

## Modern improved and effective design of boundary layer turbine for robust control and efficient production of green energy

**M Usman Saeed Khan<sup>1</sup>, Ehsan Ali, M Irfan Maqsood and Haq Nawaz**  
Univesity College of Engineering and Technology, The Islamia University of  
Bahawalpur, Pakistan

E-mail: usmansunshine@gmail.com

**Abstract.** Boundary layer turbine, although invented long before but has failed to commercialize and beat the bladed turbines due to certain lacks. In this paper we have proposed and suggested some techniques to improve the design of the boundary layer turbine such that to take the optimum advantage of its efficiency, compensating all of its draw backs. A test model of proposed boundary layer turbine has been physically made and tested under different conditions. The experiments using different flow rates, different discharge rates and changing many other factors has been made and the results of these experiments are included in this paper which verifies the improvements in the output power obtained from boundary layer turbine system. This modified turbine can thus become an efficient way of producing green energy like any other renewable energy resource.

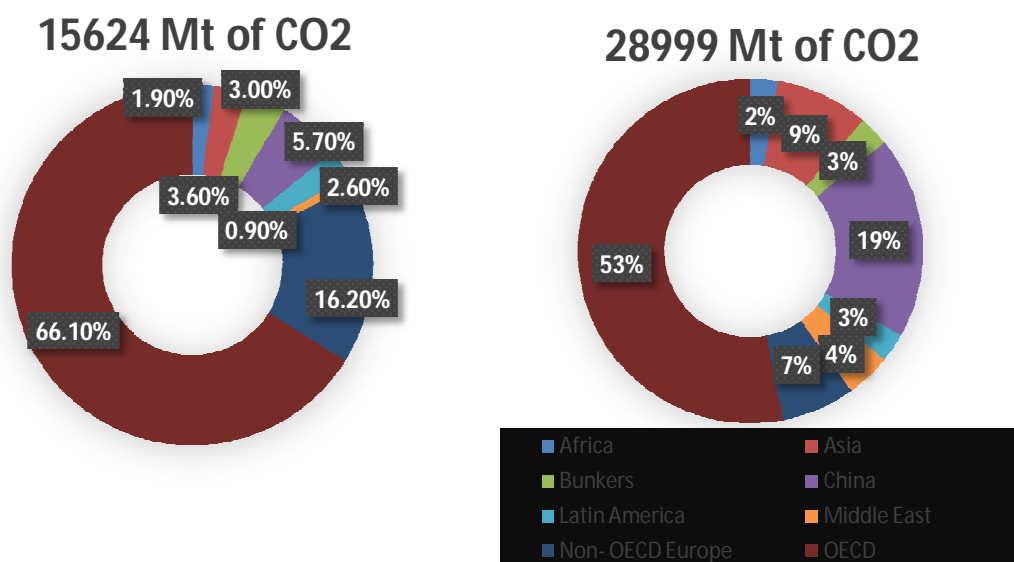
### 1. Introduction

The trend of using renewable energy resources is increasing day by day due to the fact that conventional fuels are decaying with the time and the price of these fuels are becoming so high that they are not being liked for economical operation of power generation plants. Renewable energy resources are also providing an advantage of being environment friendly and the emission of carbon is very low in case of using renewable energy resources in the industries, transportation and power generation plants. Many types of renewable energy resources are being implemented in the different parts of the world. The research area and the implementation techniques regarding these sources of energy is becoming most popular topics of this age. Particularly the implementation of these sources in the field of power generation is considered to be the need of hour for the green future of this world. Solar and wind energy techniques are most common sources which are rapidly being implemented to compensate the fast growing energy demands. Although both of these sources are environment friendly but still they are not considered to be fully reliable if they are installed alone without any other source of energy. The reason is that these resources can never work all the day. Photovoltaic cells will generate the energy only when the sun light is available and the wind turbines will work only when a strong wind is blowing in the environment. That is why it is must to find out the renewable energy resources which is able to deliver its output all the day. Hydro turbines are also providing good results to compensate the energy requirements but these turbines are being used only for bulk level generation. As the present Francis and Kaplan water turbines require the specific head to work that is

