Footprint are: *cost savings, operational efficiency, business opportunities, and good corporate reputation.*

The common ways for the reduction of CO<sub>2</sub> emissions include:

- ✓ *Utilization of renewable energy sources. However, nuclear power would be more environmentally friendly energy source than many renewable energy sources due to its lower carbon footprint*
- ✓ *Conserving electricity and heating fuels*
- ✓ *Recycling materials unless the recycling process requires less energy than obtaining virgin material*
- ✓ *Stop deforestation and planting trees and so on.*

### References

1. <https://saferenvironment.wordpress.com/2008/09/04/reduction-of-carbon-footprint-is-necessary-to-save-environment/>
2. [http://www.oneplaneteconomy.com/resources/programmedocuments/WP1\\_MRIO\\_Technical\\_Document.pdf](http://www.oneplaneteconomy.com/resources/programmedocuments/WP1_MRIO_Technical_Document.pdf)
3. <https://carbonneutral.com.au/measure-your-carbon-footprint/>

## POST 2000 GAS HYDRATE INHIBITION TECHNOLOGIES

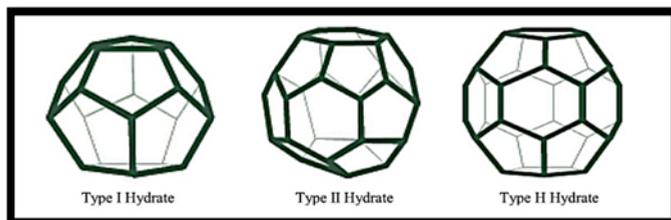
**Javad Iskandarov**

[javad.iskandarov.b0084@bhos.edu.az](mailto:javad.iskandarov.b0084@bhos.edu.az)

**Supervisor: Sadaqat Farzullayeva**

*Gas Hydrates* are crystalline compounds consisting of *host* (water) and *guest molecules* (CO<sub>2</sub>, CH<sub>4</sub>) and are members of *clathrates*. Though they look like ice, *Gas Hydrates* have different chemical properties such as existing well above freezing point of water (up to 20°C). In the formation process, water molecules create framework via hydrogen bond and hold gas molecules inside the empty cavities formed inside these frameworks [1].

The general formula for gas hydrates is  $M.nH_2O$ . Three forms of hydrates are known (*Type I*, *Type II* and *Type H*). *Type I* and *Type II* are the most common ones.



**Figure1.** Forms of gas hydrates

*Type I* hydrates are able to hold small molecules such as methane, ethane, hydrogen sulfide and carbon dioxide; while *Type II* hydrates

form larger cages and can encapsulate larger molecules like propane and butane. Type H hydrates are the largest gas hydrate type with more complex frameworks that can host even iso-pentane molecules [2].

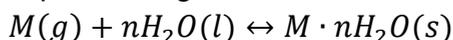
Gas hydrates naturally exist in different places of the Earth. It creates challenges for petroleum and gas industry in exploration, production, processing and transportation. For gas industry it mainly causes plugs in pipes that can inhibit the flow in streams; the removal of plugs can be difficult and expensive.

### Formation of Hydrates

Gas Hydrate formation can be considered as both physical and chemical processes and includes 4 constituents:

- 1) **Host molecules** (water)
- 2) **Guest molecules** (gases),
- 3) **Low temperature** (<20°C)
- 4) **High pressure** (>30 bar).

The main step of Hydrate formation is *formation of cages*. They are formed with hydrogen bond and guest molecule is rotating in the void spaces of empty cavities. The process can be divided into hydrate nucleation and growth [1]. *Hydrate nucleation* is the process (known as *hydrate nuclei*) of formation of a *liable cluster* from water and gas molecules. As *liable cluster* is not stable, it continues to disperse and grow. The process equation is given below:



*Hydrate growth* process is continuation of the *gas hydrate nucleation* and is known as *agglomeration process*.

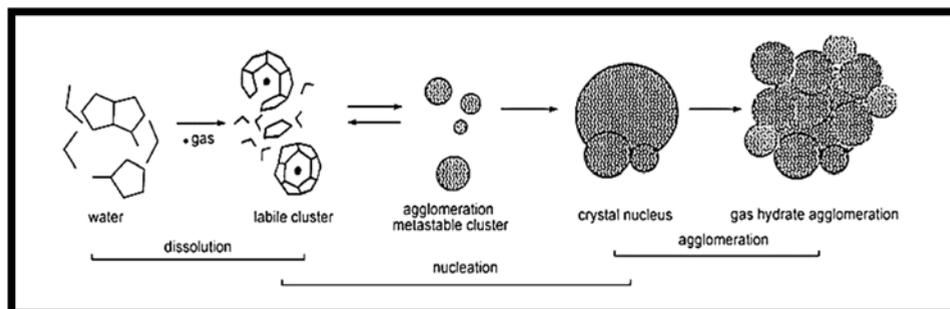


Figure 2. Formation mechanism of gas hydrates [2]

## Hydrate Inhibition

For *inhibiting hydrate formation* oil and gas platforms have *Water Dehydration* systems. As it is very costly to install this unit on platforms, cheaper alternatives of it have been investigated by researchers. The most known alternatives are *chemical inhibitors* that are changing the hydrate forming curve to change hydrate formation conditions. *Thermodynamic inhibitors (TDIs)* (*methanol, ethanol glycol*) have been used for inhibiting hydrate formation since end of 20<sup>th</sup> century. However due to their disadvantages such as *corrosion, salt formation* and high cost alternatives for *TDIs* are being also investigated.

### Low Dosage Hydrate Inhibitors

*Low Dosage Hydrate Inhibitors (LDHIs)* affect only kinetics of hydrate formation rather than thermodynamics and delay formation of hydrates rather than completely inhibiting them [3]. *LDHIs* are classified into *kinetic hydrate inhibitors (KIs)* and *anti-agglomerants (AAs)* and have own advantages and drawbacks.

*KIs* are mainly *water soluble polymers* and affect the kinetics of hydrate formation by inhibiting the nucleation and growth of hydrate crystals. *AAs* only prevent agglomeration of hydrate crystals what leads to the formation of transportable hydrate slurry. *LDHIs* have being implemented starting from the 21<sup>th</sup> century, however their applicability on limited conditions only (moderate sub-cooling, low water content) as well as degraded performance resulted from contact with other added chemicals (anti-corrosion, anti-wax, anti-foam inhibitors) restricts *LDHIs'* wider utilization.

### References:

1. Sloan, E.D., *Fundamental principles and applications of natural gas hydrates*, Nature, 2003, 426(6964)
2. Engeloz P., *Clathrate Hydrates, Industrial and Engineering Chemistry Research*, vol.32,p.1253, 1993
3. Igboanusi U.P., Opara A.C. *The Advancement from Thermodynamic Inhibitors to Kinetic Inhibitors & Anti-Agglomerants in Natural Gas Flow Assurance*. International Journal of Chemical and Environmental Engineering, 2011, vol. 2, No.2.

## **TULIP SHAPED SOLAR POWER PLANTS**

**Novruzov Fərid**

*farid.novruzov.b0325@bhos.edu.az*

**Supervisor: Dr Sanan Eminov**

Today, while a substantial progress occurs and energy is the important factor which can lead a maintainable development over the world. Over the history, it has been irreplaceable to almost of human activities as examples of industry, agriculture, domestic life, and transportation. However, the fossil fuels have a hugely dominated influence in today's energy system. In the developed countries - in other words- industrialized countries, the energy consumption is much higher (80% of total fossil fuels). In accordance with this fact, it is the main reason of the greenhouse effect. As considering the scientists' assumption, the world population will double till 2050 and the energy demand will increase triple by the middle of this century. It is hardly to imagine the future of our planet if we consider the environmental pollution causing from many decades of demographic growth. The energy demand will apparently increase due to developing of technology and modern equipment. In order to protect our Earth we should modify the course of events. The best way is the saving of energy consumption and the using the renewable energy sources. In the Earth there is many renewable energy sources which can provide a huge amount of energy. Such as, solar power, wind power, hydroelectric power, hydrogen, geothermal, biomass, ocean energy and etc. Today we will talk about one of the special type of solar power- Tulip shaped solar power plants.

As mentioned above solar power is one of the most perspective alternative energy sources. As human society being, the Sun will shine. Nowadays, there are several types of equipment which can utilize solar power. The tulip shaped solar power plants is the innovative type of device between the alternative energy devices.

The designer of this turbine is Israeli architects Haim Dotan and Aora Solar, and this solar turbine are able to supply the energy demand of 60-80 homes at the same time, connecting of sculptural infrastructure and architecture, to establish a magnificently efficient—and appealing—power source

As seen its name it has 100-foot height and shape of the tulip. This solar power source supplies clean and continuous generated energy, even if at night, because it is the first hybrid solar power producer in the world.

A lens which is placed in the tulip-shaped tower, admits the concentrated sun rays and it reflects off these rays to the 50 mirrors. On the other side of the lens, 1000 Celsius temperature is utilized to heat air, following with hot pressurized gas. This gas is supplied after, to twist on the baled of turbines in order to generate the electricity. The mirror is constructed to regularly pursue the sun rays, guiding the light in the direction of tower's lens, all times. Throughout cloudy weather or the night, the tower's turbine automatically utilizing biofuels to warm air inside and supply the turbine with power. This allows the tower generating energy all times (24/7). Comparing with other conventional solar thermal systems, it supplies the steam to run large turbines and the Tulip needs only 8% of the amount of water, making it excellent in the desert region.

