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Lifting of Water at Remote Places using Steam and Compressed Air

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Abstract: Lifting of water at remote places using steam and compressed air .the objectives of this unit is to pump water at remote places. In this project we use turbocharger (turbine& compressor), furnace, water pump, IBR valves and mechanical hardware equipment's. The main objective is pump water at places where the electricity is not available or available at high cost with the help of steam and compressed air which help to rotate turbine and pump. It can also use to generate electricity at remote places by assembling electrical generator. This thesis also takes into consideration the material used with minimum possible cost. The design of project is such that it can easily dissemble and assemble and easy to operate
Keywords: Compressed, Furnace, Generator, Lifting

I. INTRODUCTION

The main purpose of project is to getting rotary motion for doing work at remote places. With the help of steam and compressed air which is generated the by water tube boiler and compressed air which is impinged on turbine blade of turbocharger. Since the renewable source like biogas is used to generate work and sometimes LPG also. The project lifting of water at remote places using steam and compressed air is eco-friendly. Biogas production has many benefits in organic farming. The main product of biogas production is slurry, a high quality fertilizer that is higher in nutrients than compost or farmyard manure. The slurry (organic fertilizer or biogas manure) has great potential especially in organic farming systems where crop rotation is practiced and nutrients recycled to improve agricultural productivity.

Research has shown that the slurry can increase crop yields in organic farms by up to 30 per cent. Green energy comes from natural sources such as sunlight, wind, rain, tides, plants, algae and geothermal heat. These energy resources are renewable, meaning they're naturally replenished. In contrast, fossil fuels are a finite resource that take millions of years to develop and will continue to diminish with use. Renewable energy sources also have a much smaller impact on the environment than fossil fuels, which produce pollutants such as greenhouse gases as a by-product, contributing to climate change. Gaining access to fossil fuels typically requires either mining or drilling deep into the earth, often in ecologically sensitive locations. Green energy, however, utilizes energy sources that are readily available all over the world, including in rural and remote areas that don't otherwise have access to electricity. Advances in renewable energy technologies have lowered the cost of solar panels, wind turbines and other sources of green energy, placing the ability to produce electricity in the hands of the people rather than those of oil, gas, coal and utility companies Guidelines

II. DESIGN CONSIDERATION

A. 10 bar pressure &300^0C
B. Use of 20 litres of water to avoid Boiler regulations
C. Selection of Turbocharger
D. Selection of furnace
E. Coil Design
F. Selection of accessories
G. Selection of mountings
H. Fabrication of coil using TIG/MIG Welding
I. Extension to Turbocharger Shaft for Coupling the pump
J. Selection of pump
K. Trial for leakages in coil
L. Trial for generating steam at considered pressure of 10 bar
M. Trial for running the pump at 8bar maximum
N. Measurement of pump rpm at 8 bar -2300rpm

III. ENGINEERING PRINCIPLES USED

A. Laws of Conservation

The law of conservation of energy, adapted for thermodynamic systems. The law of conservation of energy states that the total energy of an isolated system is constant; energy can be transformed from one form to another, but cannot be created or destroyed.

B. 1st law of Thermodynamics

Net heat supplied to the system from the surrounding is equal to net work done by the system on the surrounding.

C. 2nd law of Thermodynamics

It is impossible to construct the heat engine whose effect is to convert all the heat supplied into equivalent work done.

D. Bernoulli's Principle

It is the sum of pressure energy, kinematic energy and potential energy.

$$P/2g+v^2+z=\text{constant}$$

E. Pascal's Law

Pressure intensity at a point in static fluid is equal in all direction.