<sup>1</sup> To whom any correspondence should be addressed.



why it is impossible to use these turbines at low level i.e. home level generation. Our proposed design for the new tesla turbine is of great importance in this regard, it can be implemented not only for higher level generation but also it is equally efficient for low level power generation. Previously the tesla turbine was used only for very low level applications like low height pumping and in small motors etc. but the new optimized design of tesla turbine will make it more efficient to be used in different applications of power generation. Tesla turbine uses water or air as its fuel so it is one of the greenest source for the generation of power. Global warming is increasing very rapidly and the world will face an enormous danger if the rate of increase in the emission of CO<sub>2</sub> was not controlled. Power generation is a one of the major source to destroy the environment with the other sources like transportation and industries. If we look at the figures of carbon dioxide emission then we comes to know that it has been increased twice from 1973 to 2009. These figures are given below in figure 1. In 1973 the emission of CO<sub>2</sub> in all the regions of the world was a total of 15624 million tonnes which increased to 28999 million tonnes in the year of 2009 [5]. Tesla turbine will thus help in reducing the carbon dioxide emission. The new designed proposed for the tesla turbine with some experimental results on a prototype model has been explained in the ongoing paragraphs.



**Figure 1.** Comparison of the CO<sub>2</sub> emission in 1973 and 2009 in different regions of the world

## 2. Proposed design and working principle

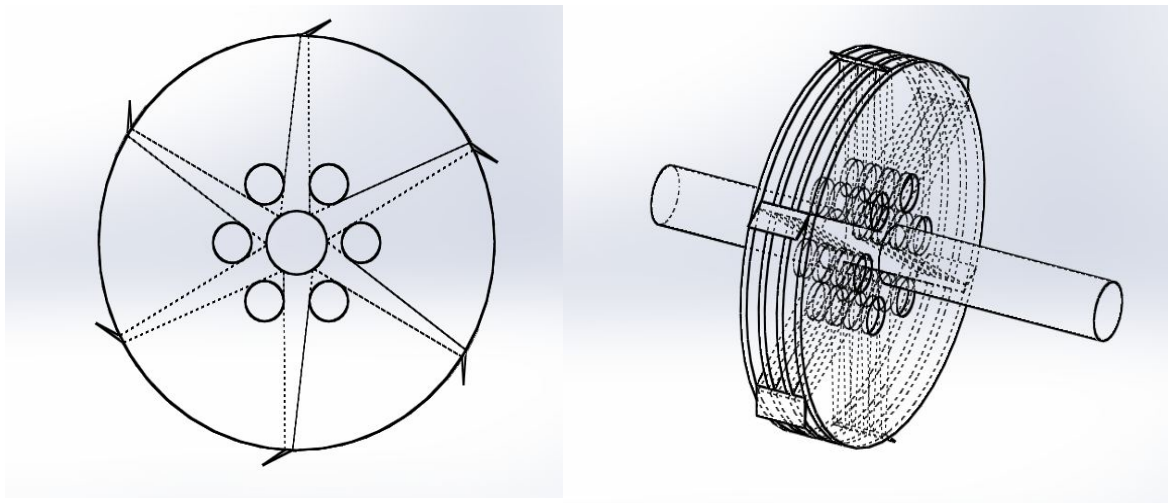
Nikola Tesla, a well-known inventor was a great achiever in the fields of electrical generation, transmission and utilization. But his invention was not limited to these specific fields. Tesla invented a new type of turbo machinery having a different type of working principle and design. He designed a multi-disc rotor for his turbine which was spaced along a common shaft. These flat discs were very simple in construction and the experiment on Tesla's turbine gave an extra ordinary result regarding the speed of the turbine. A huge speed was obtained but when the torque was measured it was very much discouraging. At the same time the bladed turbine came out in the markets and made their place instead of the tesla turbine. Thus tesla turbine remained far behind and it was deprived from the attention of the stake holders although only a few changes were required to remove the weakness of the turbine.

