Design and Fabrication of Power Generation System Using Buoyancy and Gravity

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Abstract: Man has always been in pursuit of energy to meet his ever increasing demand. The conventional power generation techniques cause environmental problems. Also there is a growing need to generate power from renewable resources. In this project we are designing and fabricating a machine which generates power using buoyancy and gravity. This machine utilizes the upward force exerted on an immersed body by supporting fluid medium. It also uses the downward motion of the body due to its own weight. These two forces on either side make the system unstable and can be used to rotate a shaft for generating power efficiently. The buoyancy and gravity are the sources of energy so it can be used all over the earth. It would not make any environmental problems. This machine can work entire day and can generate power which will be enough to satisfy the needs. Also this power generating unit is flexible to use in industries and households by converting the output into any useful energy form.

Keywords: renewable; buoyancy; gravity; weight; power.

I. INTRODUCTION

Energy is the fundamental thing that keeps us going. But the most fatal threat which our world is facing is energy crisis. We are totally dependent on non-renewable sources of energy to meet our energy needs. According to scientific interpretations, resources are at the edge of extinction. The non-renewable energy sources such as fossil fuels, coals etc. have remain a very short life span. The case of renewable resources is also not much agreeing. World does have enough resources which are renewable, but converting that resources into useful energy which we consume is not effective. Our largest source of energy comes from the sun. The earth gets more energy from the sun in an hour than the humanity uses in an year. But we do poor job of harnessing it. Today solar cells have efficiency of conversion averaging to about 17 to 23%. The rest is lost. So researches are going in search of a better alternative. An alternative is a renewable one and can produce energy effectively. During this search for an alternative source we came across on this idea.

The production of electricity from renewable sources is highly unstable, especially as wind, solar energy and hydro power strongly depend on weather and climate conditions. Generation of electric power is a necessary component for the operation of modern society. Alternatives to conventional electric power generation sources fuelled by coal or nuclear materials continue to be explored. One of the most inexpensive and cleanest methods for generating large amounts of electric power is hydroelectric power generation. The use of hydroelectric power generation, however, is limited because it requires the availability of vast quantities of water and the feasibility of constructing a large dam to store the large amount of water. These limitations often require reliance on other means of power generation such as nuclear and fossil fuel power plants, which are expensive and environmentally unattractive [1].

Other sources of energy, such as wind and solar power, are environmentally clean and relatively inexpensive. However, a large-scale utilization of these sources for electric power generation is not currently in practice because of several limitations that are inherent in these methods. For example, wind power and solar energy both require a disproportionately large surface area for a large-scale operation. Further, these methods are unreliable because of their dependence on the weather conditions.

There is a general need for alternate sources for power which are inexpensive to operate and efficient in operation. Power generators tend to be highly inefficient and lose a great deal of the power generated before that power can be utilized [2]. Additionally, there is a need for power generators type which require little maintenance, and, when maintenance is required, are easy to repair.

In this project we are making a machine which transforms the gravitational energy and buoyancy into usable electrical energy. In science buoyancy is an upward force exerted by a fluid that opposes the weight of immersed object [3]. Buoyancy force is a form of gravitational force. For ease of explanation, however, "gravity" or "gravitational" will be used for scenarios in which the capsule is denser than the surrounding environment. "Buoyant" or "buoyancy" will refer to scenarios in which the capsule is less dense than the surrounding environment, and thus rises upwardly [4]. In a column of fluid, pressure increases with depth as a result of weight of overlying fluid. Thus a column of fluid or an object submerged in the fluid experiences greater pressure at the bottom of the column than the top. This difference in pressure results in a net force that tends to accelerate an object upwards. The magnitude of that force is proportional to the difference in the pressure between the top and bottom of the column and is also equivalent to the weight of the fluid that would otherwise occupy the column that is the displaced fluid. For this reason an object whose density is greater than that of fluid in which it is submerged, tends to sink. If the object is either less dense than the liquid or is shaped appropriately, the force can keep the object afloat [5].

In this project, we are fabricating an apparatus or a machine to generate power using the buoyancy force and gravitational force. Practically it is not possible to produce energy without introducing any input. So for a working model, an input power is essential for the production of energy using buoyancy and gravity. By introducing an input power, the output is increased with the help of buoyancy and gravitational force.