F. Rankine Cycle

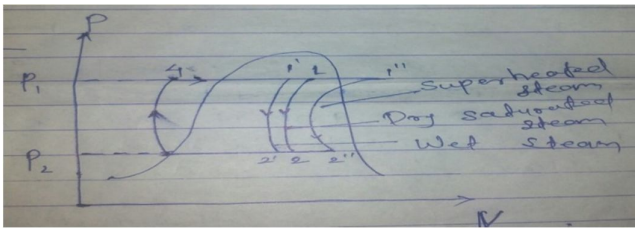


FIG NO 1: RANKINE CYCLE

Process 1-2:- Reversible adiabatic expansion in the turbine.
Process 2-3:- Constant pressure transfer of heat in the condenser.
Process 3-4:- Reversible adiabatic pumping process in the feed pump.
Process 4-1:- Constant pressure transfer of heat in the boiler considering the 1kg of fluid

IV. BOILER MOUNTINGS AND ACCESSORIES

A. Non Return Valve

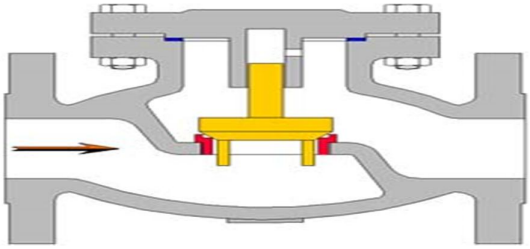


FIG NO 2: PISTON LIFT NRV

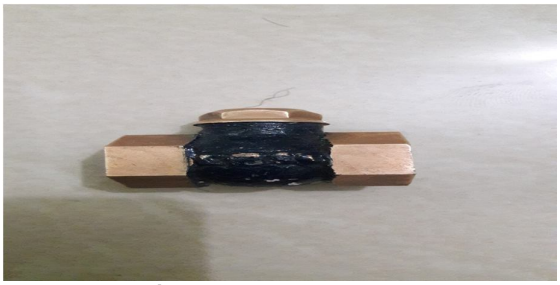


Fig No 3: 2nd TYPE OF NRV (HORIZONTAL)

As the name indicates, this non return valve is used to ensure unidirectional flow of fluids. It is used to prevent the back flow in order to safeguard the critical equipment such as pumps, compressor etc. and also used for positive. This non return valve is also known as check valve. This valve is self-operated valve and doesn't require any hand wheel or gear for operation

1) *Pistons Lift Check:* The piston lift non return valve has body similar to that of globe valve. The piston will be in cylindrical form, the lower end of which is shaped to form asserting disk. The cylindrical part fits into the guide making an effective dash pot. When it is in fully open position, the net area between the seating disk and the seat will be equal to the area through the seats. The body will be provided with renewable body seat rings like in globe valves. In carbon steel valves, there can be hard faced seats deposited directly on to the body. The lift check valves can also be provided with spring loaded piston. In this case, a spring of specified tension has to be placed, between the guide and the piston within the cylindrical portion. The piston lift check valves can only be placed in the horizontal position.

B. Spring Loaded Safety Valve



Fig No 3: Spring loaded safety valve

It is loaded with a spring instead of weights. Hence it is called spring loaded safety valve. It consists of a stainless steel body having two branch pipes p1 and p2. Two separate valves are placed over the valve seating, which are fixed to the top of the branch pipes. A lever is placed over the valves by means of two conical pivots.

The lever is attached to a spring at its middle. The spring pulls the lever in downward direction. The lower end of the spring is attached to the valve body by means of a shackle. Thus the valves are held tight to their seats by the spring force.

1) *Working:* When the steam pressure exceeds the normal working pressure, the valves rise up against the action of the spring and allows the steam to escape from the boiler till the pressure in the boiler reaches its working pressure.

The spring loaded safety valve is much lighter and compact compared with other safety valves. For locomotive or marine service, the safety valve should be such that it is unaffected by jerks and vibration likely to occur in such device. Hence spring loaded safety valve is preferred for locomotive and marine services, in addition to stationary boilers.

