Design and Implementation of Advanced Impeller for lifting of Highly Inflammable Liquid without using electricity.

Mr. N. M. Bante
Email: sanjay_sanjay505@rediffmail.com
PBCOE, Nagpur

Mr. A. D. Landge
Email: amitdlandge@gmail.com
PBCOE, Nagpur

ABSTRACT

As per the technical evolution and latest technological trends taken into consideration so here effectively created an optimistic system i.e. ***Design and Implementation of Advanced Impeller for lifting of Highly Inflammable Liquid without using electricity.****The manufacturing of this project is followed by using Human Power and available resources taken into consideration so that this will be helpful for common man in their daily life. This project works on the human power so that, there is no utilization of any electricity. This project can be useful in the highly inflammable refineries, factories and sensitive plant area to provide oil, petrol and diesel supply to plants where system cannot us electricity because of chances of fast burning and heavy blasting with availability of small fire. This project can be use where there is requirement to lift oil, petrol and diesel towards overhead tank for any relevant application which will helps to avoid chances of heavy fire and blasting. In this project there is manufacturing of advanced impeller and related design to lift the oil with minimum RPM without using electricity. This project works on the principle of centrifugal force and vacuum created by minimum rotation of Impeller. This projects works on the bicycle pedal gear and related setup. Initially with the use of basic things available with us that are Driver i.e. front Sprocket pedal gear, driven element i.e. Sprocket gear and chain. In this project, pumping of oil, petrol and diesel done by centrifugal pump which is created according to oil, petrol and diesel movement should at the top and inlet at the bottom level so that oil, petrol and diesel can be able access from anywhere and able to lift at the top of the building while creation of this vacuum creation is very much important task which is taken into consideration This project can be use in oil refineries, sensitive power plants, Alcohol Factories, Mercury Plants and Kerosene Refineries.*

Keyword : - *ID(Impeller Design), RFMB (Round Flange Mounted Bearing), PB (Pedestal Bearing), HI (Hybrid Impeller), ID (Internal Diameter),OD (Outer Diameter).*

1. Introduction

This projects works on the bicycle pedal gear and related setup. Initially with the use of basic things available with us that are Driver i.e. front Sprocket pedal gear, driven element i.e. Sprocket gear and chain. In this project, pumping of oil, petrol and diesel done by centrifugal pump which is created according to oil, petrol and diesel movement should at the top and inlet at the bottom level so that oil, petrol and diesel can be able access from anywhere and able to lift at the top of the building while creation of this vacuum creation is very much important task which is taken into consideration. Centrifugal pumps are a sub-class of dynamic axis symmetric work-absorbing turbo-machinery. Centrifugal pumps are used to transport fluids by the conversion of rotational kinetic energy to the hydrodynamic energy of the fluid flow. The rotational energy typically comes from an engine or electric motor. The fluid enters the pump impeller along or near to the rotating axis and is accelerated by the impeller, flowing radially outward into a diffuser or volute chamber (casing), from where it exits. There are basic three types of impeller which is described below. The efficiency of centrifugal pump is determined by impeller. Vanes are designed to meet a given range of flow condition.

1.1 Open Impeller:

Vanes are attached to the radial hub, without any form, sidewalls or shroud and are mounted directly onto a shaft. It is structurally weak and require higher NPSHR value. It is used in small diameter, inexpensive pumps, and pumps handling suspended solids. It is more sensitive to wear than closed impeller.

1.2 Closed Impeller:

The closed impeller has both a back and front wall for maximum strength. They are used in large pumps with high efficiency and low NPSAR. It has high wear rate. It is most widely used impeller in centrifugal pump handling clear liquid.

