



PERFORMANCE ANALYSIS OF SOLAR/VORTEX GENERATOR

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Abstract

An atmospheric vortex engine is a device generating mechanical energy using controlled tornado or vortex. The vortex is formed by admitting air tangentially at the base of a circular chamber. Wind energy, converts wind to electricity using a bladed propeller but is this the only source of wind energy. New techniques to convert various energy sources and distributing that energy to consumer levels are gaining much importance these days. In this study, Vortex/Solar Hybrid Power Generator combines two forms of natural energy sources and enhances the efficiency of energy production without causing any kind of harm to the planet Earth. With these kinds of hybrid technology being developed, there are ways to sustain energy. Mechanical energy is generated when heat moves upward by convection in the atmosphere. Warm air expands, and it becomes less dense than cool air thus tends to move upwards, this phenomenon

is called as stack effect. An atmospheric vortex engine uses an artificially created anchored vortex, to capture the mechanical energy generated during upward heat convection. The vortex is developed by admitting warm or humid air tangentially into the base of a circular wall. In this study, the heat source is solar energy. The solar collector is used to give a start for the formation of an anchored tornado or vortex in the atmospheric vortex engine which helps to obtain a renewable source of hybrid energy at the same time can be used to study the formation and the average pressure difference of an anchored vortex.

Key Words: A solar collector, anchored tornado, atmospheric vortex engine, hybrid energy.

1 INTRODUCTION

Combining natural resources and producing efficient and clean hybrid energy is something that has been researched on for years. This project is entitled the 'solar/vortex hybrid power generator,' and the project description is to develop a prototype of a vortex/solar hybrid power generator and to study the characteristics of a vortex in a group of three. The project aims at developing an efficient method to convert solar energy to wind energy in the form of a vortex and studying the characteristics of the thus formed vortex. One of the other advantages of this project is that it can be further developed into a power generation unit that can produce renewable energy from water. It opens up an opportunity for industries that discharge water to produce power in a much efficient way. This report details the development of the prototype's mechanisms and mentions the project management. The prototype is roughly broken down into three sub-systems for convenience. The first sub-system consists of a solar collector, made of spiral copper winding welded to a copper plate and placed in a mild steel tray covered with glass. This setup preheats the water to approximately 60 degrees. The preheated water is stored in an insulated tank and is passed on to the second sub-system through a flow controlled valve. The second sub-system consists of a steam unit where the preheated water is converted to steam using a 'drip let system.' Air-heaters are used to vaporize the droplets coming out of the pores from the copper

tubes. A flow control valve will be used to control the rate of flow of water in the copper tube so that there will not be excess water coming through the pores. The steam is then directed to the third sub-system which is the most important system of the project. The third sub-system is where the vortex is formed, hence called 'Vortex Chamber.' The 'vortex chamber' is a self-designed chamber where the steam is directed to, from the steam unit. The chamber contains four vents which are tangential in design so that the steam that enters interacts with the cool air and starts to form a vortex. The characteristics of this anchored vortex are thus determined using a raspberry pi. M. K. Gupta et al.,[1] proposed methods to use copper coils for transferring solar energy to heat energy and pre-heating water in the International Journal for Energy Resources in 2009. The thermodynamic cycle of the heat convection in the atmosphere is explained by Louis Michaud in the 'Meteorology and Atmospheric Physics,' 2010. In 2013, Louis M Michaud et al.,[2] proposed methods to produce mechanical energy utilizing controlled tornado-like vortex, in the journal 'Applied Energy.' In the 'Meteorology and Atmospheric Physics,' published in 2011, Louis Michaud introduced a method to calculate the total energy and intensity of a hurricane.

2 EXPERIMENTAL SETUP

An Atmospheric Vortex Engine is a machine that converts wind energy into mechanical energy and then into electricity. Inside an Atmospheric Vortex Engine, an anchored-tornado like the vortex is formed which is then converted into mechanical energy. The anchored vortex is formed by admitting warm air through tangential vents into a chamber, where warm air combines with ambient air to form a vortex. The operation of an Atmospheric Vortex Engine is based on the principle that warm air expands and moves upwards. When cool air is passed into the chamber tangentially, it combines with the warm air and creates a vortex which rotates the turbine. The air is heated using fuel, gas or electric air heaters.

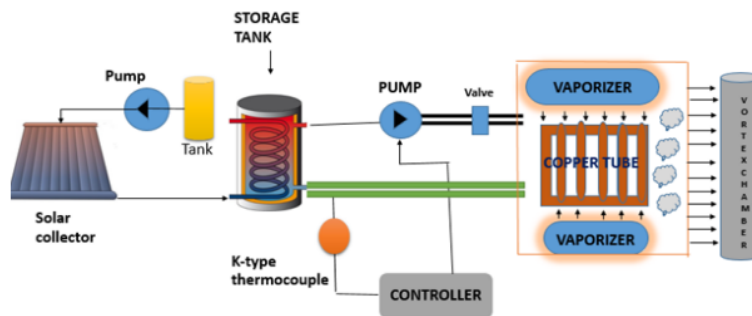


Figure 1 Solar operated vortex generator.