C. Bourdon Tube Pressure Gauge



Fig No 4: Bourdon Tube Pressure Gauge

The bourdon tube is the most frequently used pressure gauge because of its simplicity and rugged construction. It covers range from 0-16 bar or 0-16 kg/cm^2

1) *Construction and Working:* A c-type bourdon tube consist of a long thin-walled cylinder of non-circular cross section , sealed at one end , made from materials such as phosphor bronze , steel and beryllium copper, and attached by a light line work to the mechanism which operates the pointer. The other end of the tube is fixed and is open for the application of the

pressure which is to be measured.As the fluid under pressure enters the bourdon tube, it tries to change the section of the tube form the oval to circular, and this tends to straighten out the tube. The resulting movement of the free end of the tube causes the pointer to move over the scale. The tip of the bourdon tube is connected to segmental lever through an adjustable length link. The lever length also may be adjustable length link. The segmental lever is suitable pivoted and the spindle holds the pointer. A hairspring is sometimes used to fasten the spindle to the frame of the instrument to provide the necessary tension for proper meshing of the gear teeth, thereby freeing the system from backlash.

D. Steam Stop Valve



Fig No 5: Steam stop valve

1) *Function:* The function of the steam stop valve is to regulate the flow of steam from one steam pipe to the other or from the boiler to the steam pipe. The steam stop valve when directly mounted on the steam space of the boiler shell & connected to the steam pipeline which supplies steam to the prime mover is called a junction valve.
2) *Working:* When the hand wheel is turned in anticlockwise direction, the spindle is raised up. This will raise the valve from its seat. Thus a passage for the steam from the clearance between the valve and the valve seat is formed.In order to lower the valve, the hand wheel is rotated in clockwise direction. This rotation will close the passage for steam. Adjusting the position of the valve based on the requirements can regulate this. Under the normal working condition, the valve is open and the steam flows from the boiler to the steam pipe.

E. Boiler Drum



Fig No 6: Boiler Drum

Boiler drums are used on recirculating boilers that operate at subcritical pressures. The primary purpose of the steam drum is to separate the saturated steam from the steam-water mixture that leaves the heat transfer surfaces and enters the drum. The steam-free water is recirculate within the boiler with the incoming feed water for further steam generation. The saturated steam is removed from the drum through a series of outlet nozzles or valves
The steam drum is also used for the following:

- To purify the steam by removing contaminants and residual moisture.
- To provide storage of water to accommodate any rapid changes in the boiler load.
- The most important function of the steam drum, however, remains as the separation of steam and water. Separation by natural gravity can be accomplished with a large steam-water surface inside the drum. This is not the economical choice in today's design because it results in larger steam drums, and therefore the use of mechanical separation devices is the primary choice for separation of steam and water.
- It prevents the carry-over of solids. Solids are dissolved in the water droplets that may be entrained in the steam if not separated properly. By proper separation, this prevents the formation of deposits in on the turbine blades.
- Efficient steam-water separation is of major importance because it produces high-quality steam that is free of moisture.

F. Turbocharger

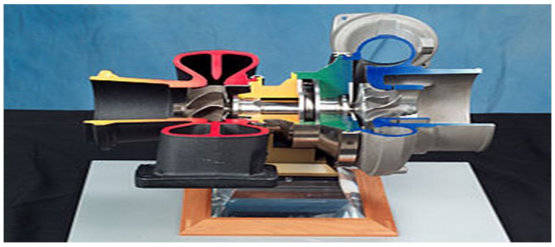


Fig No 7: Turbocharger

A turbocharger consists of a compressor and a turbine connected by a common shaft. The exhaust-gas-driven turbine supplies the drive energy for the compressor.
It consist of three main parts
Compressor
Turbine
Bearings

1) Compressor:

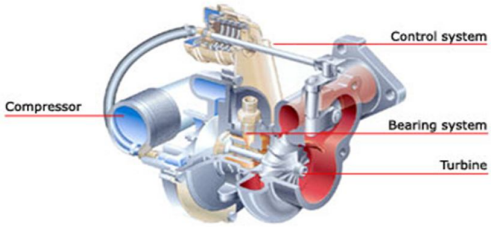


Fig No 8: Compressor

Turbocharger compressors are generally centrifugal compressors consisting of three essential components compressor wheel, diffuser, and housing. With the rotational speed of the wheel, air is drawn in axially, accelerated to high velocity and then expelled in a radial direction. The diffuser slows down the high-velocity air, largely without losses, so that both pressure and temperature rise. The diffuser is formed by the compressor back plate and a part of the volute housing, which in its turn collects the air and slows it down further before it reaches the compressor exit.