**References:**

- [http://www.iea.org/bookshop/720-World\\_Energy\\_Outlook\\_2016](http://www.iea.org/bookshop/720-World_Energy_Outlook_2016)
- <https://www.bp.com/content/dam/bp/pdf/energy-economics/statistical-review-2016/bp-statistical-review-of-world-energy-2016-full-report.pdf>
- <http://www.alternative-energy-news.info/tulip-solar-ethiopia/>
- <http://aora-solar.com>
- <http://www.goodnewsnetwork.org/when-a-solar-plant-becomes-a-sculpture-garden-tulip-power-blooms/>

## **GEOHERMAL POWER, NON-CONVENTIONAL METHODS**

**Shabnam Mursalova**

*Shebnem.murselova27@gmail.com*

**Supervisor: Dr Sanan Eminov**

The term of “Geothermal” is the combination of two basic and crucial Greek words. “Geo”- means “earth”, while “thermal” means “heat”. Hence, geothermal energy is the heat which is harnessed from the earth [1]. Temperature of the earth is increasing from surface to the center and heat is continuously radiating due to radioactive decay of elements including uranium, thorium, potassium and radium and the generated temperature is so high that temperature reaches to approximately 5500 °C, to the center of the Earth (~6500 km deep) and interior core is molten. With the increasing demand for energy and considering environmental problems by fossil fuels encouraged to consider development of renewable energy utilization. Without any dependence on weather or time of day, clean, renewable and indigenous energy can be harnessed by geothermal power. Improvements of the geothermal industries have been achieved by great advancements in geosciences including geology, geochemistry, and geophysics. Geothermal power differ from other renewable energies including large amount of reserves, higher reliability and sustainability, lower environmental effects such as lower carbon footprint. Although its maintenance cost is satisfactory, as a crucial hindrance, its high initial investment costs and longer payback period restrict usage of geothermal power. According to the estimation of scientists, there are 42 million Megawatts (MW) power present beneath our feet. This amount means billion years limitless and renewable supply of energy. Three main conventional power plants are available: Flash, Dry steam, and Binary power plants. In addition

to power plants, without getting to the deep depth of the earth, geothermal power is utilized by means of GHPs (Geothermal Heat Pumps). Having discussed the conventional techniques used in geothermal power industry, there are also emerging technologies and processes will be presented which are predicted to develop and expand geothermal power usage and collaborate working in which “win-win” mechanism is satisfied. EGS (Enhanced Geothermal Systems) are used to create artificial conditions for reservoirs to develop potential of producing geothermal power. Reservoirs require working fluid, heat, permeability and in the case of any deficiency, EGS can enhance fracture networks, introduce water or build on a reservoir in which it is very difficult to obtain power in a conventional methods and technologies. Using EGS, energy can be extracted from dry rock formations in 4-10 km depth [2]. Another essential chance for geothermal power is coproduction in oil and gas industry. It is known that million barrels of hot water is thought “waste” annually, however from this “wastewater” quite large amount of geothermal power can be harnessed. The wells in which oil extraction has been abandoned, geothermal power can be harnessed and as a result both drilling cost will be diminished and achieved more renewable energy [3]. Another perspective of geothermal power usage is “Supercritical cycles”. Here as a working fluid, supercritical fluids are introduced to the wells. When the fluid is in supercritical state, it means temperature and pressure is above the critical point for that fluid. In that state, liquid and vapor do not differ from each other. Introducing such a fluid into wells, these fluids heat up and expand, as a result fracture system in rock is increasing which is desirable for geothermal production. The fluid then pumped to the surface to transfer the energy to the turbine, after that fluid is returned to the reservoir. As an example of such fluid CO<sub>2</sub> (carbon dioxide) can be said. Using this substance both geothermal power production is expanded and emissions from nearby plants can be decreased resulting in negative CO<sub>2</sub> emission [1]. It would be said that geothermal power sources are considered endless, however their

potential depends on commercial possibilities including available land and technological limits.

### **References**

- [1]. Geothermal Basics: Q&A, Geothermal Energy Association, September 2012
- [2]. "A Special Issue on Geothermal Energy"- Roland Horne, Kewen Li ,Published online: 12 December 2014, International Association for Mathematical Geosciences 2014
- [3]. Geothermal energy production utilizing abandoned oil and gas wells, 2011 Elsevier Ltd.

## **USING OF MUNICIPAL SOLID WASTE (MSW) IN THE WASTE- TO-ENERGY PLANT**

**Tunzala Imanova**

[tunzale.imanova@inbox.ru](mailto:tunzale.imanova@inbox.ru)

**Supervisor: Dr Sanan Eminov**

It is obvious that the population of the world increases year by year which results the increase of the demand for the energy. Also the growing world population and welfare causes the raise of the consumption basket. Due to the expanding consumption basket the amount of municipal solid waste also enhances. Firstly, it will be better to define the term of municipal solid waste, namely MSW. MSW is the daily waste such as food trash, plastics, papers, metals, glass and others that are thrown out by the people. There is one important thing that the medical, industrial and agricultural wastes are not taken into account as the municipal solid waste. Huge amounts of municipal solid waste now are existent in everywhere, poisoning the surrounding and breeding serious risk to the human health. Mainly countries landfill these wastes which reason the garbage overflow in landfilling areas. However, proper management of MSW can diminish trash and can

guard the environment. Energy from waste subsidizes to fathom the problem of waste accumulation and actively helping to protect the environment. Also appropriate management of MSW can help to encounter the energy demand of increasing population to some extent. There are several methods of getting energy from the municipal solid waste. One of the most popular techniques is using MSW in the waste to energy plants.

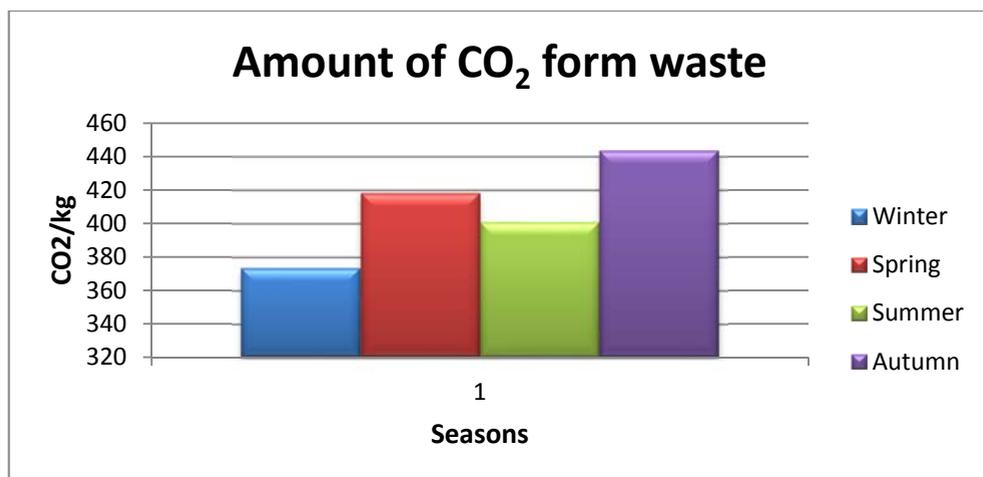
It is necessary to define the term waste-to-energy. Waste-to-energy is the process which produces heat or electricity from the municipal solid waste and plants which do this work is called waste-to-energy plants. During this process heat or electricity, which can be used for providing the homes with heat or electricity energy, are produced by the incineration of the municipal solid waste. However one question arises about the gas like carbon dioxide that is emitted from the burning of the municipal solid waste because these gasses are the greenhouse gases. It is essential to highlight that when the municipal solid waste is landfilled the amount of methane that releases from it is 62 m<sup>3</sup> for 1 metric ton of the MSW which has the more global warming prospective. Nevertheless, the amount of carbon dioxide that coming from the burning of the MSW is two times less from the amount of the methane that comes from the landfilled MSW [1]. Therefore in the most countries there are waste-to-energy plants and also in Azerbaijan, in Baku on 19<sup>th</sup> December 2012 such plant was constructed. In Baku the municipal solid waste is 350 kg per capita and 500 000 tons annually for the whole Baku population [2]. These wastes are collected in Balakhani polygon and then are sent to the waste-to-energy plant. In this plant 231.5 kW-h/year electricity energy is produced from the waste [3]. It is obvious that this amount of electricity cannot provide the whole Baku with the energy but it is advantageous to some extent and most importantly this method is ecologically friendly and landfilling litter. In order to indicate the benefits of this plant I did some statistical research and got some results which are shown on the following diagrams:

number of members of family	5	amount of gas which creates electricity
household waste (kg/day)	1	1636 (kg CO <sub>2</sub> /year)

**Table 1.** Amount of CO<sub>2</sub> from waste in one family

Seasons	kg waste	kg CO <sub>2</sub>
Winter	456.25	373.49
Spring	456.25	418.29
Summer	456.25	400.92
Autumn	456.25	443.73

**Table 2.** Amount of CO<sub>2</sub> from waste seasonally in family



**Graph 1.** Amount of CO<sub>2</sub> from waste seasonally in family

All these results are obtained from the experiments that are conducted in the Baku and are average results.

### References

1. <http://www.eia.gov/>
2. [http://www.icc-r.cz/files/tamiz\\_shahar\\_baku\\_waste\\_management\\_pptx.pdf](http://www.icc-r.cz/files/tamiz_shahar_baku_waste_management_pptx.pdf)
3. [www.tamizshahar.az](http://www.tamizshahar.az)

## **NON - EDIBLE BIOMASS RESOURCES OF WORLD**

**Vugar Hasanov**

*H.vugar7@gmail.com*

**Supervisor: Dr Sanan Eminov**

In some developed countries, natural gas, oil and coals are heavily used to derive an energy. It should be taking into account that obtaining energy from those is too expensive as well as being environmentally damaging for nature of the world. Therefore, currently, it is needed to use the renewable energy sources for the future of environment. There are various kind of them such as water, solar, wind power which are mainly recharged and will never denied.

One of the most important type of them is called Biomass. Biomass are constantly utilized to create thermal energy, renewable electricity, biofuels, and so on. In addition, co firing of coal and biomass improves effectiveness of the cost and eliminate air pollution in the living power plants as well as greenhouse gas emissions. A broad diversity of biomass feed stocks can be easily generated in any places that animals & plants can exist. This makes biomass be considered an extensive and flexible resource that can be used to provide regional objectives and needs. Some of the most promising and widespread biomass feed stocks are given below:

- **Starch and grains crops** – industrial sweet potatoes, corn, sugar beets, sugar cane, wheat, etc.
- **Agricultural residues** – Orchard prunings, corn stover, rice straw, wheat straw, etc.
- **Wastes** –food processing waste, waste cooking oil , wastewater treatment sludge, lawn wastes, etc.
- **Animal byproducts** – Fish oil, manure, Tallow, etc.

Fish oils, corns, and other necessary edible products are currently used in the process of producing energy. Uses of food in this field

comes with sacrifice and high cost. It should be taking account that during the followig decades population of the world will increase. As a result of this, the importance and uses of edible products will also increase as well as the amount of energy that will needed to provide them. Therefore, the uses of edible products must be thrifty. Moreover, this would be more reasonable that if the lower-cost and reliable non-edible biomass resources are utilized instead of the edible ones in the renewable energy plans to produce electircity or heat. There are some appropriate crops that are offered to use in electricity generation and biofuel production.

### **Crops for Renewable energy**

- *Fooder and sugar beet* can be transformed into bioethanol by using the resembling techniques to those that are utilized for wheat.
- *Wheat* can easily be transformed into bioethanol by using of the fermentaion and enzymes technology.
- *Short rotation coppice (SRC)*. For example - alder, silver birch, willow, sycamore, ash, poplar.
- *grass* - switch grass, rye grass, reed canary grass
- *oilseeds* - the producted crop is depressed and purified to create the biodiesel (mahua, microalgae, karanja, jatropha)

They are easily grown in the almost anywhere, even on the saline, sandy, and gravely soils. For instance, Jatropha, It can flourish on the poorest & sordest soil with stonnes. It has a very low water requierement rate and it can stand long periods of thirsty by pouring out its leaves to eliminate the transpiration losses.