2. Literature Review:

2.1. International Journal of Advanced Technology in Engineering and Science www.ijates.com Volume No 03, Special Issue No. 01, April 2015 ISSN (online): 2348 – 7550 293 | P a g e DESIGN & FABRICATION OF HUMAN POWERED MULTI-PURPOSE MACHINE Rakesh Ambade1, Amit Sartabe2, Meghraj Arekar3, Vaibhav Khachane4, Prajakta Gawali5 1Assistant professor2,3,4,5Undergraduate Students, Dept. of Mechanical Engineering, Jawaharlal Darda Institute of Engineering & Technology Yavatmal, Maharashtra, (India)

This paper presents the concept of Human Powered Multi-Purpose Machine mainly carried out for production based industries. Industries are basically meant for Production of useful goods and services at low production cost, machinery cost and low inventory cost. Today in this world every task have been made quicker and fast due to technology advancement but this advancement also demands huge investments and expenditure, every industry desires to make high productivity rate maintaining the quality and standard of the product at low average cost. We have developed a conceptual model of a machine which would be capable of performing different operation simultaneously, and it should be economically efficient .This machine can be used in remote places where electricity is irregular or insufficient. It is designed as a portable one which can be used for cutting in various places. It can be used for operating on materials like thin metals,wood and p.v.c.The material can be cut without any external energy like fuel or current. Since machine uses no electric power and fuel, this is very cheap.Energy is the most vital aspect in the development of modern technological civilization. In the present work, a human powered multipurpose machine is developed which can perform three types ofoperations drilling, sawing and grinding. Power required for pedalling is well below the capacity of an average healthy human being. The system is also useful for the work out purpose because pedalling will act as a health exercise and also doing a useful work

2.2. Research Inventy: International Journal of Engineering And Science Vol.4, Issue 7 (July 2014), PP 01-05 Issn (e): 2278-4721, Issn (p):2319-6483, www.researchinventy.com 1 Experimental Investigation of Pedal Driven Hacksaw 1Sreejith K., 2Aravind K., 3Danie Davis, 4Farish K.A., 5George Johnson 1Assistant Professor, 2,3,4,5Under Graduate Students Dept.Of Mechanical Engineering, Jyothi Engineering College, Cheruthuruthy, Thrissur, Kerala-679 531, India.

The objective of this paper was to design, fabricate and experimentally investigate the working of Pedal Driven Hacksaw(PDH). PDH is working on Slider Crank Mechanism. The experiment was done using PDH and plywood workpieces. The main parts of PDH are hack saw, reciprocating rod welded to the pedal of a bicycle, flywheel, sprocket and chain drive. The hack saw is connected with the reciprocating rod. By pedaling the bicycle the reciprocating rod moves to and fro, the hack saw will be moving with the rod. The plywood to be cut is placed under the hack saw. Thus the plywood can be cut without any external energy like fuel or current. Since this uses no electric power and fuel, this is very cheap and best. The performance of the PDH was compared with Hand Hacksaw at different rpm. The results indicate that the PDH had given better, accurate and faster cuts when compared with hand hacksaw at different rpm. PDH reduces the effort of cutting plywood to a great extent. When compared to the Power Saw the PDH requires only manual power thereby reducing the utility bill considerably. Experimental result shows that cutting depth of about 17 mm can be obtained in one cycle of strokes for around100rpm.

2.3. Research Inventy: International Journal of Engineering And Science Vol.4, Issue 8 (August 2014), PP 56-60 Issn (e): 2278-4721, Issn (p):2319-6483, www.researchinventy.com 56 Experimental Investigation of Pedal Powered Centrifugal Pump 1Sreejith K., 2Manu Sunny, 3Martin O.J., 4Mintu Louis, 5Noble Patrick K., 6Sonal P. Thomas 1Assistant Professor, 2,3,4,5,6Under Graduate Students Dept.Of Mechanical Engineering, Jyothi Engineering College, Cheruthuruthy, Thrissur, Kerala-679 531, India.

The objective of this paper was to design, fabricate and experimentally investigate the working of Pedal Powered Centrifugal Pump (PPCP) which used in small drinking water supply and garden irrigation. PPCP consists of a centrifugal pump operated by pedal power. The centrifugal pump is positioned on its stand in such a way that driven shaft of the centrifugal pump is butted to the bicycle wheel. By pedaling the bicycle, the bicycle wheel rotates, thereby rotating the centrifugal pump which in turns discharges water from the sump. PPCP provides drinking water and irrigation in remote areas where electricity is not available. PPCP is not only free from pollution but also provide healthy exercise. PPCP reduces the rising energy costs. PPCP is designed as a portable one which can be used for irrigation in various places. The experimental investigation was executed and performance of the PPCP was carried out at different rpm. The results indicate that the PPCP had given a considerable amount of discharge and head. The PPWP requires only manual power thereby reducing the utility bill considerably. Experimental result shows that discharge of about 0.0025m3/sec can be obtained for around 140rpm.