2) Turbine:

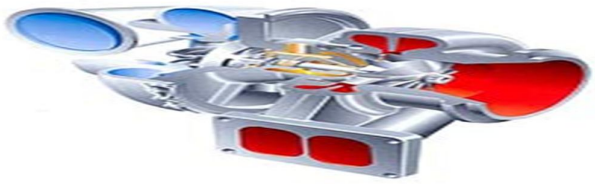


Fig No 9: Turbine

The turbocharger turbine, which consists of a turbine wheel and turbine housing, converts the engine exhaust gas into mechanical energy to drive the compressor. The gas, which is restricted by the turbine's flow cross-sectional area, results in a pressure and temperature drop between the inlet and outlet. This pressure drop is converted by the turbine into kinetic energy to drive the turbine wheel. There are two main turbine types: axial and radial flow. In the axial-flow type, flow through the wheel is only in the axial direction. In radial-flow turbines, gas inflow is centripetal, i.e. In a radial direction from the outside in, and gas outflow in an axial direction. Up to a wheel diameter of about 160 mm, only radial-flow turbines are used.

3) *Bearing system:* The turbocharger shaft and turbine wheel assembly rotates at speeds up to 300,000 rpm. Turbocharger life should correspond to that of the engine, which could be 1,000,000 km for a commercial vehicle. Only sleeve bearings specially designed for turbochargers can meet these high requirements at a reasonable cost.
   i. *Radial Bearing System:* With a sleeve bearing, the shaft turns without friction on an oil film in the sleeve bearing bushing. For the turbo charger, the oil supply comes from the engine oil circuit. The bearing system is designed such that brass floating bushings, rotating at about half shaft speed, are situated between the stationary Centre housing and the rotating shaft. This allows these high speed bearings to be adapted such that there is no metal contact between shaft and bearings at any of the operating points. Besides the lubricating function, the oil film in the bearing clearances also has a damping function, which contributes to the stability of the shaft and turbine wheel assembly. The hydrodynamic load-carrying capacity and the bearing damping characteristics are optimized by the clearances. The lubricating oil thickness for the inner clearances is therefore selected with respect to the bearing strength, whereas the outer clearances are designed with regard to the bearing damping. The bearing clearances are only a few hundredths of a millimeter .The one-piece bearing system is a special form of a sleeve bearing system. The shaft turns within a stationary bushing, which is oil scavenged from the outside. The outer bearing clearance can be designed specifically for the bearing damping, as no rotation takes place.
   ii. *Axial-Thrust Bearing System:* Neither the fully floating bushing bearings nor the single-piece fixed floating bushing bearing system support forces in axial direction. As the gas forces acting on the compressor and turbine wheels in axial direction are of differing strengths, the shaft and turbine wheel assembly is displaced in an axial direction. The axial bearing, a sliding surface bearing with tapered lands, absorbs these forces. Two small discs fixed on the shaft serve as contact surfaces. The axial bearing is fixed in the center housing. An oil-deflecting plate prevents the oil from entering the shaft sealing area.
   iii. *Oil Drain:* The lubricating oil flows into the turbocharger at a pressure of approximately 4 bar. As the oil drains off at low pressure, the oil drain pipe diameter must be much larger than the oil inlet pipe. The oil flow through the bearing should, whenever possible, be vertical from top to bottom. The oil drain pipe should be returned into the crankcase above the engine oil level. Any obstruction in the oil drain pipe will result in back pressure in the bearing system. The oil then passes through the ceiling rings into the compressor and the turbine.