**Sugar Cane**



**Jatropha**

To conclude, it is needed to change strategy of the gaining energy from the nature. It is non deniable that a renewable energy is very important to future of the world but this also should be take into account that it is possible to fullfill the renewable energy plans with the utilizing of non edible products. This helps us to preserve money and efficiency as well as to eliminate carbon emissions from environment of the world.

**References:**

1. Centi, G., Perathoner, S. (2006): Converting CO<sub>2</sub> to fuel: A dream or a challenge?
2. Materials and processes for energy: communicating current research and technological developments (A. Méndez-Vilas, Ed.) , page 241

## **SOLAR TREES, THEIR APPLICATIONS AND USAGES**

**Vusal Guluyev**

[guluyev.vusal97@gmail.com](mailto:guluyev.vusal97@gmail.com)

**Supervisor: Dr Sanan Eminov**

These days, the world population growth all over the world contributes to an increase in energy requirement, the first thing needed to be considered as a best option is renewable energy. However, one of the foremost issue that should be borne in mind is to prevent any natural jeopardies and contamination which the energy system implemented can bring about. Taking all into account, the solar energy is one of the ideal preference for the world countries which are highly populated. More importantly, the benefits from such kinds of energy systems requiring less space to construct and producing energy more efficiently should be taken. The innovation that includes all the excellences mentioned above is called “Solar tree” designed with the technique called “SPIRALLING PHYLLATAXY” which in turn, helps to get more effective plant. This design can be utilized for the industrial

power supply, for street lightening, car parks and etc. This newness is a better one than traditional PV systems due to higher efficiency and saving space. Henceforth, in more details, this new design will be discussed in the following paper.

### **What is a solar tree?**

It is an aesthetic solar energy means generating solar energy and electricity. Various number of solar panels located on a tall pole or tower that looks like a natural tree.

**TREE purports:** T- tree generating, R- renewable, E- energy and, E- electricity. In terms of structure, it is like a real tree and the panels on it resemble tree leaves generating energy.

**SPIRALLING PHYLLATAXY:** this is a way/technique which the solar tree is designed with. The method prevents the lower panels from the shadow of ones on the upper side, henceforth, the tree is able to accept maximum power from the Sun.

**Components of Solar Tree:** The solar tree comprises of primarily 5 sections. 1) Solar Panels 2) Stems for attaching the panels 3) Batteries 4) Long Tower 5) LDEs

**Working of Solar Tree:** Throughout the day, the solar panels on the Tree charge batteries. This Solar Tree switches robotically on the LEDs at the dusk side. Based on the amount of charge gone in the batteries, the internal regulator also control the light quantity produced.

The advantages:

1) No air pollution 2) When the streets are lightened, there is no impact of power outages. 3) People are able to save money 4) Land prerequisite is extremely less 5) In the countries that are poor, electricity would be accessible for people 6) Almost, in all sites, these trees can be feasibly established.

The disadvantages:

1) Cost is high 2) Dangerous for eyesight 3) Hazardous to birds and insects (Indeed these are the disadvantage of Solar panels)

**Research part:** Why is it better than traditional ones?

In order to produce 2MW power from PV modules, 40468.6m<sup>2</sup>-48562.3m<sup>2</sup> of land is required to house panels. Nevertheless, to get the same amount of energy, 404.686 m<sup>2</sup>- 485.6228m<sup>2</sup> land is needed. During Research Process, some interesting results are acquired with comparison to traditional ones.

The way to arrange solar panels	Electricity
Traditional (flat)	100% (just assumption)
Solar cells on the tree	20% more than traditional(flat) ones

- With the series circuit, the solar tree system generates 2.68watts, which in turn going to be 9.648kilowatt-hours, further 84516.48 kilowatt hours per year. However, if it is single solar panel system, this produces accurately 1waatt, which in turn going to be 3.6 kilowatt-hours, further 31536 kilowatt-hours per year. This results in that, solar tree with the design parallel circuit generates 268% more power.

**Applications:**

1) Street light 2) House supply 3) Industrial power supply

Applications and Usages in Azerbaijan are being worked on, for Baku boulevard. Energy to lighten-will be determined, correspondingly, the numbers of tree-will be determined. Overall Cost- will be determined. Eventually, the potential for our boulevard will be possible to detect and apply this project

To conclude, solar tree seems the perfect way for future energy requirements. It is a groundbreaking city lighting idea which displays picture-perfect association betwixt initial design and leading-edge eco-friendly tools.

**References:**

- Agrafiotis, C.; Roeb, M.; Konstandopoulos, A.G.; Nalbandian, L.; Zaspalis, V.T.; Sattler, C.; Stobbe, P.; Steele, A.M. (2005). "Solar water splitting for hydrogen production with monolithic reactors".
- Bradford, Travis (2006). *Solar Revolution: The Economic Transformation of the Global Energy Industry*.
- Anderson, Lorraine; Palkovic, Rick (1994). *Cooking with Sunshine (The Complete Guide to Solar Cuisine with 150 Easy Sun-Cooked Recipes)*.

## ZEOLITES AS CATALYSTS IN PETROCHEMICAL INDUSTRY

**Garanfil Ahmadova**

*qerenfil ehmedova@mail.ru*

**Supervisor: Sevda Fatullayeva**

Zeolites (zeo-boiling, lithos-stone) are microporous crystalline solids comprised of aluminum, silicon and oxygen in their frameworks, cations, water or other molecules inside their pores. Due to their unique porous properties, zeolites and molecular sieves have played an important role in reforming, improving and revolution of oil-refining processes by making changes in product selectivity and working parameters in order to obtain desirable yield without changing whole process.

### **The role of zeolite catalysts**

Zeolites can behave as acid catalysts for cracking and isomerization processes, metal catalysts for redox and hydrogenation processes, base catalysts, and bifunctional catalysts which have acidic and hydrogenating functions used for hydrocracking, aromatization, and isomerization of light alkanes, catalytic dewaxing, and isomerization of C<sub>8</sub> aromatics [1]. Zeolites are also used in alkylation of benzene by short and long olefins, and transalkylation of toluene-xylene aromatics.

**Fluid catalytic cracking catalysts (FCC)** include zeolite Y and ZSM-5 catalyst, and are used primarily in improving yield of gasoline, C<sub>3</sub> olefin, and LPG distillate. Zeolite Y has two functions: (1) octane making, and (2) gasoline making which is dependent on the refiners need. The main difference between them is rear earth (RE) amount. Y zeolite which has higher RE, about from 3 wt% up to 15 wt% Re<sub>2</sub>O<sub>3</sub> is capable to preclude zeolites from strongly de-aluminating, as a result, provides high acid site density, and stabilization of acid sites, ability of hydrogen transfer, and provide hydrothermal stabilization of zeolites [2].

If the RE below 3 wt%, dealuminating increases, and it leads to that products less aromatic, and more olefinic, and also the activity of coke formation (condensation reactions) is decreased. ZSM-5 zeolite catalyst is octane boosting additive that increases the octane number resulting the increase in olefin content. Nowadays, in order to meet the continuous demands, 232 unique zeolite frameworks such as ITQ-n, for example, ITQ-13/-17/-21 have been identified recently, for maintaining favorable conversion of heavy crudes into lower aromatic content fuels with producing maximum light olefins. The synthesis of germanium silicate according to ITQ-13 framework constitutes of three directional group channels, each two group which intersect each other are comprised 10 MR (member ring), and third group is comprised of 9 MR. ITQ-13 zeolite crystals are plate-like form, and as the temperature of crystallization increases, the thickness of the plate increases. ITQ-13 has stronger acid sites than ZSM-5 framework, and provides higher propylene production [2].

Catalyst Feed	ZSM-5		ITQ-13	
	1-Hexene	4-Methyl-1-pentene	4-Methyl-1-pentene	1-Hexene
Cat/oil	0.05	0.05	0.09	0.09
Conversion (wt%)	54	9	49	54
Liquids (wt%)	25.81	21.84	16.03	18.37
Gases (wt%)	27.85	26.82	32.31	34.81
Coke (wt%)	0.35	0.34	0.67	0.53
H <sub>2</sub> (wt%)	0.01	0.01	0.009	0.003
C <sub>1</sub> (wt%)	0.04	0.05	0.1	0.06
C <sub>2</sub> (wt%)	0.13	0.07	0.06	0.14
C <sub>2</sub> <sup>-</sup> (wt%)	2.67	2.33	2.02	2.43
C <sub>3</sub> (wt%)	1.7	1.65	0.88	0.6
C <sub>3</sub> <sup>-</sup> (wt%)	<b>11.91</b>	<b>11.21</b>	<b>19.17</b>	<b>20.86</b>

**Table 1.** Catalytic cracking of 1-hexene and 4-methyl-1-pentene over ZSM-5 and ITQ-13 [2]

As seen from the Table 1, catalytic studies show that by using ITQ-13, higher propylene selectivity, higher percent of coke and gases, and larger conversion percentage of compound are obtained. ITQ-13 has strong electric field gradient due to its smaller pore dimensions and strong acidity as comparison with ZSM-5, and because of that ITQ-13

gives higher propylene production. Further development to germanium-silicate crystallization based on ITQ-33 framework which has 18 and 10 MR with 1.2 nm pore diameter in order to overcome the increase demand in diesel. The larger 18-MR pores also result in larger proportion of alkylation products, especially, di-isopropyl- and tri-isopropylbenzene [2].

### **Conclusion**

Zeolites are considered the most favorable catalysts because of their specific physicochemical properties: pore dimensions, high surface area, interconnection of pore-channel system, possibility of adjusting of the acid sites, high absorption capacity, and ion exchanging capacity [3].

### **References**

1. C.Henriques, Department of chemical engineering, "Catalysis by Zeolites".
2. N.Choudary, B.Newalkar "Use of zeolites in petroleum refining and petrochemical processes: recent advances", Journal of Porous Materials, 2011, v.18, pp. 685–692.
3. A.Chica, "Zeolites: Promised Materials for the Sustainable Production of Hydrogen", ISRN Chemical Engineering 2013, V. 2013, Article ID 907425, 19 p.