II.PROJECT DESCRIPTION

In our project we are setting up an apparatus for generating power using buoyancy and gravity. The apparatus consists of a long chain connected around two sprockets. Funnels are attached to the chain. The sprockets are held in position by steel frame. The shafts are attached to the sprockets, with bearing supporting two ends of the shaft. The entire apparatus is immersed in tank made of steel frame filled with water. A pipe is fixed to bottom of the tank with one end connected to the compressor and other end having nozzle at the tip, below the funnels. The upper shaft is connected to another sprocket. This sprocket is connected via chain to another sprocket with smaller diameter.
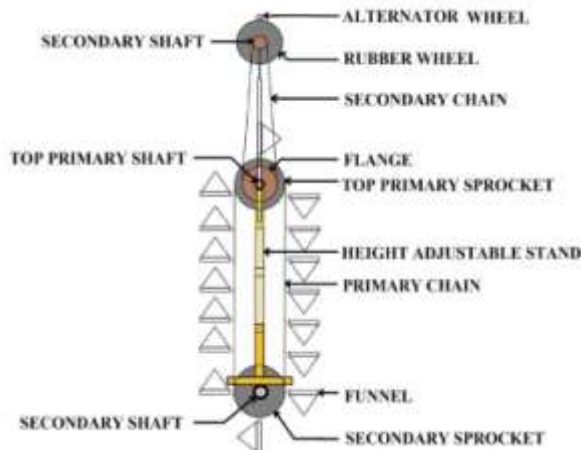
Fig. 1 Experimental setup

A shaft holds the smaller sprocket at one end, bearing and a rubber wheel at its other end .An alternator is made in contact with the rubber wheel. The wires of alternator are connected to a multimeter. As the air is made to flow from the compressor through the nozzle to the funnels immersed in water, the funnels starts moving upwards which rotates the sprockets and shafts connected to it. Other than the force given by air, an extra force is attained by the funnel due to the force of buoyancy acting in the upward direction. This external force gives an extra power rather than the power from the compressor. As the shafts rotate the sprocket connected to upper shaft rotates which drives the smaller sprocket and this smaller sprocket rotates the rubber pad which in turn drives the alternator.

In this apparatus we are using two primary shafts and a secondary shaft. Primary shafts are fixed on frame using bearings on each end. Secondary shaft is fixed using a single bearing at the centre. Primary sprockets are fixed on primary shaft using flange. Flange is welded to the shaft and the sprockets are attached to the flange by nuts and bolts. Primary sprockets are connected using a primary chain. Air carrying cups are attached to the primary chain at equal distance. In order to fix the cups on chain an appropriately shaped metallic plate is welded to the chain in such a way that the normal working of chain would not get interfere and cups are bolted those plates.

Secondary shaft carries a rubber wheel at one end and a small secondary sprocket on the other end. A slight tension in length is provided at one end of the top primary shaft, in order to carry another sprocket. These two sprockets are connected using secondary chain to transmit power from top primary shaft to secondary shaft. A generator is fixed on the frame in such a way that the wheel of the generator makes good contact with the rubber wheel for transmitting power.

Frames are connected by welded joints and in order to make adjustments in tension on the chain, a nut and bolt arrangement is provided. The entire structure is placed inside the water tank. In order to carry the load and to avoid interference of the cups during operation, a clearance space is provided with help of frame at the bottom of the tank.

Water tank has made at required height, breadth and width. Tank is made in a shape of rectangular block using sheet metal. Steel pipes of square and rectangular cross section are used to support the sheet metal tank.

A metallic pipe of circular cross section with a length more than the height of the tank is inserted into the tank from top to the bottom. A nozzle is fixed at the bottom end of the pipe to deliver the air to the cups which causes the upward movement of cups. The pipe from the compressor is connected to the top end of the pipe. The air from this compressor is delivered to the cups through the nozzle.

Output voltage and current from the generator is measured using multimeter. Wire of multimeter is connected at the correct point of generator and its nob is adjusted to get the value within the limit.

III. COMPONENTS

A. Sheet Metal Tank

Sheet metal tank is the main component because the entire experiment takes place inside the tank. The tank has a height of 176cm, length of 76cm and a breadth of 68cm.The tank is made into the final form with the help of a series of operations in sheet metal. For the better resistance to the external expansion of the tank, it is kept inside a frame made of pipes with square and rectangular cross section. Silicone gel is coated in the corners and bottom of the tank to prevent the leakage of the water from the tank. The tank has also got a provision to hold the apparatus which contains sprocket and chain arrangement. A steel pipe from the compressor is also fixed inside tank.

B. Compressor

The compressor is used to force out air to drive the funnels. The compressor provides an initial acceleration and provides the movement of funnels in the upward direction. The compressor is used to deliver compressed air to the air carrying cups. Compressor delivers the air to the circular pipe and through the nozzle the air flows upward within the water tank. The compressor should have the capacity to withstand a pressure of 20 kpa (2.9 psi). Compressor should have to deliver the air at a rate of 36 litres per minute. The normal tire inflator used for four wheel vehicles can be used as a compressor in our apparatus.