2.4. International Journal on Recent and Innovation Trends in Computing and Communication ISSN: 2321-8169 Volume: Issue: 2 072– 074 72 IJRITCC | February 2015, Available @ *http://www.ijritcc.org*
Design and Fabrication of Human Powered Wood Cutting machine
Asst. Prof. Zoeb khan Department Of Mechanical Engineering VDCET, Mouda Nagpur, India *Khan.sohail47@gmail.com* Mr.Sushil Dopekar Department Of Mechanical Engineering VDCET, Mouda Nagpur, India *sushildhopekar@gmail.com*

Science is basically "passive" observation of the universe, as it exists to generate knowledge. Engineering is making use of that knowledge to meet human needs by creating machine, systems, process and technologies that have not previously existed. Design and manufacturing are the synthetic part of engineering practice. Manufacturer has received a lot of attention recently for very good economic reasons.
This is improved design of the human powered wood cutting machine which gives the less efforts of man and commonly used in rural areas where there is no power supply. The design ensures a smooth operation during the cutting process. The cutting force is provided by means of chain drive, gear assembly and other kinematic mechanism and all the parameter need to be optimized to get maximum cutting force. This machine is used for heavy duty wood cutting process for multiple operations like furniture, farm equipment's, workshop and construction areas etc. It is light in weight and portable machine.

2.5. International Conference on Global Trends in Engineering, Technology and Management (ICGTETM-2016) ISSN: 2231-5381 http://www.ijettjournal.org Page 417
Human Power Using Bicycle Mechanism as an Alternative Energy Source: A Critical Review M. P. Mohurle1,D.S. Deshmukh2,P. D. Patil3 1Student of Master of Engineering, SSBT`s COET, Bambhori, Jalgaon, M.S., India.2Prof. & HOD of Mechanical Engineering Dept., SSBT`s COET, Bambhori, Jalgaon, M. S., India.3Professor of Mechanical Engineering, SSBT`s COET, Bambhori, Jalgaon, M.S., India

.In this paper importance of human power as an alternative energy source is investigated, since beginning to present state and its future scope. Natural fuel use is increased due to industrial development and these sources oil, coal and natural gas reservoirs are limited. Energy crises need to search for alternate source of energy that is specifically renewable energy. Human power credit is more because of health benefit as a source of energy. More effective use of human power could be achieved through properly designed mechanisms. Human power as prime mover used to operate working unit is termed as human powered machine. Design considerations for bicycle mechanism are discussed in this paper. Owing to appropriate and most effective technology to use human power efficiently is bicycle technology. In bicycle technology operator uses mostly pedal to operate machine and transmits power through crank, chain and freewheels to the working unit. This machine is widely used to generate electric power, to operate various home appliances, to drive water pump, harvesting activities in agriculture sector and simultaneously useful for physical fitness of operator.

2.6. International Journal of Current Engineering and Technology E-ISSN 2277 – 4106, P-ISSN 2347 – 5161

649| International Journal of Current Engineering and Technology, Vol.6, No.2 (April 2016)

Design and Fabrication of Pedal Powered Circular Saw for Wood Working Applications

Dhanasegaran A†, Dhilip Kumar H†*, Dinesh Kumar V T† , Gopi Kumar K. † and S.Gokul† †Mechanical Engineering, Jansons Institute of Technology, Coimbatore, India

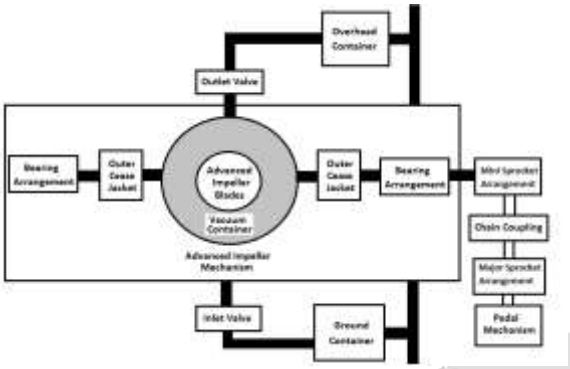
Accepted 14 April 2016, Available online 16 April 2016, Vol.6, No.2 (April 2016)