## **USE OF COMPUTATIONAL FLUID DYNAMICS FOR SIMULATING TWO PHASE FLOW**

**Aygul Karimova**

*Kerimova.aygul@gmail.com*

**Supervisor: Sevda Zargarova**

### **Introduction**

Modelling of multiphase systems is a great interest in chemical engineering field in terms of interactions between multiple phases during transportation, reaction, separation and other type of process where more than one phase is present. Fluid phase distribution in

horizontal, vertical pipes, in tubes of heat exchanger as well as reactor are main objective of this research project. In multiphase systems, interaction between phases or particles of each phase strongly affects momentum, velocity, pressure, and other parameters of whole system [1]. The prediction of these issues is challenging in terms of experimental methods and require high amount of capital investment. Multiphase flows are observed when either more than one material is present in flow or more than one phase of the same material is present in different physical state or in distinct chemical properties. It could be either immiscible liquids, or even solid gas/liquid phases, which are often observed in catalytic reactors where solid phase plays role as catalyst within the reactor [2]. Several situations are possible depending upon either the one phase are stationary or movable, the interaction between the phases, influence of phase to flow of whole mixture and etcetera.

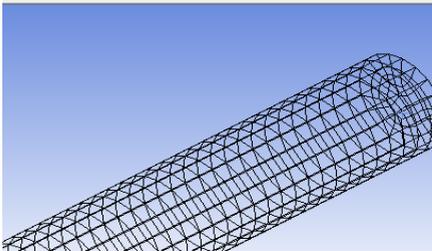
### **Research Overview and Objectives**

The experimental investigation of this work was done by simulating of horizontal tube with diameter length 26mm and 1000mm respectively in 2D model of ANSYS FLUENT before [3]. Experimental values of liquid holdup and plug formation was analyzed per 7 cases, by fluctuating the supercritical inlet velocities of 2 phases, namely water and air. In computational fluid domain, the method of modeling was volume of fluid which is considered as the best in convergence with experimental flow regime of air and water [4]. As gas and liquid phases were flowing through small diameter, the regime was treated as turbulent. From theory, it was defined that the suitable method of turbulent flow modeling us k-epsilon model which was applied to this work as well. The simulation models [5] showed that from observation point of view plug formation within the experimental object (horizontal tube) was relevant what software simulated [6], while experimental results are not available from literature. In this research project, I have investigated the software prospective in simulation of 2 phase flow in 3-dimensional space. Water-air mixture at 7 seven different inlet boundary conditions were simulated [8]. The main objectives were;

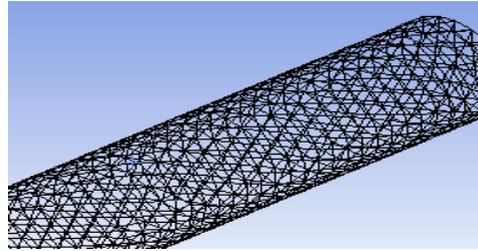
1. To simulate water-air mixture at different boundary conditions in 3-dimensional space and compare the results with 2 dimensional space simulation that were carried out via ANSYS FLUENT with the same model approach.
2. To check convergence of other models (Eulerian and Mixture)
3. To investigate CFX fluid flow application for this work and compare the results obtained from FLUENT

## **Results and discussion**

Examples of meshing:



**Figure 1a**



**Figure 1b**

Figure 1a indicates standard meshing with elements of 16666 and nodes of 11729 while figure 1b demonstrates tetrahedron meshing with number of elements and nodes of 51649 and 18942 respectively. Meshing type with tetrahedron geometry increases the number of elements to be calculated by software [10], hence iteration time with this meshing for obtaining numerical solutions will require more time and subsequently good quality of hardware. [9] The principle of solution for partial differential equations determined by models is based on either FEM, FVM or FDM. [8]

Models selection in FLUENT was Volume of Fluid and Eulerian and the results of them is demonstrated below.

From graphs of residuals shown it was clear that the VOF model was more accurate in comparison to Eulerian model as the residuals were decaying with iteration in the first model, which is the same as theory states [6].

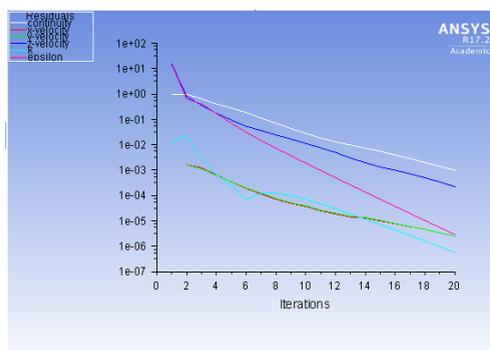


Figure 2a

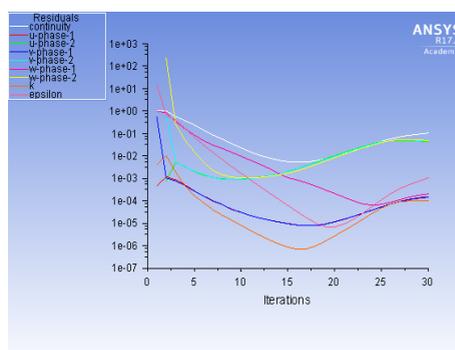


Figure 2b

Simulation shows that the plug is formed near to the outlet of the pipe due to movement of air present in the composition of the mixture toward the upper part of the pipe hence disturbing the velocity profile of the mixture. Several experiments with software at different boundary conditions were carried out and in conclusion it was found out that VOF model was best suited to plug flow air water mixture within the horizontal pipe.

### Reference

1. J.D. Anderson, J. *Governing Equations of Fluid Dynamics*.
2. Bengt Andersson, Ronnie Andersson, Love Hakanson, Mikael Mortenson, Rehman Sudiyo, Berend van Wachem, 2012
3. W.E.Dunn, A.K.Vij, 1996
4. Deenderlianto, M. A. (2013). CFD studies on gas liquid two phase flow in horizontal pipe.
5. G.P.Nikishov. (2004). *INTRODUCTION TO THE FINITE*.
6. Gibson, V. A. (2007). DOE Multiscale Summer School, Oregon State University.
7. Barkonov, E. (2011). *INTRODUCTION TO THE FINITE ELEMENT METHOD*. Riga
8. Joaquim Peir'ó and Spencer Sherwin, D. o. *FINITE DIFFERENCE, FINITE ELEMENTAND FINITE VOLUME METHODS FOR PARTIAL DIFFERENTIAL EQUATIONS*.
9. Kuzmin. (Dortmund). <http://www.mathematik.uni-dortmund.de/~kuzmin/cfdintro/lecture4.pdf>. Retrieved from introduction to CFD lecture 4.
10. Marqu'és, J. M. *Introduction to the Finite Volumes Method.Application to the Shallow Water Equations*.

## **FACE RECOGNITION METHOD BASED OF PHOTO**

**Leyli Abbasova**

*leyli.abbasova.b0218@bhos.edu.az*

**Supervisor: Naila Allakhverdiyeva**

### **Introduction**

Humans identify and recognize objects or people automatically. They don't need specific teaching or ability for this. So for the interest and purpose, scientists try to apply this characteristic of people to machines by helping of different type of methods. Nowadays, face recognition is widely used in most of the areas. Scientists and engineers always search the best way to identify and detect human's face. Main goals are to decrease the number of steps in the code, to get more accurate answers, to avoid errors, and to use this program for many applications.

### **Process**

The process of recognizing faces in the image has different steps. The first step is finding all the faces in the image. It is also called face detection. There are many ways to detect the face. In my research, I used Histogram of Oriented Gradients. In this stage, we will use an image in black and white. Because we don't need a colorful picture at this stage. The program will detect arrows which go from lighter pixels to darker pixels. This arrows also can be called gradients. At the end, we will get HOG version of the image. So, by comparing this HOG version of an image with another HOG version of images, we can get result easily that whose face this is.

Step 2 is about finding projecting and posing faces. This step is much more difficult than the first one. I used face landmark estimation algorithm in this stage. After detecting mouth and eyes by helping of this algorithm, the picture will be rotated, scaled and shared.



**Figure 2.** HOG version of image

Next step is face recognition. In this stage, we need image database. By helping of the database, we can compare current image with old images. But, before comparison we to get data about face measurements. Deep Convolutional Neural Network helped me in this stage. This method takes 3 pictures and compares them with one another.

- First picture is face of known person
- Second picture is another face of same known person
- Third picture is face of different person

Finally, after getting the measurements of faces we continue to the final stage. The last stage is about finding a name of the person. This stage is pretty simple. I did it by the simple classification algorithm. As a result, the program should give a right name of the person which is shown in the picture.

### **Strength and Weakness**

The main strength of this program is its accuracy. By using this method, we can face fewer errors. The weakness of this method is similar to other program's challenged. For example:

- Illumination variations
- Pose variations
- Facial expressions
- Use of cosmetics and accessories, hairstyle changes
- Temporal variations (aging, etc)

### **Summary**

There is no 100% perfect system in nature. So, this system which I discussed is not perfect too. But we can approach to perfect value and decrease errors. This method has fewer errors comparing with other methods. So, by using this method we can get more accurate answers.

## **MOBILE APPLICATION FOR STUDENTS**

**Hajali Bayramov, Rashad Shirizadeh**

*hajalibayram@outlook.com, shirizade98@gmail.com*

**Supervisor: Leila Muradkhanli**

Technological developments in mobile phone market bring about dozens of brand new applications every minute. They have not changed their holy purpose of being created yet. They still serve to bring comfortableness and make human life simple and easy to live. It has become part of our daily life since then, and is turning smarter.

There are almost as\_endless\_as the reasons for using them, however the biggest advantage of smart phones can be considered as their simplicity, accuracy, and all-in-one principle. Instead of using some complicated machines, the problem can be handled by one pocket size smart phone at the moment. Moreover, it is simple to use rather than dealing with sophisticated machines.

Simply, this project represents an application for students that they can use for their convenience in their university life. By using this app,

students of any university can easily know their truancy level and be informed when they exceed the limit immediately. Besides, each user can see their timetable at any time they want by opening application. Apart from that, we plan to send cutting-edge notification about their truancy state, condition of their stipend to each student uses this application.

For start point we try to keep it simple, so do not add extra features, but in not far future, app can not only meet students' basic ends, but also provide many complicated data and demands that seem inconvenient for students.

In order to complete this project we basically had to know android programming which is based on Java programming language. Besides, we give support to this project by so many online tools from the Internet.

In a nutshell, this project can be quite useful for numerous number of students, and can be considered very vital in an attempt to make students more enthusiastic to attend classes and be more informative about their situation at any time they want in anywhere they need.