C. Chain

A Long chain of 2m length is used to connect the two sprockets and this chain causes the transfer of power from funnels to the sprockets. The funnels are fixed to the chain at equal distances between the consecutive funnels. Another chain is used to connect the sprocket, at the end of upper shaft, and a smaller sprocket to transfer power to the shaft which consists of the rubber pad which is in contact with the alternator. Funnels are connected to chain via steel GI sheets. Steel sheets are wound around the side of funnels and welded firmly to the chains. The chain drive is used instead of belt drive due to its perfect velocity ratio and absence of slip.

D. Sprocket

In a chain assembly, the main function of chain is to transfer power from one point to another. Sprocket is the part which provides the motion or power which the chain is transferred.

Primary chain connects two primary sprockets fixed around the two primary shafts. The primary sprockets and the top primary shafts are of same kind so their gear ratio is unity. The top primary shaft carries another sprocket at one end these sprockets is linked with the sprocket of the secondary shaft using chain drive and has a gear ratio of 1:0.55.
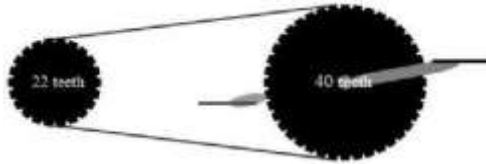
Fig. 3 Secondary sprocket

E. Bearings

We are using roller bearings in this power generating instrument. In roller contact bearing, the contact between the bearing surfaces is rolling instead of sliding as in sliding contact bearings. It is an outstanding advantage of a rolling contact bearing over a sliding bearing that it has a low starting friction.

TABLE I   DETAILS OF BEARING

Bearing Number	Inner Diameter (mm)	Outer Diameter (mm)	Width (mm)	Maximum Permissible Speed (rpm)
6204	20	47	14	16000
6404	20	72	19	8000

The apparatus uses a total number of four bearing of two different types. The two ends of the top and bottom primary shafts are attached to the bearing. Secondary shaft also uses a single bearing which is placed at the centre. Shafts are inserted into the bearing and the bearings are pressed into its housing after carrying out boring operation. The housing is then welded to the frame for the support.

F. Alternator

Alternator converts the mechanical rotary motion into electrical energy. A sprocket having small diameter is connected to one end of the secondary shaft and the other end consist of a rubber wheel. Alternator is bolted to the frame in such a way that the wheel of the alternator makes sufficient contact with the rubber wheel. Rubber wheel transfers the mechanical power from the secondary shaft to the alternator. Rubber wheel has a larger diameter compared to wheel of the alternator and hence the gear ratio is very high. So the rpm of the alternator is very high compared to the rubber wheel, it causes the generation of high voltage from the alternator. The generator has a rated rpm of 100 and it generates 60W power during its working.

G. Funnels

The funnels are the major component in the apparatus. The funnels are attached to the chain with equal spacing between two consequent funnels. All the funnels used in this experiment have same dimensions. The funnel has a diameter of 13cm and has a height of 9cm, so each funnel can enclose a volume of 477cm3. The tail end of the funnel is closed with rubber cork so that no air leaks out from the funnel.

H. Shafts

In this project, we are using a total number of three shafts .These three shafts include two primary shafts and a single secondary shaft. Shaft is made of mild steel material. The top primary shafts carry primary sprockets at its center and a secondary sprocket of larger diameter at its one end. The secondary shaft carries secondary sprocket of smaller diameter at one end and the rubber wheel to transmit power to alternator at the other end. The secondary shaft is supported by the bearing at the centre. Shafts of about 20cm length are used to transmit power from one sprocket at upper shaft to another sprocket at other end of same shaft.

I. Multimeter

The alternator generates electric power by using mechanical power. The generated voltage and current is measured using multimeter. Mutimeter is connected to alternator in parallel to measure voltage and is connected in series to generate current.

J. Rubber wheel

Rubber wheel is used as the driver for the alternator. The Rubber wheel has an external radius of 12cm which is flanged and bolted along with the shaft. The rubber wheel is fitted to the shaft and transmits power to the alternator.

K. Circular Pipe and Nozzle

The circular pipe is made of steel material. Its length is much greater than the length of the tank so that its one end is connected to the pipe of the compressor. The other end of the pipe is connected to nozzle. The nozzle has a diameter of 4mm at its tip and the material used is brass. Function of nozzle is to increase the velocity of air flowing through it.

L. Height Adjustable Stand

The adjustable stand is made of steel frame. Steel frame is welded to the housing of the bearings .The steel frame can be adjusted and made constant according to the required need. A nut and bolt arrangement is used for this adjustment. Two bolts of varying sizes are used for adjustment. One bolt is of length 15cm and the other of length 22cm. The steel frame is corrosion resistant and has high strength to hold the entire weight of shafts and the sprockets.