### 2.1. Principle of operation of the boundary layer turbine

As it is clear from the name that the basic working principle of operation of the turbine is the boundary layer effect between the fluid and the walls of the rotor discs. Unlike other conventional turbines this turbine does not have any kind of blades. The fluid when enters between the spaces of the discs then adhesive forces tends the water to slow down its speed as the water molecules tends to stick with walls of the discs at that time. The viscosity of the fluid also helps to decrease the speed of water further more. But the water coming after word is in speed so it exerts a force which compel the discs to move in the direction of the water. That was the basic working principle of the conventional turbine. The experiments revealed that the conventional turbine was not efficient enough to rotate a heavy generator due to low torque. The new proposed design of tesla will combine the characteristics of both the bladed turbine and the tesla turbine. Its working principle is the combination of the principles of both these type of turbines i.e. it will work on the boundary layer effect as well as the pushing effect of the water.

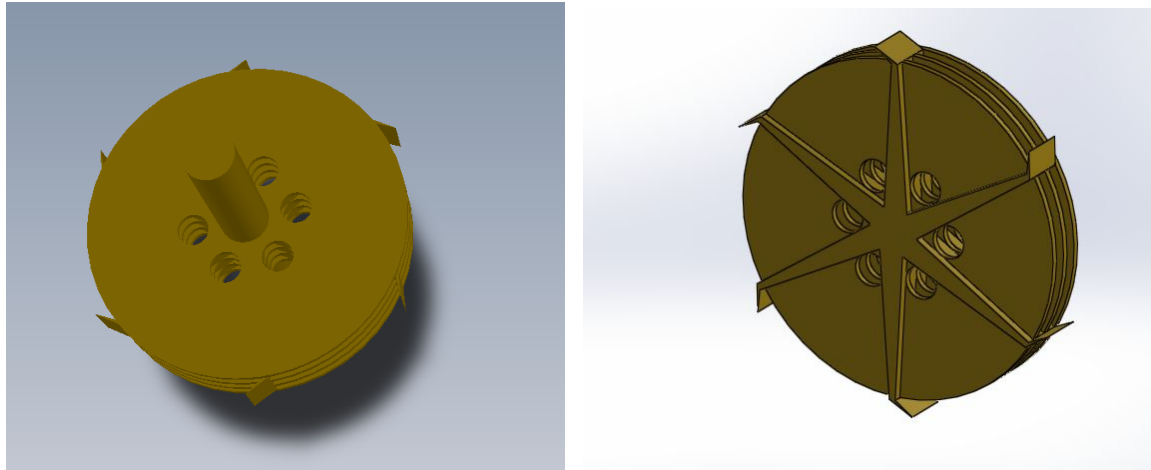
### 2.2. Construction and designing

The basic design of the new turbine is similar to the conventional tesla turbine with some additional components in the rotor of the turbine and the special nozzle design. A number of particular size discs depending upon the generation requirement are stabilized on the shaft at a specific distance apart from each other. Some holes are made near to the centre of the each disc which acts as spill ways from where the fluid gets out of the turbine. The new addition in the design is that a special blade type strip is mounted on the top of the each disc. The purpose of which is to enhance the torque of the turbine.



**Figure 2.** Two and three dimensional models of the proposed tesla turbine.

Three dimensional model of the new proposed design of the tesla turbine has been made with the help of a simulation and designing software Solid Works. The diagram of this model has been shown in figure 2 and figure 3. Another suggested improvement in the design of the turbine is to use the specific design nozzles. A separate nozzle must be applied for the each spacing between the discs instead of using a common nozzle for all the discs. This will increase the fluid pressure and amount of the working fluid will also increase. Thus the efficiency of the turbine will increase to a great extent. The round holes near the shaft are the spill ways to exit the water from the turbine. The strips mounted on discs are to increase the push of the water and thus to increase the torque of the turbine.



**Figure 3.** Three dimensional models of the proposed tesla turbine.

### 3. Experimental analysis

A prototype model of the new tesla turbine was made according to the design which has been discussed in details in the previous paragraphs. The rotor of this newly designed boundary layer turbine is shown in figure 4. It can be seen that there are strong strips mounted on each disc. These strips will not only increase the torque but also they will collect the maximum fluid and will send it to the spaces between the discs. After the experiments in different condition the new turbine was proved to be very efficient than its conventional design. The experiments was carried out using specific pressure of water and the results recorded has been shown in the table 1.

