IJARSCT
ISSN (Online) 2581-9429
International Journal of Advanced Research in Science, Communication and Technology (IJARSCT)
International Open-Access, Double-Blind, Peer-Reviewed, Refereed, Multidisciplinary Online Journal
Impact Factor: 7.301
Volume 3, Issue 15, May 2023

Dual Axis Solar Tracker

Prathamesh Kulkarni, Rohit Deepak Khairnar, Vishal Sheshrao Rathod, Tathagat Balasaheb Devadhe
Department of Mechanical Engineering
Sinhgad College of Engineering, Vadgaon BK, Pune, Maharashtra, India

Abstract: *Solar tracking is the best way to increase the efficiency of solar photovoltaic modules. This study presents the energy conversion efficiency of photovoltaic modules with solar tracking systems and stationary photovoltaic. The sun detection system uses four photoresistors on either side of the photomodule. These photoresistors make the sun tracking system more sensitive and accurate. Light trackers are used along with systems that point in specific directions due to the earth's rotation and the sun's changing position throughout the day. Designing and constructing a dual axis solar tracker requires a thorough understanding of electronics, control, and mechanics.*

Keywords*:* Arduino Solar Energy, Dual Axis, Renewable Energy Source

I. INTRODUCTION

Energy can be categorized into two types: renewable and non- renewable. Non-renewable energy sources, such as coal, gas, and oil, are finite and will eventually run out. Renewable energy sources, such as solar, hydro, and wind energy, are replenished naturally and can be used indefinitely. Non-renewable energy sources are commonly used to power vehicles and generate electricity. Coal is the most common non-renewable energy source, and it is used to generate electricity, heat homes and businesses, and make steel. Natural gas is another common non- renewable energy source, and it is used to generate electricity, heat homes and businesses, and cook food. Oil is a non- renewable energy source that is used to power vehicles, generate electricity, and make plastics. Renewable energy sources are becoming increasingly popular as a way to reduce our reliance on non-renewable energy sources. A renewable energy source that derives from the sun is solar energy. Solar energy may be used to heat water, power cars, and produce electricity. Hydropower is a renewable energy source that is generated by the force of water. Hydropower can be used to generate electricity and pump water. Wind energy is a renewable energy source that is generated by the movement of wind. Electricity can be produced using wind energy. There are numerous advantages associated with the utilization of sustainable energy resources. Greenhouse gases are not produced by renewable energy sources, which are pure. Renewable energy sources are also abundant and can be used to generate electricity and power vehicles indefinitely. For instance, even if PV module efficiency were only 10%, the predicted domestic electricity consumption for 2015 would still be a thousand times higher. the typical solar radiation received by India's various areas.

The Gujarat government and the Clinton Foundation have signed a memorandum of understanding (MOU) to build the world's largest solar-power plant in the region. The undertaking, which forms a component of the William J. Clinton Foundation's project, efforts to promote renewable energy, will involve the construction of four solar-power plants, the largest of which will be a 3,000 megawatt facility located near the border between India and Pakistan.The additional potential locations are in Australia, South Africa, and California. The drawback of solar energy is that it is a direct function of light intensity. Our goal for the project was to develop a commercially feasible solar tracker that actively moves in two axes, ensuring a maximum allowable error of

10 degrees. To determine our approach, we initially examined previous research on solar tracking methods. Subsequently, we generated and assessed various mechanical and electrical options, choosing the ones with the most favorable characteristics. Finally, we designed, tested, and compared our ultimate tracking system to ensure the realization of our initial objective. Given the population growth and economic growth that have occurred so quickly, concerns over the energy issue and the implications of global warming are growing in recent years. The main solution to these issues is the use of renewable energy sources. One of the main sources of clean, plentiful, and unending energy that not only offers alternative energy sources but also reduces environmental degradation is solar energy

IJARSCT
ISSN (Online) 2581-9429
International Journal of Advanced Research in Science, Communication and Technology (IJARSCT)
International Open-Access, Double-Blind, Peer-Reviewed, Refereed, Multidisciplinary Online Journal
Impact Factor: 7.301
Volume 3, Issue 15, May 2023

II. BACKGROUND

In recent years, the cost of solar energy has continued to decrease, making it increasingly competitive with traditional fossil fuel sources. Due to this outcome, a significant number of people, companies, and administrations have embraced solar power as a means of diminishing their environmental impact and cutting down expenses on energy consumption. Dual Axis Solar Trackers are an important technology in this transition to clean energy, and are likely to become even more widely used in the coming years.