G. Ball Type Gate Valve



Fig No 10: Ball type gate valve

A ball valve is a form of quarter-turn valve which uses a hollow, perforated and pivoting ball (called a "floating ball") to control flow through it. It is open when the ball's hole is in line with the flow and closed when it is pivoted 90-degrees by the valve handle. The handle lies flat in alignment with the flow when open, and is perpendicular to it when closed, making for easy visual confirmation of the valve's status. Ball valves are durable, performing well after many cycles, and reliable, closing securely even after long periods of disuse. These qualities make them an excellent choice for shutoff applications, where they are often preferred to gates and globe valves, but they lack their fine control in throttling applications. The ball valve's ease of operation, repair, and versatility lend it to extensive industrial use, supporting pressures up to 1000 bar and temperatures up to

752 °f (500 °c), depending on design and materials used. Sizes typically range from 0.2 to 48 inches (0.5 cm to 121 cm). Valve bodies are made of metal, plastic, or metal with a ceramic; floating balls are often chrome plated for durability)

H. Flange Gasket

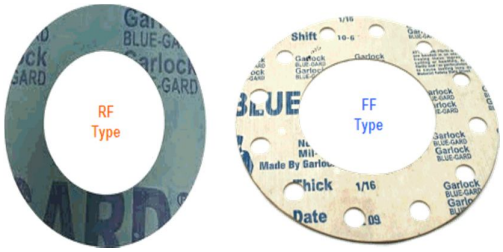


Fig No 11: flange gasket sheet

Flange gaskets are used to create a static seal between two flanges faces, at various operating conditions, with varied pressure and temperature ratings. A gaskets fills the microscopic spaces and irregularities of the flange faces, and then it forms a seal that is designed to keep liquids and gases. Correct installation of damage-free gaskets and damage-free flange faces is a requirement for a leak-free flange connection. If it would be technically possible, in order to manufacture flanges perfectly flat and smooth, and perfectly compatible with one another under all operating conditions, a gasket would not be necessary. But in normal practice it is not possible, because flange connections under any circumstances should be made. Small impurities and a small bit of dirt, is in practice not be avoided and therefore it is necessary to use a gasket.

Non-metallic gaskets are usually composite sheet materials are used with flat-face and raised-face flanges in low pressure class applications. Non-metallic gaskets are manufactured from arimid fiber, glass fiber, elastomer,teflon), graphite etc.Full-face gasket types are suitable for use with flat-face flanges. Flat-ring gasket types are suitable for use with raised face flanges.

I. Cast Steel Pipes



Fig No 12: Cast Steel Pipes

Specification: 1) Id =15 Mm
2) Od= 21mm
Material: Cast Steel
Composition Elements Name: - Carbon , Chromium ,Silicon ,Steel ,Nickel , Aluminum ,Copper And Manganese.

V. WELDING PROCESS USED

A. Gas Tungsten Arc Welding

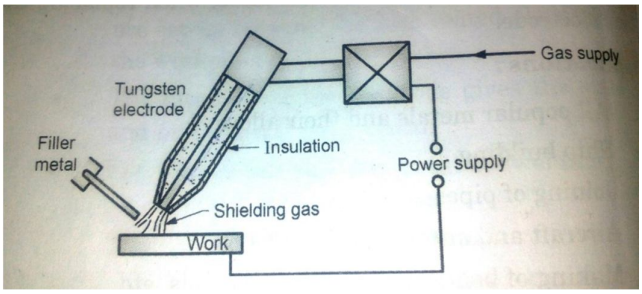


Fig No 13: Gas Tungsten Arc Welding

Tig welding of a bronze sculpture gas tungsten arc welding, also known as tungsten inert gas(TIG)welding, is an arc welding process that uses a non-consumable tungsten electrode to produce the weld. The weld area is protected from atmospheric contamination by an inert shielding gas(argon or helium), and a filler metal is normally used, though some welds, known as autogenously welds, do not require it. A constant-current welding power supply produces electrical energy, which is conducted across the arc through a column of highly ionized gas and metal vapors known as plasma.