In this paper, Pedal operated circular saw machine which can be used for industrial applications and household needs is fabricated. It does not requires any specific input energy or electric power. The objective of this model is using the conventional mechanical process which plays a vital role. This project consists of a larger sprocket which rotates with a help of human powered pedal. The smaller sprocket is connected to the plane which is mutually perpendicular to the axis of the larger sprocket is made rotated by using chain drive. The smaller sprocket is rigidly supported by means of shaft and bearing support. The circular saw is mounted on the same shaft where the smaller sprocket is mounted. When the pedal is operated, circular saw rotated which in turn cuts the wooden block material. The main aim is to reduce the human effort for machining various materials such as wooden blocks etc. The power circular saw machine, which runs on human power, works on the principle of the conversion of rotational motion in a mutually perpendicular axis. Importance of this paper lies in the very fact that it is green project and helps us to reduce our electricity need too. Secondly, this cutter can be used and transferred to our working place easily. Moreover, if needed we can generate electricity with our project by connecting it to dynamo, diode and battery.

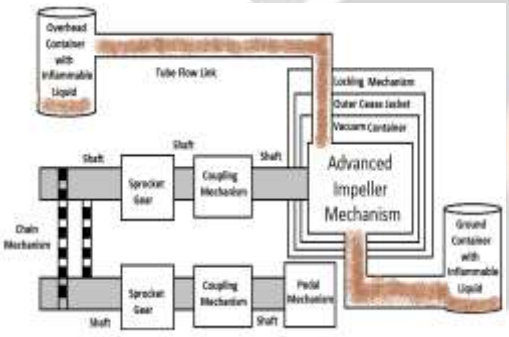
3. Research Methodology:

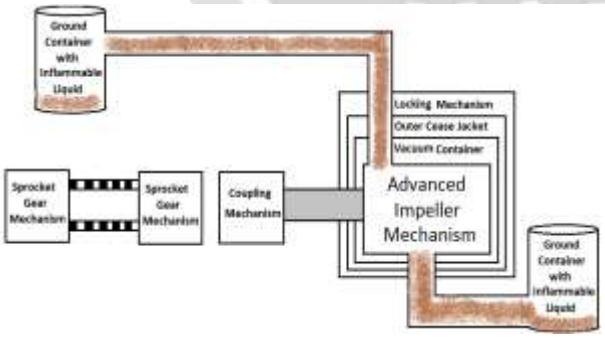
This project uses centrifugal force which will produce by advanced Impeller mechanism which will rotate through human power mechanism. **Centrifugal pumps** are a sub-class of dynamic axis symmetric work-absorbing turbomachinery. Centrifugal pumps are used to transport fluids by the conversion of rotational kinetic energy to the hydrodynamic energy of the fluid flow. The rotational energy typically comes from an engine or electric motor. The fluid enters the pump impeller along or near to the rotating axis and is accelerated by the impeller, flowing radially outward into a diffuser or volute chamber (casing), from where it exits. This project basically depends on the fabrication of minimum RPM impeller that means with the minimum rotation of Impeller the fluid get able to lift towards overhead container. The selection of this project taken into consideration according to according to problem identification of lifting highly inflammable liquid i.e. problem of chances of fire, blasting. This project uses advanced impeller which will lift highly inflammable liquid towards overhead container with minimum RPM using human power system. The advanced Impeller consists of aerodynamic fan placed inside the vacuum vessel to generate minimum RPM centrifugal force. This system cease into a locking assembly and shaft is taken out from complete assembly to couple human power rotating assembly. This Impeller consists of inlet and outlet valve to input oil from a particular source and to lift oil towards overhead destination. There is piping assembly from ground source container towards overhead container with care to maintain suction.

3. Experimental Block Diagram:



3.1. Conceptual Diagram:





Description:

In this project, here used bycycle and centrifugal pump to lift oil, petrol and diesel. There basic important units of the system.

1. Coupling Unit to carry Main ARM.
2. Main ARM.
3. Sub ARM.
4. Chain coupling between Main ARM and Sub ARM.
5. Centrifugal Unit
6. Inlet and outlet Pipeing Unit.

In the bicycle unit there are two arm's.