## **GYROSCOPE-BASED ARDUINO CONTROLLED CAR PROTOTYPE**

**Nicat Hasanov**

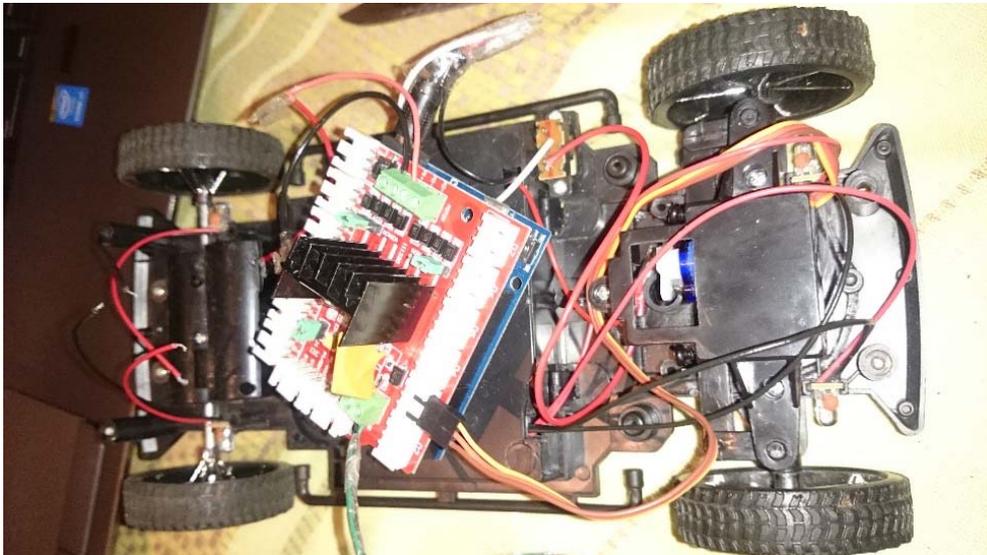
*[nicathesenov@hotmail.com](mailto:nicathesenov@hotmail.com)*

**Supervisor: Abbas Alili**

AcceleroCar is a RC car which enables us to get rid of traditional controller with buttons and drive the car with wheel. By tilting the wheel in two directions, the car can be fully controlled. But for convenience, there is another control mode to drive the car back and forth with buttons and steer with just tilting the wheel. Distant WiFi connection between car and wheel is established with Wemos D1 board which is

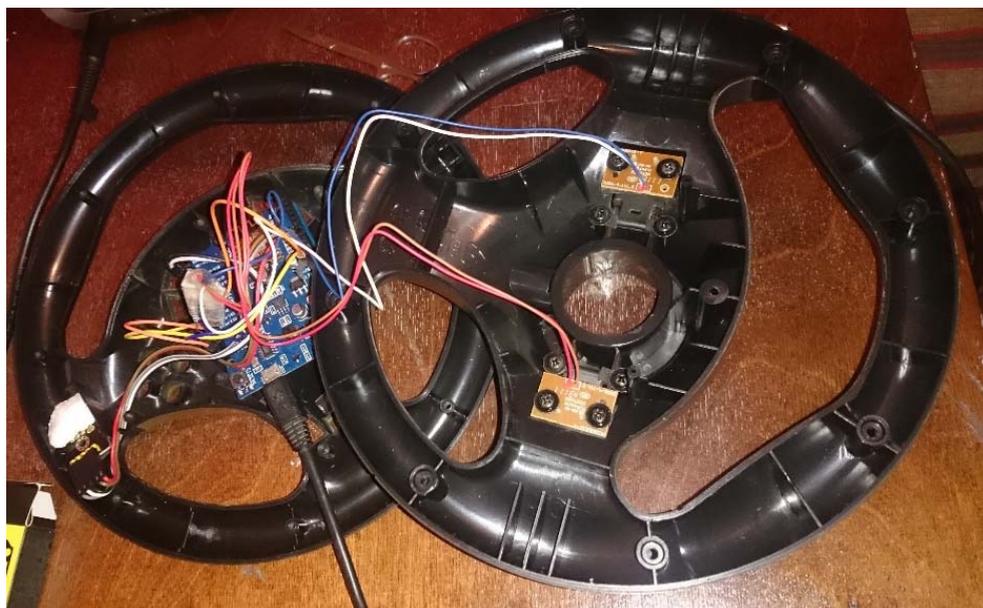
based on ESP8266 low-cost WiFi chip. Thanks to this chip, the car can be controlled from distances up to 1km. Now let's take a closer look at car and wheel and their parts separately.

**Car** consists of 4 main parts: Wemos D1 board, L298N Motor Shield Dual High Current DC Motor Driver, a DC motor(back wheels), a servo motor(front wheels). A servo motor is added in order to make the car steer more precisely. Power source of the car is a 8.4V 3800mAh Ni-MH battery pack.



*Picture 1: Inside of the car*

**The wheel** is made up of 4 parts: Wemos D1 board, a gyroscope, two buttons at the back of wheel and an indicator LED. And also there is a switch on the wheel to easily turn the wheel on and off. The gyroscope plays the main role in the wheel system by sensing the orientation of the wheel and sending this data to the Wemos D1 board, which, in turn, send an appropriate command to the board in the car over wireless connection. Two buttons at the back are used to change the driving mode. If they are pressed together for 3 seconds, the driving mode will be changed.



**Picture 2:** Inside of the wheel

Two driving modes can be used to control the car.

First mode enables us to control it only by tilting the wheel around two axes. If it is tilted forward and backward, the car will be moving in the corresponding direction. If the wheel is tilted right or left, the car will be steering to the right and left, respectively.

In second mode, the car can be controlled by both turning wheel and pressing the buttons at the back of the wheel. Turning the car to left and right will be the same as in the first mode (by tilting the wheel). The button at the right-hand side of the wheel will accelerate the car forward, while the button at the left-hand side will move the car in reverse direction.

There is also a RGB light on the wheel that shows the status of the wheel. If the light is flashing slowly, it means the wheel is connecting to the car. If it is flashing rapidly, there is a connection problem. When the light is showing blue, the control mode is the first one, whereas if the light is green, the car is in second control mode.

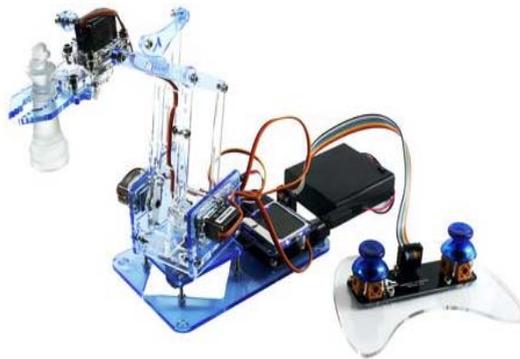
## **ARDUINO CONTROLLED ROBOTIC ARM**

**Rauf Mahmudzade**

*rauf.mahmudzade.b0319@bhos.edu.az*

**Supervisor: Abbas Alili**

Robotic devices have become more viable as the recent developments in this sphere have enabled to reduce the cost of equipment. As far as the factories, businesses or exploration is considered, these machines have integrated to all parts of human lives. Most robotic designs employ human-like behavior and their ability to be modified, remotely controlled, and updated if needed made them great assets for assistance.



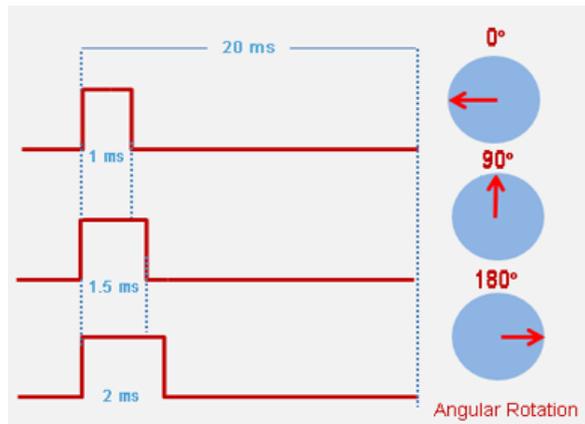
This project aims to develop a robotic arm via joystick control with 3 degrees of freedom-an independent movement in different axis connected with a specific joint. Although there are several type of joints available, in this design revolute joints were used which are only capable of rotation. To provide these movements in the joints of servo motors are placed.

Servo motors are special devices that includes 3 parts: Controlled device, output sensor and a feedback system. There is a closed loop where positive feedback system is exploited to control and define final position of arm. The feedback signal is created by the difference of input and output signals and they work based on the PWM (Pulse with Modulation).

Servo motors are constructed from DC motor controlled by a variable resistor (potentiometer) and some gears where the force is converted into torque.

Having discussed the mechanical design part of this projects, it is also

crucial to state that all these processes in different axis are controlled by arduino which is an open-source platform for building electronic projects. The microcontroller (Arduino R3) and IDE (Integrated Development Environment) are employed to link your project with the code you wrote.



### Future prospects

In this project, this robotic arm is controlled by joystick. However, the software can be manipulated to operate arm with a smartphone or even replicate the hand gestures. Considering hardware, sensors could be added to utilize trajectory planning. This could be modified to sense an object's speed and distance while it is directed towards the robot and will have an advantageous usage in manufacturing.

### Reference

- 1) Arm Project: Web-Based Control with Spatial Awareness and Intuitive Manipulation, by Robert S. LaForge, Janusz Zalewski, AL5A Robotic, Page: 1-5
- 2) Robotic Hand in motion using Arduino-controlled servos by Nicholas Bonini, Nithya Iyer Page:1-4
- 3) <http://www.3ders.org/articles/20151115-the-eezybotarm-cool-3d-printed-robotic-arm-to-learn-the-basics-of-robotics.html>
- 4) <https://shop.mime.co.uk/collections/mearm/products/mearm-your-robot-nuka-cola-blue?variant=4766020165>

## **SMARTPHONE CONTROLLED DOOR LOCK**

**Rustam Hasanov, Mirakram Aghalarov**

*rustamh1916@gmail.com*

**Supervisor: Abbas Alili**

As dependence of our everyday life on modern technologies increases day by day, designing innovations is turning into inevitable necessity for engineers working in related areas. Major aim of designing these technologies is to make people's everyday life possibly simple. Therefore people designing such systems mostly focus on this feature and beneficialness of projects is one of the main points that appreciated by professionals in this area and huge technology companies.

Taking such aspects into consideration, we also tried to make a project that simplifies people's life. By simplifying I mean to make automated system that will replace classic mechanical system and make control of system far easier than before. We apply this automated system into front door lock of houses.

Briefly, project named "Door lock controlled by smartphone" is to control by using application compatible to the that lock in our smartphones. In other words, in our project, phone application functions as the substitute of the key, that of classic lock is automated door lock. In order to make the meaning of the automated door lock more clear, we can say that , by using this system people will avoid from carrying number of keys on themselves and they will not be afraid of losing keys anywhere.

Using this automated door lock can deal with the number of problems:

- 1) People often lose keys of their house or they forget the place where they put them. So, by using automated smart door lock, people will never use keys and never carry keys with themselves.