III. LITERATURE SURVEY

"Design and Development of Dual Axis Solar Panel Tracking System for Normalized Performance Enhancement of Solar Panel" By -Vikash Kumara, Sanjeev Kumar Raghuwanshi, International Conference on Sustainable Computing in Science, Technology & Management (SUSCOM-2019) [1]

In the modern period, human existence is dependent on energy, as this study explains. The capacity to get energy is somehow related to a country's development. The most notable, renewable, and cleanest energy source is solar energy. With the assistance of solar photovoltaic (PV) panels, it is easily harnessable. The crucial observation is that most solar panels are positioned at fixed angles. To optimize solar radiation absorption, solar tracking devices are employed to track the sun's movement throughout the day. This enhances the energy production potential of the system. This research undertakes a performance comparison between an experimental dual-axis solar tracker and a stationary solar panel. Additionally, it involves the development and design of a dual-axis solar panel tracking system. The tracking mechanism utilizes a light-dependent resistor (LDR) to detect optimal light availability, while two servomotors facilitate vertical and horizontal movement for controlling the panel's position. By utilizing an Arduino Uno controller and implementing written code, the software aspect of the system is successfully accomplished.

"Dual Axis Solar Tracking System" By- Sadashiv Kamble, Sunil Kamble, Vaibhav Chavan, Anis Mestry, Nilesh Patil, IJIERT 4APR.-2015 [2]

Solar power is gaining recognition as a significant means of increasing the availability of renewable energy sources. Therefore, it is crucial for professionals in the engineering field to have a comprehensive understanding of the related technology. As part of our project, we will construct a solar panel tracking system that is powered by a microcontroller. This system enables the solar array to remain aligned with the sun, resulting in increased electricity production. The project builds upon concepts covered in the course and aims to validate the design by creating a fully functional system. Moreover, it will address any issues that arise and propose solutions. The use of sustainable energy systems is vital for both a prosperous economy and a clean environment. To overcome the challenges posed by energy scarcity, it is necessary to multiply the utilization of renewable energy sources. The main objective of this work is to develop a control system that enhances the alignment of photovoltaic (PV) arrays with sunlight and optimizes solar energy harvesting. By utilizing light sensors to detect changes in light intensity, the proposed system adjusts its orientation along two axes to track the position of the sun. The hardware of the suggested system undergoes testing to ensure its effectiveness in tracking and following the sun. Furthermore, the advantages of fixed PV systems and dual-axis solar tracking systems over single-axis solar tracking are discussed.

"Review of dual axis solar tracking and development of its functional model" By- Emmanuel Karabo Mpodi, Zeundjua Tjiparuro, Oduetse Matsebe, ScienceDirect (2019) [3]

The researchers in this study suggested that due to its widespread availability and eco-friendliness, the utilization of solar energy is increasing. However, there is still a notable challenge regarding efficiency in various applications. To address this, tracking systems are commonly employed as a form of mitigation. Therefore, this research focuses on examining dual-axis sun tracking devices from a two- dimensional standpoint. To assess the current state of efficiency, a comprehensive review of existing literature was conducted. The review revealed that the efficiency of dual-axis tracking configuration currently ranges between 35 and 43 percent. Additionally, based on the findings from the review, a general functional model outlining the operation of a successful tracking system is provided. This model will guide the design and development of an efficient solar tracker. The use of renewable energy sources for electricity generation has expanded due to their abundant availability and positive impact on the environment. These resources are being utilized as alternatives to

IJARSCT
ISSN (Online) 2581-9429
International Journal of Advanced Research in Science, Communication and Technology (IJARSCT)
International Open-Access, Double-Blind, Peer-Reviewed, Refereed, Multidisciplinary Online Journal
Impact Factor: 7.301
Volume 3, Issue 15, May 2023

fossil fuels, which are becoming increasingly scarce. Among the various renewable resources, solar energy is considered the most crucial due to its extensive availability.