A. Main Arm.
B. Sub Arm

In this project the centrifugal pump rotation depends on the movement of main ARM and linking with the sub ARM via chain coupling. In this project here used bicycle i.e. human power to lift the oil, petrol and diesel. This project suitably selected for common man who will use their own power and for that there will be no requirement of electricity. This project can be useful in agricultural area where there no availability of electricity. In this project here use Coupling Unit to carry Main ARM which is use to carry all following thing that are, Driver : front Sprocket pedal gear, Chain, Chain wheel, crank ARM, Crank Bolt, Spider, Chain Ring Bolt and Chain Ring Teeth. Ultimately the aligned movement of Main Sprocket gear depends on the Coupling Unit.

Main ARM uses following sub parts are as follows,

1. Driver : front Sprocket pedal gear.
2. Chain
3. Chain Wheel.
4. Crank Arm
5. Crank Bolt
6. Spider.
7. Chain ring Bolt.
8. Chain ring Teeth.

The Sprocket gear carries chain and pedal for the accessories used are chain wheel, crank ARM, Crank Bolt, Spider, chain ring bolt and chain ring teeth and finally all these assemblies mount over Coupling unit. With the movement of pedal all assembly will start to rotate i.e. aligned movement of front sprocket gear and chain over coupling unit.

The Sub ARM consists of following unit as follows,

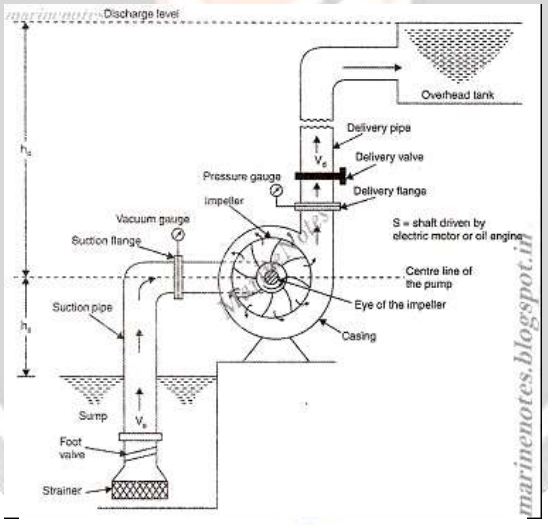
Sub ARM Consists of,

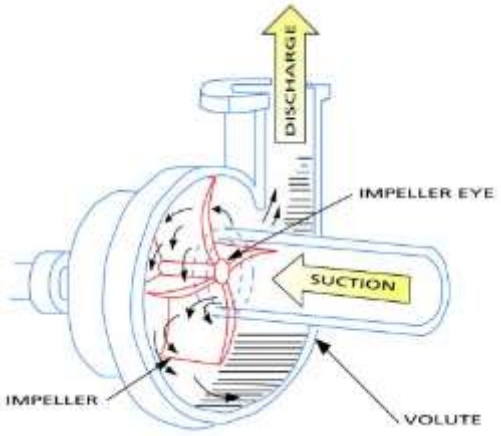
1. Driven element :Sprocket gear.
2. chain

Some Tools use to crete this that are.

1. Cutting Maching.
2. Bending Machine
3. Drilling Machine
4. Welding machine.
5. Smoother
6. Fixers
7. Threading Machine.
8. Lethe Machine.
9. Gear Cutter Machine.
10. PUC Pipes and Bents.
11. Nozzles
12. Bucket
13. Bucket Nozzle and nipple.

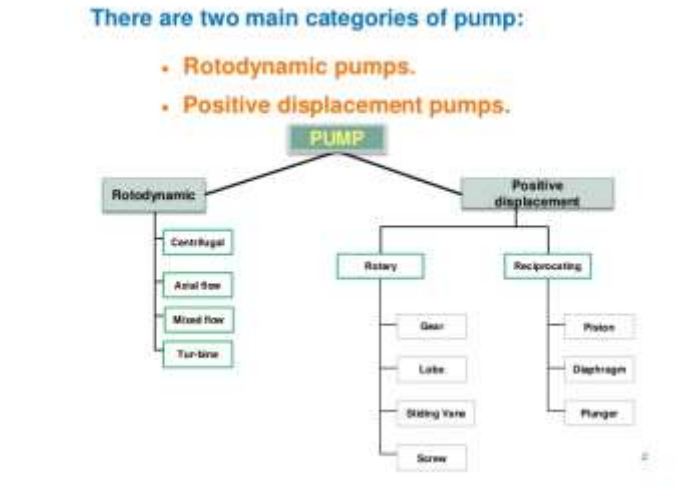
4. Working Principle Design :