It is most commonly used to weld thin sections of stainless steel and non-ferrous metals such as aluminum, magnesium, carbon steel and copper alloys. The process grants the operator greater control over the weld than competing processes such as shielded metal arc welding and gas metal arc welding, allowing for stronger, higher quality welds. However, gtaw is comparatively more complex and difficult to master, and furthermore, it is significantly slower than most other welding techniques.

B. Metal Arc Welding

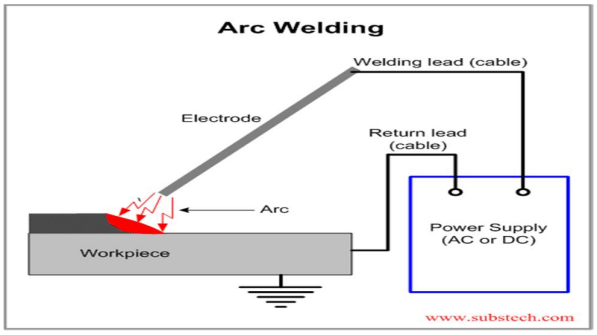


Fig No 14: Metal arc welding

Any arc welding method is based on an electric circuit consisting of the following parts:
Power supply (AC or DC);
Welding electrode;
Work piece;
Welding leads (electric cables) connecting the electrode and work piece to the power supply.

In this process an arc is drawn between a coated consumable electrode and the work piece. The metallic core-wire is melted by the arc and is transferred to the weld-pool as molten drops. The electrode coating also melts to form a gas shield around the arc and the weld pool as well as lag on the surface of the weld-pool, thus protecting the cooling weld-pool from the atmosphere. The slag must be removed after each layer. Manual Metal Arc welding is still a widely-used hard-facing process. Due to the low cost of the equipment, the low operating costs of the process and the ease of transporting the equipment, this flexible process is ideally suited to repair work.



Fig No 15: performing arc welding

VI. FUEL USED

A. Liquefied Petroleum Gas

Liquid petroleum gas (LPG or LP gas), also referred to as simply propane or butane , are flammable mixtures of hydrocarbon gases used as fuel in heating appliances , cooking equipment, and vehicles. It is increasingly used as an aerosol propellant and a refrigerant [citation needed] , replacing chlorofluorocarbons in an effort to reduce damage to the ozone layer . When specifically

used as a vehicle fuel it is often referred to as auto gas. Varieties of LPG bought and sold include mixes that are primarily propane (c 3 h 8), primarily butane (c 4h 10) and, most commonly, mixes including both propane and butane .

B. Biogas - The Perfect Energy Source

Biogas is a renewable energy source with many different production pathways and various excellent opportunities to use .Biogas typically refers to a gas produced by the anaerobic digestion or fermentation of organic matter including manure, sewage sludge, municipal solid waste, biodegradable waste, energy crops or any other biodegradable feedstock. Biogas is comprised primarily of methane and carbon dioxide. One main advantage of biogas is the waste reduction potential. Biogas production by anaerobic digestion is popular for treating biodegradable waste because valuable fuel can be produced while destroying disease-causing pathogens and reducing the volume of disposed waste products. Biogas burns more cleanly than coal, and emits less carbon dioxide per unit of energy. The carbon in biogas was recently extracted from the atmosphere by photosynthetic plants. Releasing it back into the atmosphere adds less total atmospheric carbon than burning fossil fuels

Typical composition of biogas

Methane	50-80 %
Carbon dioxide	25-50 %
Nitrogen	0-10 %
Hydrogen	0-1 %
Hydrogen sulphide	0-3 %
Oxygen:-	0-2 %