IV. EXPERIMENTAL ANALYSIS

Air from the compressor flows through the circular pipe and it releases through the nozzle at high velocity. The entire structure is placed inside the water tank and it is filled with water. The nozzle is fixed to circular pipe and is placed inside the water at the bottom. Hence air is released from the bottom of the tank to the water. Air is thousand times less dense than water and so air flows upward when it is released inside the water. These air bubbles get trapped in the cups provided in the primary chain. So naturally the cups move upward because of buoyancy effect. This pulls the primary chain to move. Primary chain connects the two sprockets arranged one at the bottom and other at the top. Hence both the sprockets rotate when the chain moves, cups are fixed at equal distance on the chain. When air filled cups reach at the top it releases the contained air and moves down. Again these cups are filled with air when they reach at the bottom.

Movement of chain causes rotation of the top primary shaft. Another sprocket is fixed on these shafts and the power is taken from this sprocket using chain drive system. The chain connects this sprocket with the sprocket on the secondary shaft. So the secondary shaft also rotates during the

working of the machine. A rubber wheel is attached to the other end of secondary shaft and is fixed using flange, bolts and nuts. Rotation of the sprocket also causes the rotation of the rubber wheel. The generator is bolted to the frame in such a way that the wheel of the generator makes sufficient contact to the rubber wheel. Rubber wheel transmit the power and rotation of the wheel of the generator generates power. The generated voltage, current and power are measured using multimeter.

The following are the atmospheric conditions in which the prototype is operated to measure the developed voltage and current.

Date   : 06 - January - 2016
Place   : Pazhayannur (Thrissur, Kerala) Co-ordinates   : 10.52^0N 76.21^0E
Time zone   : IST (UTC+5:30)
Sea level   : 62 meter above sea level
Temperature   : 30.56^0C - 20^0C Humidity : 48 %
Wind   : 11 km/hrs. Pressure   : 1.012 bars

Under the above condition we have tested our prototype and the output readings has been noted down and the obtained output power from the alternator is 70 watts for the input of 50 watts

V.   RESULT AND DISCUSSION

The experiment was completed by giving compressed air as input from the compressor to the nozzle to the cups which in effect due to the buoyancy effect lifts the cups upwards. This will makes the primary chain and sprocket assembly to rotate continuously which is connected to the alternator to other assembly. The alternator shaft is meshed with rubber wheel of considerably large diameter which will give an increase in the gear ratio. This will give an output torque approximately equal to 70 watt where the input is almost 50 watt.

The increase in the power output than the input supplied which is given as compressed air is due to the buoyancy effect of water. The air filled cups which is less denser than the density of water will float even if it is immersed in it, but the mechanical energy which is produced from chain assembly is cyclic or rotatory in motion, the cup should sink inside the water which will make the force on both sided of the chain assembly at equilibrium. As the law of conservation of energy states, "Energy neither be created nor be destroyed, it can only be transformed from one form to another", an external work or power is applied to imitate the motion of the cups which will disturb the equilibrium of the force. The output thus produced will be the sum of power supplied for the working of the compressor and the energy added up due to the buoyancy inside the medium.

The compressed air is given under the cups. The air as it moves upwards will take the cups also along with it which in results adds up the output energy of work. So the total sums of all these works are delivered to the alternator which is the reason for the increase of the output power than the input.

But in practical cases so many losses incurred while taking the output. Some of the losses include frictional resistance, loss of power from the chain and sprocket assembly, loss in the meshing of rubber wheel and alternator. These losses will reduce the power which is produced due to buoyancy and gravity when it reaches the alternator. After reducing all these losses the output produced will be greater than the input supplied so the output power can be increased by providing proper lubrication at appropriate places.

VI.   CONCLUSION

After the complete fabrication of apparatus the experiment was conducted successfully. The input energy was given by compressor and output energy obtained from alternator is greater than the input. From the experiment conducted we came to the conclusion that an external force is attained by the body by the force of buoyancy acting in the upward direction against the force of buoyancy and on the other side due to the force of gravity the funnel has the tendency to come downwards. This energy produces a power other than the input power measured by means of multimeter. The power also can be increased even better if the losses in the system is minimizes. The experiment conducted enables us to understand the new concept for power generation. The generated power can be used for domestic as well as for industrial purposes depending upon its usage.

VII.   FUTURE SCOPE

In this project we proposed a method to generate a power using buoyancy and gravity. This apparatus can be used as power generator in future. Efficiency can be increased by slight modification on the air carrying cup design. It could be modified to flexible or folding cups. Such cups will expand only when carrying air and moves upward and then which contract after releasing air at the top. Folded cups can move through the water easily and consume less power.

Power output can be increased by increasing the volume of cup. It increases the air carrying capacity of the cups and hence buoyancy force increases. It can also be increased by increasing the number of cups on the chain by reducing the distance between adjacent cups.

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