4.1. Centrifugal Pump:

Centrifugal pumps are a sub-class of dynamic axis symmetric work-absorbing turbomachinery. Centrifugal pumps are used to transport fluids by the conversion of rotational kinetic energy to the hydrodynamic energy of the fluid flow. The rotational energy typically comes from an engine or electric motor. The fluid enters the pump impeller along or near to the rotating axis and is accelerated by the impeller, flowing radially outward into a diffuser or volute chamber (casing), from where it exits.



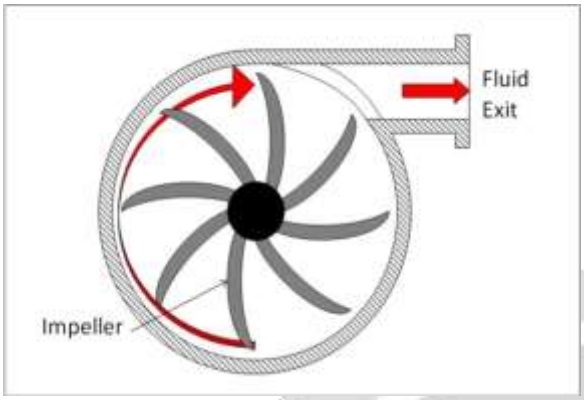
Common uses include water, sewage, petroleum and petrochemical pumping; a centrifugal fan is commonly used to implement a vacuum cleaner. The reverse function of the centrifugal pump is a water turbine converting potential energy of water pressure into mechanical rotational energy.

General explanation: Like most pumps, a centrifugal pump converts rotational energy, often from a motor, to energy in a moving fluid. A portion of the energy goes into kinetic energy of the fluid. Fluid enters axially through eye of the casing, is caught up in the impeller blades, and is whirled tangentially and radially outward until it leaves through all circumferential parts of the impeller into the diffuser part of the casing. The fluid gains both velocity and pressure while passing through the impeller. The doughnut-shaped diffuser, or scroll, section of the casing decelerates the flow and further increases the pressure

4.2 Description by Euler

A consequence of Newton's second law of mechanics is the conservation of the angular momentum (or the "moment of momentum") which is of fundamental significance to all turbomachines. Accordingly, the change of the angular momentum is equal to the sum of the external moments. Angular momentums $\rho \times Q \times r \times cu$ at inlet and outlet, an external torque M and friction moments due to shear stresses $M\tau$ are acting on an impeller or a diffuser.

Since no pressure forces are created on cylindrical surfaces in the circumferential direction, it is possible to write Eq. (1.10) as



5. Advantages:

1. Able to pump oil, petrol and diesel without using electricity.
2. Saving of power.
3. Fire Resistant.
4. Use of human power so economical as no requirement external input.
5. No chances of Shock i.e. shock resistant.
6. Easy to use.
7. Placement is possible anywhere.
8. Optimistic Design.
9. Easy to understand.
10. No requirement of external manpower.
11. Efficient design as able to lift maximum oil, petrol and diesel.
12. Lifetime Setup i.e. able to sustain long time.
13. Maintenance is easier.
14. Work in all seasons and no chances of permanent damage.

6. Applications:

1. Oil refineries.
2. Sensitive power plants.
3. Alcohol Factories.
4. Mercury Plants.
5. Kerosene Refineries.
6. Forest

7. Household Use.
8. School
9. Colleges.
10. Hospitals
11. Shopping Malls
12. Factories.
13. Refineries.
14. Hill Stations

7. Problem Identification:

1. For lifting of highly inflammable liquid, requirement of High RPM impeller to generate centrifugal force or need to fabricate minimum RPM Impeller.
2. High RPM generates through high capacity electrical motor which is quite difficult to use because use of electricity chances of fire or blasting.
3. High capacity electrical motor requires electrical power and related power system manufacturing at relevant places which is a biggest issue and chances of trouble.
4. Gasses state of highly inflammable liquid also create a huge problem of fire if it comes under the influence of any small fire.
5. Highly inflammable liquid easily comes under influence fire or easily emit into the atmosphere so encapsulation required.rth crust because of limited RPM.
6. Difficult to lift up crude oil from Earth.
7. Quite difficult arrange setup anywhere.
8. Setup cost is very high.
9. Requirement of manual assembly.
10. Factories are separated from local areas.
11. Requirement of non electrical centrifugal force arrangement requires multiple areas of refineries.
12. Requirement of proper pipe flow and vessel arrangement through non electrical centrifugal force arrangemen.