"Dual Axis Solar Tracking System-A Comprehensive Study: Bangladesh Context"mBy, Amit Chakraborty Chhoton, Narayan Ranjan Chakraborty, International Conf erence on Adv ances in Electrical Engineering (ICAEE), 28-30 September [4]

Bangladesh, a developing nation in the third world, faces a significant challenge in the form of an energy crisis. The production and demand of electrical energy are severely imbalanced, leaving almost 50% of the population without access to this valuable resource. To address this issue, renewable energy sources are crucial, with solar energy being one of the most promising solutions. This research investigates the effectiveness of an Arduino-based solar tracking system that operates in two axes. The main objective is to compare the performance of a fixed solar panel with a solar tracker. The study involves two sections: hardware and software. The hardware section utilizes four light dependent resistors (LDRs) to detect the strongest light source, the sun, while two servo motors adjust the position of the solar panel accordingly. The software component is coded in the C programming language targeting the Arduino UNO controller. The analysis and comparison of the solar tracker system and fixed solar panels demonstrate superior performance in terms of voltage, current, and power. These findings highlight the effectiveness of the solar tracker in maximizing sunlight capture for various applications, particularly in star harvesting. Notably, the dual- axis solar tracking system generates more energy based on the obtained results.

IV. PROPOSED SYSTEM

The utilization of a solar tracker device has diverse applications in enhancing the utilization of solar radiation. The main objective is to develop a system capable of increasing solar power generation by 30-40%. To achieve this, a microcontroller is employed to execute the control circuit, which subsequently adjusts the position of a motor responsible for optimizing the alignment of the solar panel.

- Develop a dual axis solar tracking system that enhances reliability and efficiency.
- Decrease expenses.
- Enhance the availability of electricity in remote regions.
- Reduce use of electricity

Once we had conducted the literature survey and decided on the components required for our project, the next step was to create a detailed 3D model and draft of the dual axis solar tracker using CATIA software. This stage involved designing each component with precision, taking into account the specific requirements for the solar tracker's movement and orientation. The manufacturing process was then initiated, and each component was carefully fabricated according to the 3D model and draft. Assembling the components together was a crucial step that required careful attention to detail to ensure that the solar tracker would function correctly. After the assembly was completed, we conducted a thorough testing process to ensure that the solar tracker was operating at optimal efficiency. We monitored the tracker's movement and energy output, making any necessary adjustments along the way to ensure that it was functioning as intended.

Finally, we analyzed the test results and drew conclusions regarding the effectiveness and efficiency of our dual axis solar tracker. By comparing our results to existing research on similar solar tracker systems, we were able to assess the performance of our project and identify areas for future improvement. Overall, the project represented a significant contribution to the field of solar energy technology, demonstrating the potential of dual axis solar trackers to significantly increase energy output efficiency.

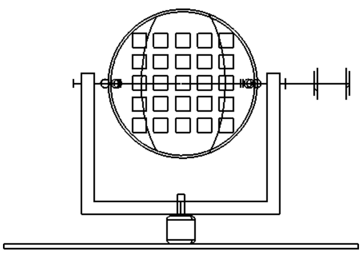

Fig 1. 2D Model

IJARSCT

ISSN (Online) 2581-9429

International Journal of Advanced Research in Science, Communication and Technology (IJARSCT)

International Open-Access, Double-Blind, Peer-Reviewed, Refereed, Multidisciplinary Online Journal

Impact Factor: 7.301

Volume 3, Issue 15, May 2023

Computer-aided design (CAD) is a process of using computers to create, modify, analyze, or optimize a design. CAD software is used to create a digital representation of a design, which can then be used to create a physical product. CAD can be used in a variety of industries, including architecture, engineering, manufacturing, and product design.CAD has many benefits over traditional drafting methods. CAD is more accurate and efficient, and it allows designers to create more complex designs. CAD also allows designers to collaborate more easily, and it can be used to create simulations of products, which can help designers to identify and fix potential problems. CAD software is typically used to create two-dimensional (2D) or three-dimensional (3D) models of a design. 2D models are typically used for drafting purposes, while 3D models are used for visualization and simulation. CAD software can also be used to create animations of a design, which can be used to communicate the design to others. CAD is a powerful tool that can be used to improve the design process. CAD can help designers to create more accurate, efficient, and complex designs. CAD can also help designers to collaborate more easily and to identify and fix potential problems.