In a 'Vortex/Solar Hybrid Power Generator,' water is pre-heated using a spiral solar collector. The pre-heated water is passed on to an insulated tank and from where the warm water is pumped into the steam unit. The flow rate is controlled using a flow control valve. In the steam unit, water is converted into steam using the principle of induction heating. The steam then enters the vortex chamber tangentially and combines with cool ambient air resulting in a vortex formation.

A. Solar collector

The first sub-system of the project consists of a solar collector as shown in Fig 1, which absorbs solar energy and converts it into heat. Copper coils are used for collecting the solar energy. A copper coil of 5/8 inches diameter and 8 meters in length is bent into a spiral shape. The spirally bend copper coil is welded or clamped into a copper plate with a dimension of 600 * 600 mm. The spirally bend copper coil along with the copper plate is placed in a metallic box, covered with glass on top. The dimension of the metallic box is 700*700 mm. These components along with a pump for pumping water from the storage tank to the copper coil constitutes the first sub-system. When the solar collector is placed under sunlight, the copper coil starts to absorb heat energy. Since copper has high heat exchange capabilities, the heat absorbed by the spirally bend copper coil is transferred to the water that is inside the copper tubes. Even the copper plate to which the coil is welded absorbs heat from

the sunlight and transfers the heat to the water flowing inside. The metallic box also helps in creating a greenhouse effect, by allowing the heat to pass in through the glass and later by trapping it inside the box itself. Due to all these effects, the temperature of the water will rise to approximately 60 degrees. A k-type thermocouple is used to measure the temperature of the water in the solar collector. The flow rate of the water is controlled based on the measured temperature using an Arduino Uno R3 board.

B. Steam unit

The second sub-system of the project includes a steam unit as shown in Fig 3,4 and 5. The steam unit works on the principle that a current carrying conductor with high resistance experiences power loss in the form of heat. Two conducting coils are placed in water and electricity is passed through them, the coil starts heating up and eventually the heat is transferred to the already preheated water in the tank. The steam unit consists of two layers. The bottom layer contains the water, and the top layer contains steam. The unit is fabricated in such a way that, there is no water or steam leak. The water is flown into the steam unit from the insulated tank, where pre-heated water is stored, through a flow controlled valve. The steam produced is later passed through to the vortex chamber. The pre-heated water stored in the insulated tank is flown into the steam unit through a flow controlled valve. The valve can be controlled manually or automatically with the help of a servo motor. Once the water reaches the steam unit, electricity is passed through the coils. The current carrying conductor heats up immediately and starts heating the water. Since the water is pre-heated to approximately 60 degrees already, the water starts to boil immediately as the coil is heated. The steam formed, during this process, moves upwards due to the stack effect. The steam that reaches the upper part of the unit is directed into the vents of the vortex chamber through a pipe. One thing that has to be considered while selecting the material for the steam unit and the components along with it is that the material should be able to withstand high temperatures.



Figure 2 Solar collector



Figure 3 steam unit without the heating unit



Figure 4 steam unit with a heating unit



Figure 5 Complete steam unit

C. Vortex chamber

The vortex chamber is the main part of the project as shown in Fig 6 and 7. As the name suggests, vortex chamber is the place where the vortex is formed. The vortex chamber is a self-designed chamber that is designed in such a manner that the steam that

enters inside starts to form an anchored tornado or a vortex. The vortex chamber is made of mild steel. There are four vents in the bottom that are tangentially cut to initiate vortex formation. The steam entering through the four vents combines with each other and forms a vortex. The size of the vortex depends on several factors like amount of steam produced, the base diameter of the vortex chamber, the pressure inside the chamber, the speed at which steam enters the chamber, etc. The vortex chamber has an effective base diameter of 200mm.



Figure 6 Top view of the vortex chamber.



Figure 7 Side view of the vortex chamber.

The vents are 50×60 mm in dimension. Length of blades in the vents is 100mm. The vortex chamber has a length of 250mm. The steam that enters the vortex chamber through the tangential vents tend to keep rotating along the walls of the vortex chamber, but since steam tends to move upwards, in effect the steam starts to rotate as well as move upwards simultaneously. This along with the interaction with the ambient cool air results in the formation of a vortex. The characteristics of the formed vortex will be analyzed using a raspberry pi. The pressure difference between the upper and the lower ends of the vortex, temperature differences and even the pattern of air flow can be studied using the raspberry pi along with anemometer. Anemometer is being interfaced with raspberry pi for the above-mentioned purposes.

3 CONCLUSION

A clean and renewable energy for a sustainable future is a topic that has been bothering scientists for a long time now. A carbon-free source of energy that is abundantly available is something that researchers have been trying to develop. Even though several hybrid energy techniques have been developed so far, there are several

other methods of energy production that are still hidden in Mother Nature. The Vortex/Solar Hybrid Power Generator opens up new possibilities and opportunities in the field of hybrid energy technologies. Solar and wind energy are two prominent natural energy resources, and the combination of these two dominant sources will surely have the potential to be developed into enormous hybrid technology. The characteristics of the formed vortex studied in this project can be used to develop this system into a power generation plant by adding proper equipment. The energy produced using a Vortex/Solar Hybrid Power Generator is clean and carbon-free. A clean, renewable and carbon-free energy are produced for a sustainable future.

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