8. Problem Solution:

1. Advanced Minimum RPM Impeller helps to generate centrifugal force within the device.
2. Human power advanced impeller can able to lift a lift highly inflammable liquid towards overhead container.
3. No requirement of electrical motors as complete assemble is human power based.
4. No chances of fire and blasting as there is no requirement of electricity.
5. Generation of Minimum RPM Impeller with relevant centrifugal force so as to lift highly inflammable liquid towards overhead container solely depends on impeller manufacturing.
6. Advanced minimum RPM Impeller helps to lift up crude oil from the Earth.
7. Quite easier to arrange setup anywhere.

8. Setup cost is low.
9. Human power based system helps to reduce hardware.
10. Factories can be setup at any local areas as well because no chances of accident.
11. Multiple Human power impeller can be able to generate for multiple areas which will generate centrifugal force.
12. Inflammable liquid can be able to flow through pipe and vessel because of human power based impeller generated centrifugal force.

9. Future Scope

Lifting or transmission of Highly inflammable Fluid , Crude oil, Petrol , Diesel, Kerosene, Mercury from earth or any underground or ground towards overhead vessel/ container through sensitive area it's a biggest sensitive task because of chances of explosion. So in the sea level where there is availability of multiple crude oil refinery, they do not use electricity so in future with the use of force created by movement of sea level as it is fluctuating, up and down movement , this movement get converted into rotary motion which will helps to form rotation of impeller and finally with the creation of centrifugal force the oil get lift oil from ground earth station towards vessel of refinery without using electricity.Whatever advanced impeller arrangement used in this according to lifting oil with minimum RPM this will enhance in future with multiple arrangement of impeller with limited RPM so that level of fluid transmission and content of fluid flow will increase.

10. REFERENCES

[1] **H., Krain**, "A Study on Centrifugal Impeller and Diffuser Flow", ASME Journal of Engineering for Power, Vol.103, No.3, 0ctober1981, pp 688-697.

[2] **Guellich, J. F., Bolleter, U.**, "Pressure Pulsations in Centrifugal Pump",Journal of Vibration and Acustics,Transaction of American Society of Mechanical Engineers, Vol.114, 1992, pp 192.

[3] **Cornelius Scheffer**,"PumpCondition Monitoring through Vibration Analysis" Pumps:Maintenance, Design, and Reliability Conference, 2008.

[4] **Omprakash, Gupta, K., Nakra, B. C.** ,"Vibration and Noise Monitoring of Centrifugal Pumps",first international symposium on Pump,Noise and Vibrations, Paris, France , July 7-9 , 1993, pp 493.

[5] **Macay, E. , Szamody, O.,** "Survey of Feed Pump Outages ", EPRI Report no. FP 754,1978 . [6] **Cudina, M. S.**,"Noise as an Indicator of Cavitation and Instability in Centrifugal Pumps", Journal of Mechanical Engineering , Vol.45, 1999, pp134–146.

[7] **Khalifa, A. E., Al-Qutub, A. M.**, "The Effect of Impeller-Volute Gap on Pressure Fluctuations Inside a Double-Volute Centrifugal Pump Operating at Reduced Flow Rates", 7th World Conference on Experimental Heat Transfer, Fluid Mechanics and Thermodynamics, Krakow, Poland, 28 June-03 July, 2009, pp 905-912.

[8] **Bernd Dürrer, Frank-Hendrik Wurm**, "Noise sources in Centrifugal Pumps" Proceedings of the 2nd WSEAS Int. Conference on Applied and Theoretical Mechanics, Venice, Italy,November 20-22, 2006.