V. ANALYSIS

A. FEA (FINITE ELEMENT ANALYSIS)

The finite element method (FEM) is a numerical approach widely used in physics and engineering to solve a variety of problems. These problems encompass areas such as electromagnetic potential, heat transfer, fluid motion, structure analysis, and mass transportation. Typically, these problems involve solving boundary value problems of partial differential equations. By employing the finite element method, a set of algebraic equations is derived based on the given problem's specifications. This approach provides approximations of the unknown values at specific points within the problem domain. It effectively simplifies complex problems by dividing them into smaller finite components for easier resolution.

The original equations, often partial differential equations (PDEs), are simplified local approximations of the original complex equations to be examined in the initial stage. Mathematically, the process involves constructing an integral using the inner product of weight and residual functions and equating the integral to zero. Essentially, it is a method that minimizes approximation errors by fitting trial functions into the PDE. The weight functions are polynomial approximations that project the residual, representing the error introduced by the trial functions. This process eliminates spatial derivatives from the PDE and locally approximates it using:

A system of algebraic equations for problems with steady states.

A set of ordinary differential equations for problems with transient behavior.

These fundamental equations form the basis of the system. They are linear if the corresponding partial differential equation (PDE) is also linear. In transient problems, sets of ordinary differential equations are solved through numerical integration methods like Euler's method or the Runge-Kutta method. Conversely, in steady state problems, sets of algebraic equations are solved using numerical linear algebra techniques. To grasp the concept of the Finite Element Method (FEM), it is helpful to understand its practical application known as finite element analysis (FEA). FEA allows for computational engineering analysis, wherein a large problem is broken down into manageable components using the FEM algorithm and mesh generation techniques. In FEA, a complex problem typically refers to a physical system governed by the Navier-Stokes equations, the heat equation, or the Euler-Bernoulli beam equation. These equations can be expressed as integral or PDE equations. The small divided elements of the complex problem correspond to different regions of the physical system. For the analysis in the current research, the software ANSYS (Analysis System) is utilized. Essentially, the FEM approach is commonly employed today to solve a wide range of problems.

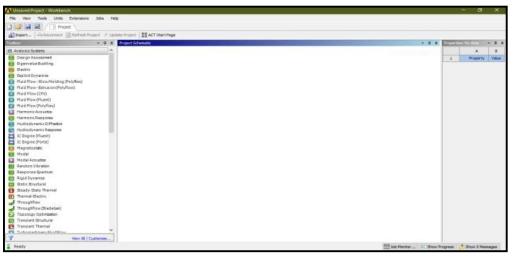

Fig 2. FEM Application

Workbench contain analysis of different types namely static, modal, harmonic, explicit dynamics, CFD, ACP tool post, CFX, topology optimization etc. as per problem defined.

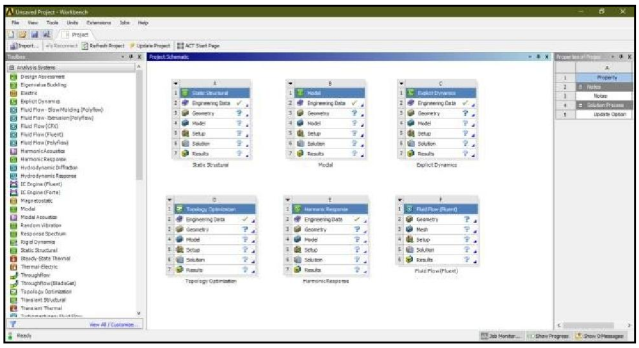

Fig 3. Working in Tables

VI. CALCULATIONS

BASE MOTOR DESIGN

Let, P = 24 watt, 12 volt, & 2A Power (P) = 2πNT/60

T = 24*60/2π10

T = 22.91Nm this is the available torque Now required torque is calculated as,

As we know the weight of the frame and tracker is 6 kg Where, R = Distance of motor centre upto the last pt of mounting frame

We know the length of tracker frame = 0.475m R = 0.2315

F = total weight of frame and tracker T = F*R

= (6*9.81)*0.2315)