- 2) It is important having keys for every family member when they use classic door locks and they have to make 4-5 copies of the same keys. However, with smart door lock this problems will be decreased and every member of family will install application to their phone and will be able to lock or unlock the door by using only smartphone.
- 3) Sometimes people are in trouble that they can not remember if they locked the door or not and in most cases they return their home in order to check the door. In this situation, if they have automated smart door lock, they can check remotely from everywhere and if door is open they can close the door via internet without any trouble.
- 4) When guest comes to the your house suddenly but you are not at home, it will be possible to open the door and let them to enter the house while with classic door lock we can not do it at all.
- 5) We can not skip one important part of project that this automated smart door lock will be beneficial also to old generation. So, if somebody come to the house and it is difficult for the old generation to stand up to open the door, with this system they can unlock door without any movement.
- 6) Thieves. It is very huge problem for all people. It is very easy to unlock the classical door because its mechanical parts are seen on the surface of the door. When we use this automated system we will hide it inside of the door and it will be covered. It will help to decrease robbery cases partly.

To sum up, his project can be very beneficial for great number of people and organizations at the same time and can be considered very essential in terms of avoidance of problems that people encounter on a daily basis.

## IMPLEMENTATION OF ADAPTIVE FILTERS FOR INCREASING THE QUALITY OF CONTROL

**Ramil Shukurov**

[sukurov.ramil652@gmail.com](mailto:sukurov.ramil652@gmail.com)

**Supervisor: Assoc.prof. Naila Allakhverdiyeva**

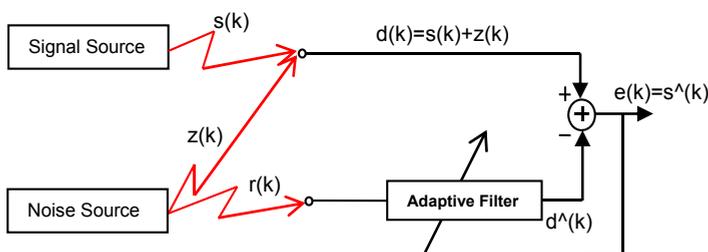
Since the technology has developed enough, Digital Signal Processing has become an important feature in the stage of noise cancellation, voice prediction. The problem is that standard DSP's is not capable enough to tackle such problems, and obtain proper outcomes, whereas the technique of adaptive filtering is a vital solution to these.

Adaptive filters are applied to various applications. The followings demonstrate 4 major application types:

- System identification
- Noise cancellation
- Signal prediction
- Modeling inverse system

My investigation is based on the noise cancellation using adaptive filters. The first thing to do is to build a model.

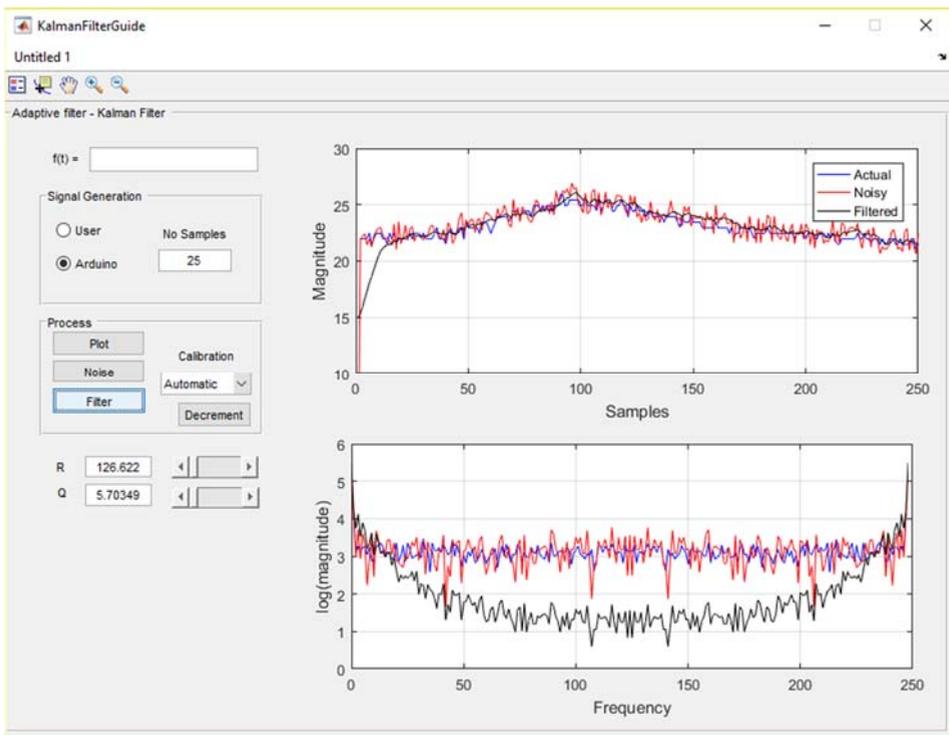
The model for the noise cancellation is given below:



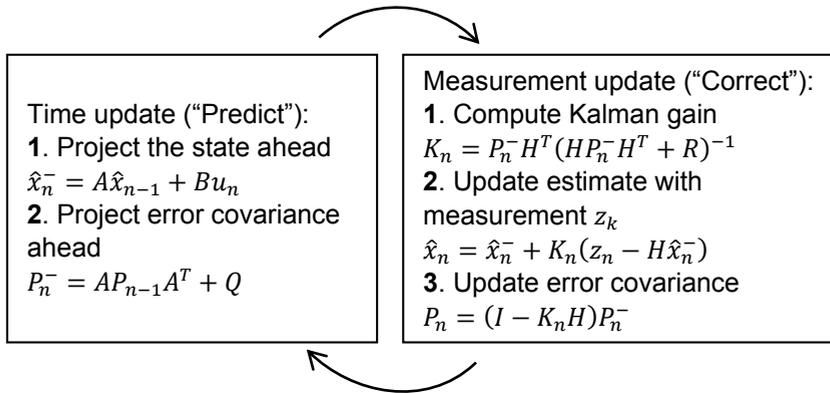
Noise is eliminated by one of 2 methods which are Least Mean Square (LMS) algorithm, and Recursive Least Squares (RLS) algorithm. Although LMS algorithm has certain drawbacks, its implementation and computation are simpler and it shows more robust

performance over RLS algorithm. In contrast, use of RLS algorithm brings a better and faster rate of convergence.

According to the given model above, further investigation is done by applying Kalman filter for real-time applications. To do this, I have written an algorithm of Kalman filter using Matlab software and used Arduino, LM35 – temperature sensor to have real time signals. It is also possible to have sinusoidal signals which are the choice of user. After having signal data, it is corrupted by applying Gaussian noise to show how actually noisy data is received. The following step is to choose calibration. It is either done manually or automatically, then filtering the noisy data. The picture below illustrates software that uses Kalman filter for noise cancellation.



Now, let's examine how Kalman filter removes noise from the real-time data.



where:

- $\hat{x}_n$  – what we want to find
- $z_n$  – measurement value
- $R$  – measurement noise covariance
- $Q$  – process noise covariance
- $K_n$  – Kalman gain
- $\hat{x}_n^-$  - current estimation
- $u_n$  – control signal
- $P_n$  – necessary for future estimate
- $A, B, H$  – general form of matrices

Kalman filters works as a feedback control which means firstly, it evaluates process data at some time, then gets noisy measurements as a feedback. That is why, Kalman filter algorithm consists of 2 parts: time update and measurement update. Simply, we can refer time update equations to predictor equations, while corrector equations relate to measurement update equations. In other words, this algorithm can be thought of predictor-corrector algorithm.

To summarize our investigation on Kalman filter, the result is analyzed in both time and frequency domains, and obviously, filtered signal with its shifted version is so close to original signal. However, improper values of process and measurement noise covariance lead to vary the shape of signal, which is not a problem, because software offers automatic calibration.

## **GPS BRACELET WHICH SAVES LIVES OFFSHORE**

**Elshan Mikayilov**

*mikayilovelshan@gmail.com*

### **Supervisor: Manafaddin Namazov**

Working offshore in drilling and production platforms is one of the most dangerous jobs around the world. There are lots of heavy moving parts, ignition sources just above the huge oil and gas reservoirs which can blowout anytime if it is not treated in the right way. In Azerbaijan, especially conditions are a bit harder because of high speed winds over the Caspian Sea. It is officially approved that totally there are dozens of people who have been fallen to the Caspian Sea because of serious accidents happened on the offshore rigs. Although many of these people have been rescued by rescuers there are significant number of people who cannot be found because of strong waves moving them to far away from the rig. In order to solve the problem of difficulty in finding workers fallen to the seas I designed a GPS bracelet which is waterproof and reliable.

This GPS bracelet is designed to track coordinates of the lost workers in the seas and oceans. Overall, the system works in this way: each offshore worker will have one bracelet which has GPS signal sender. There are separate rescuers who are responsible for offshore workers. These rescuers will have direct access to the GPS bracelet which is attached to an arm of the offshore workers. In case of emergency, if it is reported that there are some people fallen to the sea rescuers will easily see coordinates of the workers who are in the water by comparing their coordinates with the coordinates of the rig. There is also one additional function of this bracelet: if there are many of the workers have fallen to the sea rescuers will prioritize the workers who are alive. There is a heartbeat detector on the bracelet which sends signal to the rescuer informing whether the person in the water is alive or not. Whole system is integrated to be used on a smartphone having

Android platform. HMI interface of the system is designed in the Android Studio environment. The bracelet itself will be designed to have optimal size and weight keeping waterproof characteristic of the bracelet the main priority. To conclude up, this GPS bracelet will be a great step toward safety of offshore workers who are really contributing big for our country's bright future.

## **NAVIGATOR ROBOTS CONTROLLED BY MICROCONTROLLER WITH GRAPH ALGORITHM**

**Amiraslan Bakhshili**

*[aslanbaxisli.ba@gmail.com](mailto:aslanbaxisli.ba@gmail.com)*

### **Supervisor: Suleyman Suleymanzade**

Nowadays, the algorithms that are used in self-driving cars is in the limelight. Doing research in such scientific topics will broaden our horizon about artificial intelligence. As an engineering student, my preference among these algorithms is graph algorithms. The graph algorithms which are one of the most sophisticated type of all, are mainly used in the development of new generation AI.

In my research, I will demonstrate the robot-car that I have made which can find the best track to go to reach the destination. The car will receive a dataset which contains an adjacency matrix of the map. Map contains nodes. When two or more roads cross each other at one point, I will call it node. Apart from that, the roads in graph theory is called edge. So, what we have is that nodes which are connected to one another in directional or bidirectional way, have some distance among them. Distance will be called cost. More distance between two cities, the more cost the way has. The mission of robot-car is to find the shortest and lowest cost trajectory from one predetermined node to other known final node. The process will happen in several stages.