[9] **Birajdar, R. , Patil, R., Khanzode, K.**, "Vibration and Noise in Centrifugal Pumps- Sources and Diagnosis Methods ", 3rd International Conference on Integrity, Reliability and Failure, Porto/Portugal , 20-24 July 2009.

[10] **Guo, S., Maruta, Y.**, "Experimental Investigation on Pressure Fluctuations and Vibration of the Impeller in a Centrifugal Pump with Vaned Diffusers", JSME International Journal, series B,Vol. 48, No. 1, 2005. [11]

[11]**Torbergsen, E., White, M. F.**, "Numerical and Experimental Study of Impeller/Diffuser Interactions in Centrifugal Pumps", Proceedings of the ISROMAC Conference, Vol.C, Feb.22–26, 1998, pp. 1349–1358. [12] **Srivastav, O. P., Pandu K. R., Gupta, K.**, Effect of Radial Gap Between Impeller and Diffuser on Vibration and Noise in a Centrifugal Pump, IE(I) Journal- MC, Vol. 84, April 2003.

[12]Anagnostopoulus, J. S. Numerical calculation of the flow in a centrifugal pump impeller using cartesian grid**.** In: 2nd Wseas Int. Conference on Applied and Theoretical Mechanics, 2006, Veneza, Itália, **Proceedings 2nd WSEAS**, Veneza, 2006, p. 124-129. Available at: <http://www.fluid.mech.ntua.gr/lht/PYTHAGORAS/dimosieuseis/D-9.pdf>.

ANSYS CFX - Reference Guide, ANSYS CFX Release 11.0. United States, December, 2006, Software handbook, 934p. ANSYS CFX - Solver Modeling Guide, ANSYS CFX Release 11.0. United States, December, 2006, Software handbook, 566p.

[13]Asuaje, M. et al. Numerical modelization of the flow in centrifugal pump: volute influence in velocity and pressure fields, **International Journal of Rotating Machinery**, 2005:3, p. 244-255, 2005. Available at: http://www.hindawi.com/journals/ijrm/2005/345857.abs.html **BRAZILIAN JOURNAL OF PETROLEUM AND GAS | v. 4 n. 1 | p. 001-009 | 2010 | ISSN 1982-0593 9** Asuaje, M. **Méthodologie et optimisation dans la conception et l'analyse des performances des turbomachines à fluide incompressible**, 101f. Thèse de Doctorat. Ecole Nationale Supérieure d'Arts et Métiers - Centre de Paris, Paris, 2003. (in French). Available at:

[14]MALISKA, C. R. **Transferência de calor e mecânica dos fluidos computacional**. Rio de Janeiro: LTC - Livros Técnicos e Científicos Editora S.A., 2a edição, 2004. 453p. (In Portuguese).

Pèrez, J. L.; Carrilo L. P.; Espinoza H. Three-dimensional simulation of the entrance-impeller interaction of a hydraulic disc pump, **Rev. Téc. Ing. Univ. Zulia**, v. 29, n. 1, p. 49-57, 2006. Available at: <http://www.scielo.org.ve/scielo.php?script=sci_arttext&pid=S025407702006000100007&lng=es&nrm=iso&tlng=es>. STEPANOFF, A. J. **Centrifugal and axial flow pumps, theory, design and application.** Malabar: Krieger Publishing Company, 2nd edition, 1957. 462p. (In English).

[15]THOMAS, J. E. **Fundamentos da engenharia de petróleo**. Rio de Janeiro: Editora Interciência, 2a edição, 2001. 271p. (In Portuguese).

[16] van ESCH, B. P. M. **Simulation of three-dimensional unsteady flow in hydraulic pumps**, 76p, Doctoral Thesis. University of Twente, Enschede, Netherlands, 1997. (In English). Available at: <http://www.thw.ctw.utwente.nl/research/PhD-theses/Van%20Esch.pdf>.

Zhou W., Zhao Z.; Lee T. S., Winoto S. H. Investigation of flow through centrifugal pump impellers using computational fluid dynamics, **International Journal of Rotating Machinery**, 9(1): p. 49-61, 2003.
Available at: <http://downloads.hindawi.com/journals/ijrm/2003/340256.pdf>.

BIOGRAPHIES

	Mr. N.M. Bante PBCOE Nagpur
	Mr. A. D. Landge PBCOE Nagpur