VII. CONSTRUCTION AND WORKING

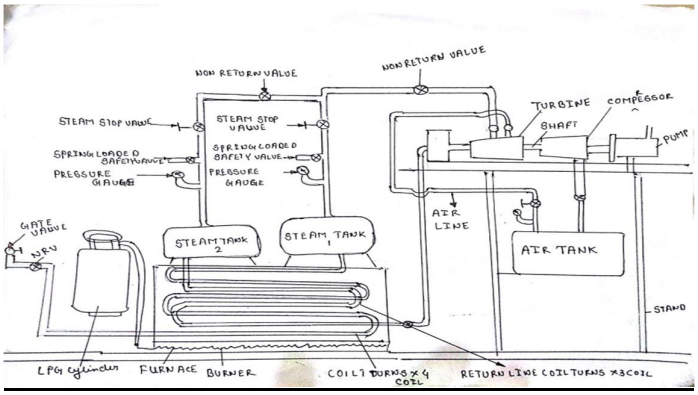


Diagram No 1: Construction & working of lifting water at remote places

A. Construction

Lifting water at remote places this unit consist of water tank located at 10 feet height from ground level .the out let from water tank is given to furnace with the help of pipe in which gate valve and NRV are connected.

Furnace consists of cast steel tubing and outlet of furnace is connected to turbine and turbine shaft is coupled to compressor and compressor shaft is coupled to pump.

Furnace also consists of exhaust steam line tubing and outlet of furnace is again connected to turbine.

Compressor output is connected to air tank on which pressure gauge is mounted and compress air is stored in it and outlet is connected to turbine.

Outlet of turbine is connected to condenser tank / water tank.

B. Working

Water is stored in water tank at a head around ten feet is supplied to the inlet of boiler through gate valve and non-return valve. Water is then circulated in boiler tube and the furnace is lighted. Water is circulated in boiler tube up to we get superheated steam which is stored in tank known as boiler drum up to required pressure is reached.

We required three (t) for successful working of boiler

Temperature

Turbulence

Time

When required temperature and pressure reaches, steam is allowed to impeached on the turbine blade, turbine shaft rotates and exhaust's steam is allowed to pass through another boiler tube and allowed to reheat and collect in another boiler drum and

thus again steam gets heated. when we get required pressure and temperature we close the stop valve for the 1st boiler drum line and then allow reheated steam to run the turbine to which compressor shaft is coupled at that time compressor start compressing the air which is collected in air reservoir or air tank when we get required pressure we stop the furnace and allow compressed air to run the turbine and this process is repeated again and again so that we get energy efficient working of turbine which can be used as prime mover to driving machine which requires rotary motion.

VIII. CALCULATIONS, COMPARISON AND FUTURE SCOPE

Considering 10bar pressure and 300^0c
Id =15mm ,ed=21,distel water=20lit in a close cycle
We will find out by considering above factor from the steam table we get
$T_{saturation}=179.96^0$ c
For superheated steam (10 bar)

- Specific volume =0.258 m^3/kg
- Specific enthalpy(h)=3052.1
- Specific enthalpy of super-heated steam (hg)=2776.2
- Specific enthalpy of dry and saturated steam(hfg)=2013.6
- $T_{sup}=300^0$c
  (All the value are from steam table)

Degree of superheat = t_{sup}- t_{sat}
= 3000c – 179.9^0c
= 120.10c

- Heat available for work done= h – hfg

= 3052.1 – 2013.6
= 1038.5

A. Advantages

- No electricity required
- Less pollution
- Renewable fuel is used
- More thermal efficiency than IC engine
- Thermal efficiency of boiler = 70-80%
- Thermal efficiency of turbine = 90%
- Thermal efficiency of IC engine = 37%

B. Limitation

- Training for operator is necessary.
- Biogas plant is essential.

C. Application

- Operating water pumps at remote places.
- Generating electricity at remote places.
- Operating machines which required rotary motion to produce work.
- In food processing.
- Agricultural equipment's.

D. Future Scope

As we can use biogas as heating source which is a renewable resource so lifting of water at remote place is possible even conventional fuel is not available.