First one, generating, analyzing and converting the map. This part is quite difficult to do. Some piece of black circular shape papers for nodes and long length rectangles will symbolize the edges of graph or in other word city. The rest place will be whitish color to make distinguishing process easier. After getting the image of terrain which contains the exact places of nodes, the data that is suitable for controller compiler should be exported from the graph image. To do it, the image will be converted “Raw file” format to modify or use its color data easily. Special algorithm will scan the image and find the places of nodes taking the center of nodes as their exact position on the map. Determining the places will enable us to calculate the exact distances between nodes by pixels. But because the robot-car will move in real conditions, we will need to convert it to meters. As an indicator, I have put some mark on map that show exactly one meter. An inch length mark will help algorithm to scale the ratios of distances among nodes to the real meter distances.

### **Making of Robot**

Robot-car consists of two wheels, two dc motors that work 3-6V range, IC SN7544NE drive for motors, case, sensor, sealed acid battery as a power source, 8 bit 32kb memory microcontroller. All parts should be combined in their exact positions for the sake of accuracy and precision. Controller board has its own voltage regulator which stabilizing voltage to 5V.

### **Algorithm**

As a graph algorithm I used Dijkstra algorithm. If we need to write it as a sequence of descriptions it will be like this. The started node will be called the initial node. Let Y node edge be the length of edge from the initial node to Y. The code itself will assign several starting edge length values and will try to enhance them stepwise. Assigning a default distance length to all nodes: if it is initial node then set it to zero and for every other node we will set max value of datatype.

Current point will be set to the first node in the beginning. The rest will be “visited = false”. A list should be created and filled with the unvisited nodes.

- 1) For the present node, take all of its unvisited nodes and estimate their default distances. Compare the last calculated default distance to the presently assigned distance and the list one should be set.
- 2) When we take in account all of the other nodes, we need to mark the current node as visited and delete it from the unvisited list. A visited node will never be checked again.
- 3) If the destination node has been marked visited (when planning a route between two specific nodes) or if the smallest default distance among the nodes in the unvisited set, then stop.
- 4) In other case, unvisited node should be selected which is marked with the list default length, accept it as the "current node", and the third step should be repeated.

[https://en.wikipedia.org/wiki/List\\_of\\_algorithms#Graph\\_algorithms](https://en.wikipedia.org/wiki/List_of_algorithms#Graph_algorithms)

## **MODELLING OF SOCAR NETWORK AND ITS SECURITY STRUCTURES IN RIVERBERD**

**Madina Shukurlu**

[medine.shukurlu@gmail.com](mailto:medine.shukurlu@gmail.com)

**Supervisor: Manafaddin Namazov**

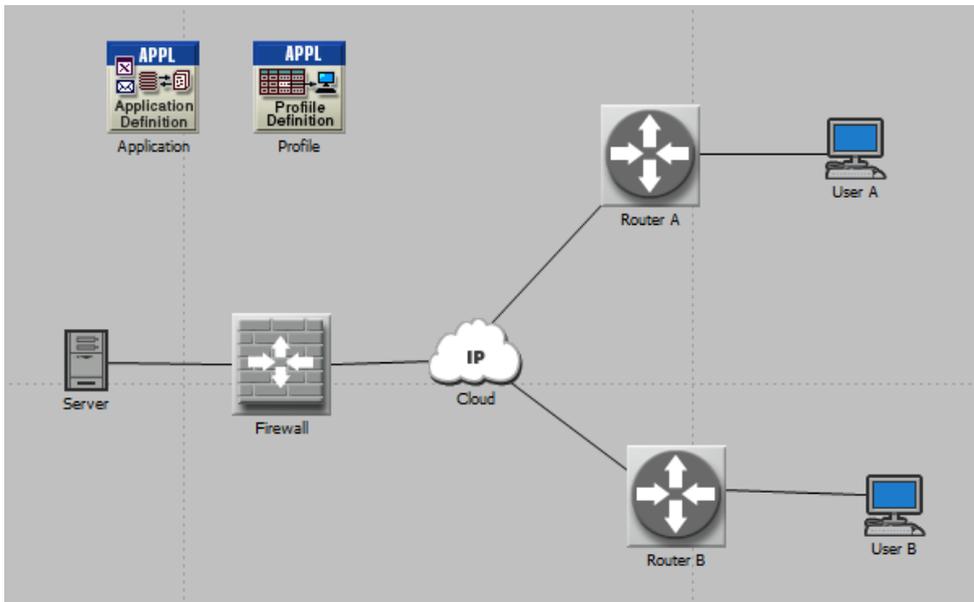
If more than one computer is synchronized or connected with each other that are constructed for sharing either software or hardware, exchanging some documents or just for communication, is called computer network. This network not only consist of computers, it contains server, peripherals and some other needed devices as well.

Networks can be categorized for their application areas. For instance, they can be intended to use in one building (Local Area Networks) such as workplace, or in whole city (Metropolitan Area Networks) or some specific areas (Campus Area Networks) and so on. In the contemporary lifestyle, internet is worldwide used network.

As in all, security is the main part of the networks too. In order to have more secured network and aside threats as much as possible not only software but also hardware technologies have an essential role. Security is increased in order to keep safe using of network and protect theft of personal data.

There are various programs for modeling and security and one of them is Riverbed modeler which I have used. Our work consists of two main parts, so firstly we should learn about firewall and VPN (Virtual Private Network) and their effects on network performance. With the help of VPN, we can access public network via internet from the distance. Firewall prevents the illegal accesses to networks it can be considered as a barrier. As it mentioned before, firewall also, can be applied to not only software but also hardware, sometimes both of them at the same time are possible.

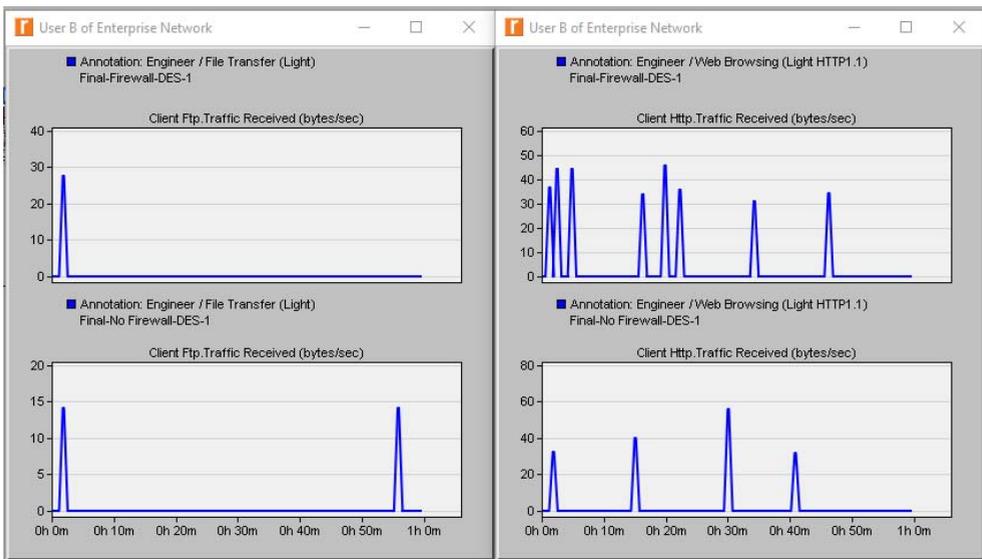
After completing first part, visual model of real network is made in Riverbed. Effect of VPN and firewall in real and visual environment is obtained and compared with each other.



**Fig 1:** Visual model of real network

Figure 1 illustrates the visual model of real network in Riverbed. In this model, we have one sever, two routers and two users that receive and send some data through the firewall.

Since both receiving and sending data path through firewall, it analyses traffic and forbids the obscure messages or accounts. In this case, certainly, some ports and IP addresses or groups are blocked. It can be clearly seen from the graphical representation of results which compares the received traffic (bytes per second) in client ftp (file transfer) and http (web browsing) in two cases, with using firewall and without firewall.



**Fig 2:** Graphical representation

In the Figure 2, the graphs that are drawn in the lower parts show the received http and ftp without firewall, but the graphs in the upper are obtained after applying of firewall. As shown, after application of firewall receiving or transferring data is reduced remarkably.

## References

- <https://www.riverbed.com/sg/>

## **DESIGN CONTROLLER FOR CRUDE OIL DISTILLATION UNIT WITH NOISE FILTRATION IN MATLAB**

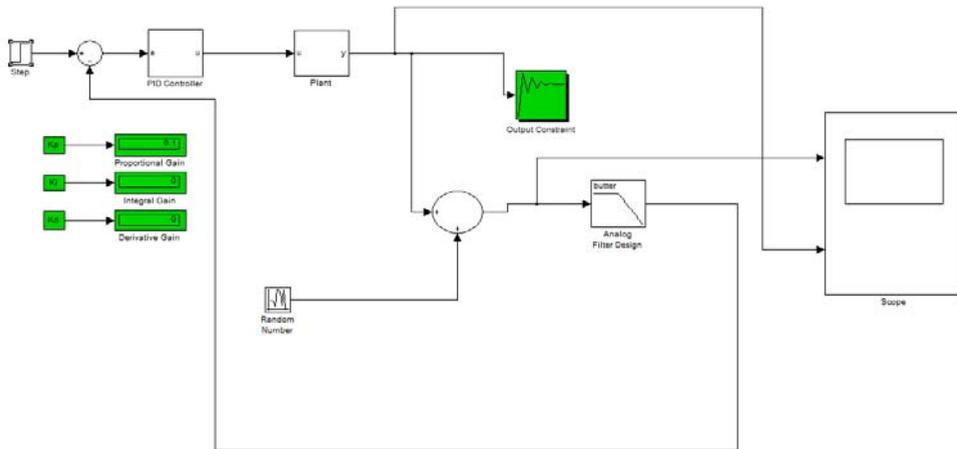
**Ramziyya Garazade**

*garazade.ramziyya@gmail.com*

**Supervisor: Manafaddin Namazov**

Steady-state and dynamic simulation plays an important role in many control processes including oil refinery units. Simulation enables us to investigate the behavior of process and control it carefully. As everybody knows the measurements we get from the system are not completely certain or accurate because most systems are so sensitive to environmental changes. For example, if the level of the kerosene is measured several times in a day, the results will be different due to temperature variations or humidity levels. These factors are known as noise and cause the process variable to deviate from its set-point. Noise is an undesired signal that affects the quality of original signal. There is not any real system without the noise but they differ for the structural types of the noise. Today designers and engineers prefer to low-noise components in control and design processes. However, so low-noise devices are not in large quantities nowadays. That's why, most engineers strive to minimize the noise level in the processes with high noise. Matlab software can be used to simulate the control process and minimize the effects of the noise on the process. In the article "Crude Oil Distillation Unit Controller in Matlab" which I worked on last year the transfer function and proper coefficients for proportional, integral, and derivative terms of PID controller were defined with the help of Matlab software. However, that control system was designed without noise signal. When PID controller is used to provide control of the processes the noise could cause an adverse effect on the process itself and the function of PID controller. The reason is that the derivative component of PID controller is getting to

infinity because of the noise signals. To prevent this situation the ideal way that Matlab suggests is a filtration. Filtration is used to reduce or remove the unwanted features from an original signal. There are various types of filters that are used in various applications: linear or non-linear, time-variant, or time-invariant, active, or passive, analog, or digital, high-pass or low-pass, etc. filters. Each of these filters has its own application areas and purposes. For example, low-pass filters cease high-frequency signals while high-pass filters cease low-frequency ones. In crude oil distillation process, we will use low-pass filtering, because we need to remove noise from the process, and noise is mainly high-frequency signals. Simulating the distillation process in Matlab, we can diminish the noise with the help of the low-pass analog filter design in butterworth method (Figure-1).