T = 13.97 Nm this is required torque

FOR UPPER MOTOR

Weight of tracker 4 kg R = 0.0015m

T = 0.058Nm

Available torque 22.91Nm

VII. RESULTS

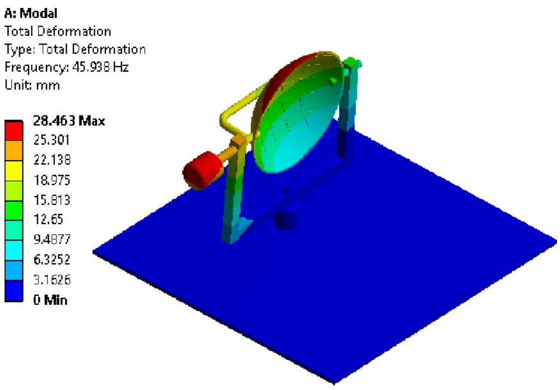

Fig 4. Mode shape 1

IJARSCT
ISSN (Online) 2581-9429
International Journal of Advanced Research in Science, Communication and Technology (IJARSCT)
International Open-Access, Double-Blind, Peer-Reviewed, Refereed, Multidisciplinary Online Journal
Impact Factor: 7.301
Volume 3, Issue 15, May 2023

MODE SHAPE-1 WITH FREQUENCY 45.938 Hz

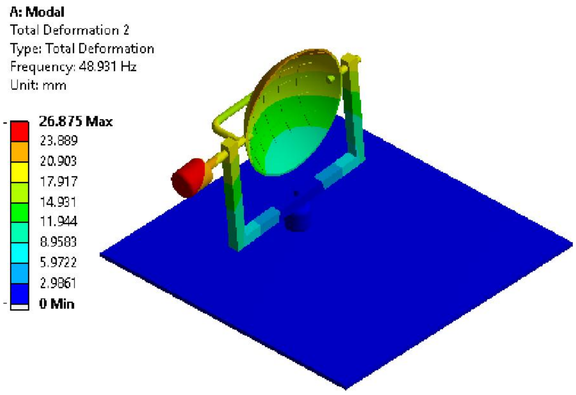

Fig 5. Mode shape 2

MODE SHAPE-2 WITH FREQUENCY 48.931 Hz

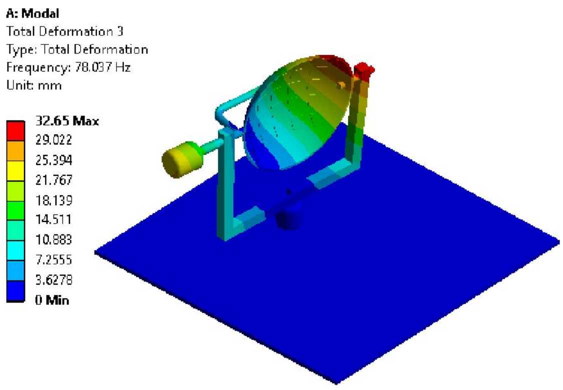

Fig 6. Mode shape 3

MODE SHAPE-3 WITH FREQUENCY 78.037 Hz

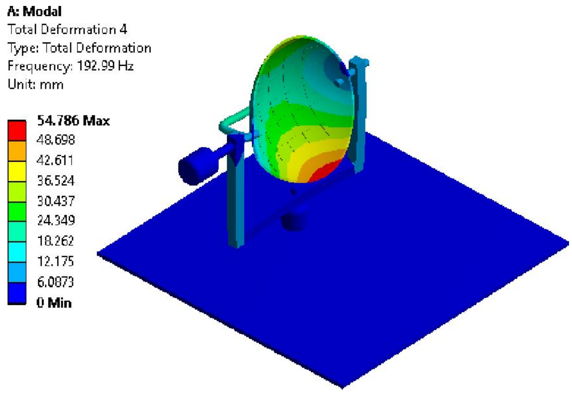

Fig 7. Mode shape 4

IJARSCT
ISSN (Online) 2581-9429
International Journal of Advanced Research in Science, Communication and Technology (IJARSCT)
International Open-Access, Double-Blind, Peer-Reviewed, Refereed, Multidisciplinary Online Journal
Impact Factor: 7.301
Volume 3, Issue 15, May 2023