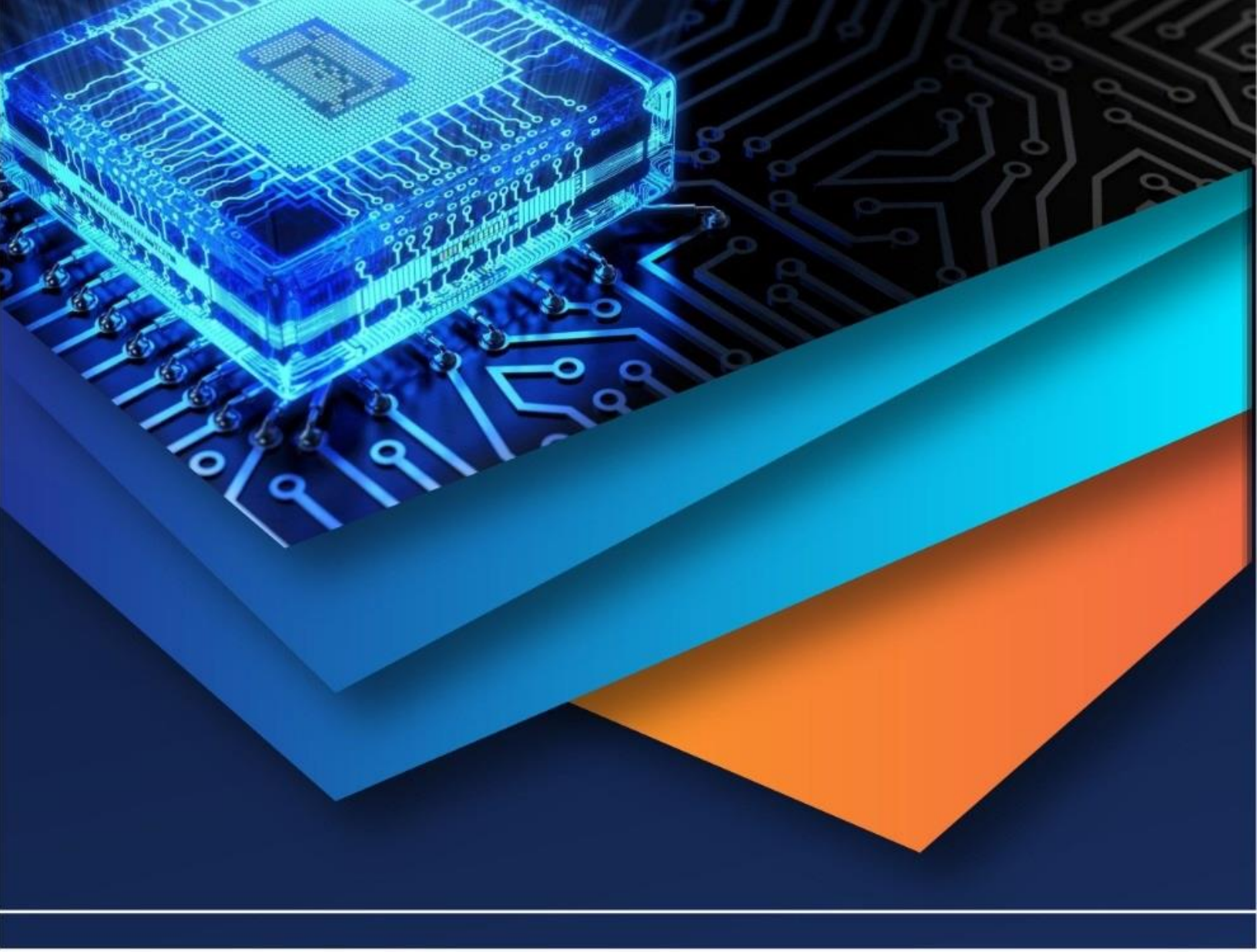
IX. CONCLUSION

As we know that our world has biggest consumption of electricity as energy resource. So various departments such as design department, R&D department giving much importance to fuel and electricity consumption as well as power output as per the need. They are trying to keep environment safe and clean .Various manufacture introducing their newer technologies to become top one in market & they have done same .they put various technologies but some of them got the success .we have shown how

these modern technologies can be used to run a pump without consuming polluting conventional fuels safe guarding the environment.

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