**Figure-1**

We add noise to the output of the controller, then filter this signal combination and finally apply it to the input. Thus, we can find the most suited, the best coefficients for the proportional, integral, and derivative terms. Moreover, it is possible to see the signal with noise (Figure-2, upper part) and after filtration (Figure-2, lower part), and to compare them.

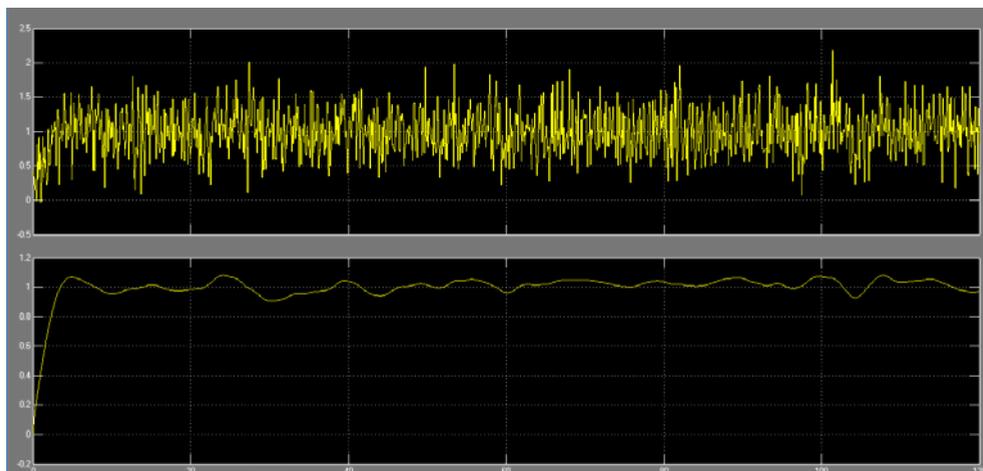


Figure-2

#### References

- [https://en.wikipedia.org/wiki/Filter\\_\(signal\\_processing\)](https://en.wikipedia.org/wiki/Filter_(signal_processing))

## CONTENTS

<b>MODELING A RLC CIRCUIT'S CURRENT WITH DIFFERENTIAL EQUATIONS</b> <i>Aytaj Abdin</i> .....	5
<b>APPLICATION OF SECOND ORDER LINEAR DIFFERENTIAL EQUATIONS FOR SCIENCE AND MECHANICAL ENGINEERING</b> <i>Agha Hashimov</i> .....	7
<b>TORRICELLI'S TRUMPET OR GABRIEL'S HORN.</b> <i>Ahad Jafarov</i> .....	10
<b>INCREASING HYDROCARBON RECOVERY FACTOR BY NANOPARTICLES</b> <i>Ismayil Akbarov</i> .....	12
<b>GRAPH COLORING AND ITS APPLICATIONS</b> <i>Ayaz Samadli</i> .....	15
<b>ALL-WEATHER SOLAR PANELS</b> <i>Narmin Bakhishova</i> .....	18
<b>CARBON DIOXIDE ENHANCED OIL RECOVERY</b> <i>Chingiz Mammadli</i> .....	20
<b>SOLAR ELECTROLYSIS FOR HYDROGEN FUEL PRODUCTION</b> <i>Elmar Asgarzada</i> .....	23
<b>EULER'S BUCKLING THEORY</b> <i>Esmira Jafarova</i> .....	25
<b>NATURALLY FRACTURED RESERVOIRS</b> <i>Gullu Ahmadova</i> .....	27
<b>MEASUREMENT WHILE DRILLING (MWD) AND LOGGING WHILE DRILLING (LWD) SYSTEMS</b> <i>Israfil Jabrayilov</i> .....	30
<b>DYNAMIC REACTIONS ON THE AXIS OF A ROTATING BODY. DYNAMIC BALANCING OF MASSES</b> <i>Mahsati Hasanova</i> .....	32
<b>GYROSCOPE AND ITS APPLICATIONS</b> <i>Allakhverdi Muradov</i> .....	35

<b>REDUCING MISCIBILITY PRESSURE FOR CO<sub>2</sub> FLOODING</b>	
Kamal Omarov.....	37
<b>MATHEMATICAL CONSTANT <math>\pi</math> (PI)</b>	
Pakiza Pashayeva.....	39
<b>RESONANT VIBRATION ANALYSIS</b>	
Humay Hamidli.....	43
<b>NEWTON'S LAW OF COOLING</b>	
Javid Zeynalov.....	45
<b>BERNOULLI'S PRINCIPLE</b>	
Amir Namazov.....	47
<b>HARNESSING HIGH-ALTITUDE WIND POWER</b>	
Huseyn Aliyev.....	50
<b>VIBRATIONS IN CO<sub>2</sub> MOLECULES: COUPLED OSCILLATORS</b>	
Ellada Isazade.....	53
<b>STUDY OF MODERN METHODS OF CALCULATING THE BASIC CATEGORIES OF WIND POTENTIAL IN AZERBAIJAN</b>	
Ismat Aghayev.....	55
<b>INVESTIGATION OF WIND ENERGY IN AZERBAIJAN</b>	
Parvin Guliyeva.....	58
<b>ARCTIC OIL DRILLING</b>	
Mahammad Aliyev.....	60
<b>SMART FLOATING FARMS</b>	
Toghrul Karimov.....	63
<b>ENHANCED OIL RECOVERY USING POLYMER NANOCOMPOSITIES</b>	
Gulay Ibrahimova.....	66
<b>REMOVAL OF TOXIC MATERIALS BY NANOPARTICLES IN DRILLING FLUIDS</b>	
Gulshan Jabbarzadeh.....	68
<b>ENHANCEMENT OF MECHANICAL AND GAS BARRIER PROPERTIES OF HDPE NANOCOMPOSITES FOR PIPING AND PACKAGING INDUSTRY</b>	
Kamran Aliyev.....	70
<b>NITRATE AND PHOSPHATE REMOVAL FROM WATER AND WASTEWATER USING NOVEL ION-EXCHANGERS</b>	
Sanam Amirli.....	73

<b>BIODEGRADABLE POLYMERS AND BIODEGRADABLE PLASTICS</b>	
Subhana Allahverdiyeva.....	76
<b>OPTIMISATION OF CENTRIFUGAL PUMPS BY CHANGING THE FREQUENCY</b>	
Jamil Ismayilzada.....	78
<b>SELECTION OF CENTRIFUGAL PUMPS OPERATING IN PARALLEL</b>	
Narmin Abdullazade.....	81
<b>DETERMINATION THE OPERATING MODE OF HYDRAULIC MACHINES BY MEANS OF THERMODYNAMICAL METHOD</b>	
Saida Alasgarova.....	84
<b>OIL SPILLS: PREVENTION AND CLEANUP</b>	
Fidan Abdullayeva.....	87
<b>HEAVY METALS AND THE INFLUENCE THAT HEAVY METAL CONTAMINATION HAS ON ECOSYSTEM</b>	
Sabina Mammadova.....	89
<b>CARBON FOOTPRINT MEASUREMENT</b>	
Gulnar Sadigova.....	91
<b>POST 2000 GAS HYDRATE INHIBITION TECHNOLOGIES</b>	
Javad Iskandarov.....	94
<b>TULIP SHAPED SOLAR POWER PLANTS</b>	
Fərid Novruzov.....	97
<b>GEOHERMAL POWER, NON-CONVENTIONAL METHODS</b>	
Shabnam Mursalova.....	99
<b>USING OF MUNICIPAL SOLID WASTE (MSW) IN THE WASTE- TO-ENERGY PLANT</b>	
Tunzala Imanova.....	101
<b>NON - EDIBLE BIOMASS RESOURCES OF WORLD</b>	
Vugar Hasanov.....	104
<b>SOLAR TREES, THEIR APPLICATIONS AND USAGES</b>	
Vusal Guluyev.....	106
<b>ZEOLITES AS CATALYSTS IN PETROCHEMICAL INDUSTRY</b>	
Garanfil Ahmadova.....	109
<b>USE OF COMPUTATIONAL FLUID DYNAMICS FOR SIMULATING TWO PHASE FLOW</b>	
Aygul Karimova.....	111

<b>FACE RECOGNITION METHOD BASED OF PHOTO</b>	
Leyli Abbasova.....	115
<b>MOBILE APPLICATION FOR STUDENTS</b>	
Hajali Bayramov, Rashad Shirizadeh.....	117
<b>GYROSCOPE-BASED ARDUINO CONTROLLED CAR PROTOTYPE</b>	
Nicat Hasanov.....	118
<b>ARDUINO CONTROLLED ROBOTIC ARM</b>	
Rauf Mahmudzade.....	121
<b>SMARTPHONE CONTROLLED DOOR LOCK</b>	
Rustam Hasanov, Mirakram Aghalarov.....	123
<b>IMPLEMENTATION OF ADAPTIVE FILTERS FOR INCREASING THE QUALITY OF CONTROL</b>	
Ramil Shukurov.....	125
<b>GPS BRACELET WHICH SAVES LIVES OFFSHORE</b>	
Elshan Mikayilov.....	128
<b>NAVIGATOR ROBOTS CONTROLLED BY MICROCONTROLLER WITH GRAPH ALGORITHM</b>	
Amiraslan Bakhshili.....	129
<b>MODELLING OF SOCAR NETWORK AND ITS SECURITY STRUCTURES IN RIVERBERD</b>	
Madina Shukurlu.....	131
<b>DESIGN CONTROLLER FOR CRUDE OIL DISTILLATION UNIT WITH NOISE FILTRATION IN MATLAB</b>	
Ramziyya Garazade.....	134