MODE SHAPE-4 WITH FREQUENCY 192.99 Hz

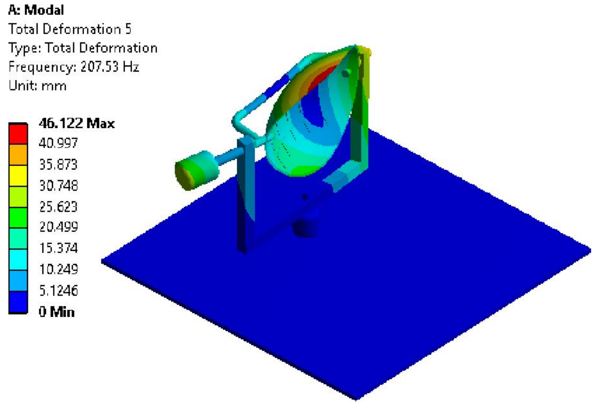

Fig 8. Mode shape 5

MODE SHAPE-5 WITH FREQUENCY 207.53 Hz

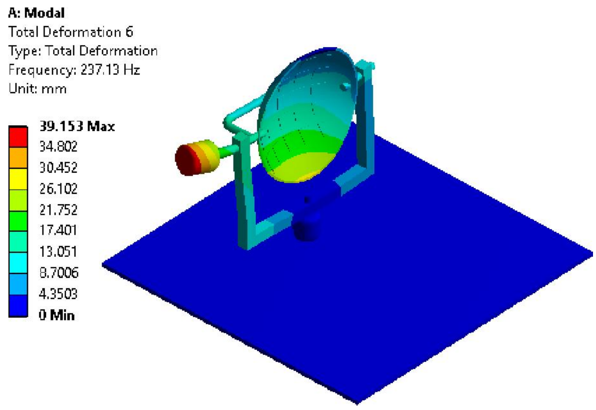

Fig 9. Mode shape 6

MODE SHAPE-6 WITH FREQUENCY 237.13 Hz

	Mode	Frequency [Hz]
1	1.	45.938
2	2.	48.931
3	3.	78.037
4	4.	192.99
5	5.	207.53
6	6.	237.13

Fig 10.Table. Natural frequency

VIII. CONCLUSION

In conclusion, the development of a dual-axis solar tracker project has been a significant undertaking with promising results. The integration of dual-axis tracking technology in solar photovoltaic systems offers substantial advantages, including increased energy generation, improved system efficiency, and enhanced overall performance. Through the utilization of precise sensors and control algorithms, the solar tracker successfully achieved optimal solar panel orientation by dynamically adjusting its azimuth and elevation angles.

The project's implementation demonstrated the feasibility and effectiveness of utilizing a dual-axis solar tracker to maximize solar energy capture. By constantly monitoring the position of the sun and aligning the solar panels accordingly, the system consistently maintained an optimal incident angle, thus enhancing the system's energy output. This approach has the potential to significantly increase the overall efficiency and output of solar power systems, making them more economically viable and sustainable.

ACKNOWLEDGEMENT

We would like to sincerely thank Prof. S.D. Lokhande, the principal of our college, for his invaluable support and guidance and to Dr. A. P. Pandhare, the Head of the Mechanical Engineering Department, for granting us permission to continue with the project and providing us unrestricted access to the laboratory resources. We sincerely appreciate the assistance and constant guidance of Prof. A.V. Jagtap, our mentor, who dedicated time and supported us during the entirety of our project. And, thanks to the staff member of Mechanical Department. And last but not the least, a hearty thanks to all our classmates for supporting me throughout the project.

REFERENCES

[1] "Design and Development of Dual Axis Solar Panel Tracking System for Normalized Performance Enhancementof Solar Panel" By, Vikash Kumara, Sanjeev Kumar Raghuwanshi, International Conference on Sustainable Computing in Science, Technology & Management (SUSCOM-2019).

[2] "DUAL AXIS SOLAR TRACKING SYSTEM" By, Sadashiv Kamble, Sunil Kamble, Vaibhav Chavan, Anis Mestry, Nilesh Patil, IJIERT 4APR.-2015

[3] "Review of dual axis solar tracking and development of its functional model" By, Emmanuel Karabo Mpodi, Zeundjua Tjiparuro, Oduetse Matsebe, ScienceDirect (2019).

[4] "Dual Axis Solar Tracking System-A Comprehensive Study: Bangladesh Context" By, Amit Chakraborty Chhoton, Narayan Ranjan Chakraborty, International Conf erence on Adv ances in Electrical Engineering (ICAEE), 28-30 September.

[5] "Design and Research of Dual-Axis Solar Tracking System in Condition of Town Almaty." By, Shyngys Almakhanovich Sadyrbayev, Amangeldi Bekbaevich Bekbayev, Seitzhan Orynbayev and Zhanibek Zhanatovich Kaliyev, Middle East Journal of Scientific Research December 2013