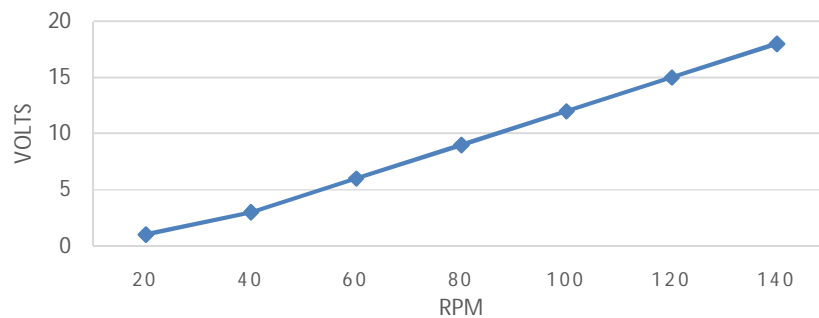


**Figure 4.** Rotor of the physically made prototype new design tesla turbine.

**Table 1.** Average results determined from the multiple experiments

Sr. No	Parameter	Value
1	Average Power	100 watt
2	Average Voltage	18 volt
3	Average RPM	140
4	Average Current	5 A

Another important characteristic of this turbine is that its speed control is very robust and easy. The relation between speed and voltage of turbine is linear so any voltage level can be acquired easily. Figure 5 shows the relation between the speed and voltage of the turbine.

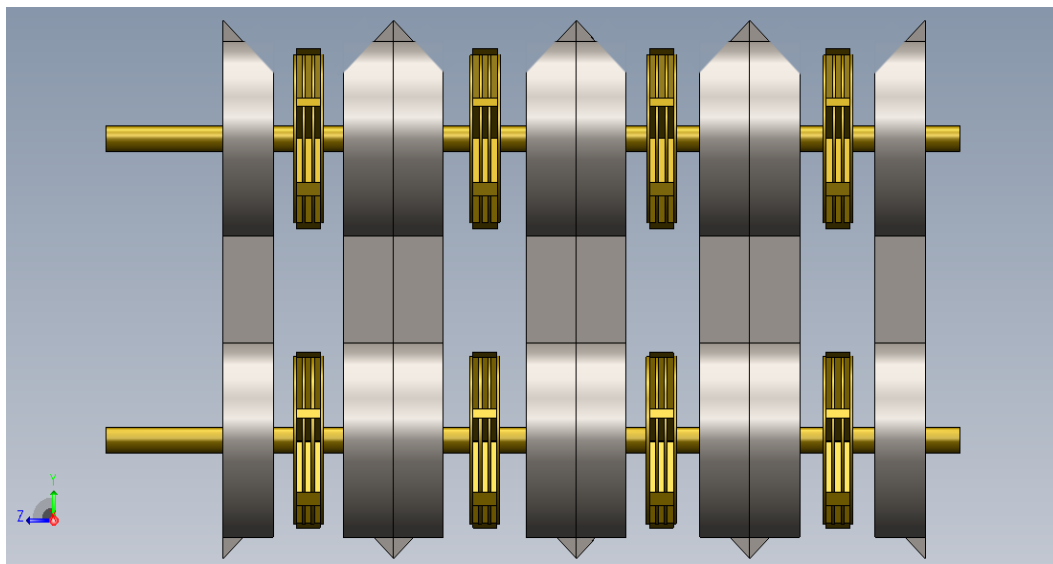


**Figure 5.**Relation between the speed and voltage of turbine.

#### 4. Implementation techniques for the proposed boundary layer turbine

After the improvement in the design of the tesla turbine, it is necessary to use the proper implementation techniques for the application of this turbine so that the optimum advantages can be taken from the performance of this turbine. Using proper techniques, the maximum efficiency can be obtained which will be probably near to the theoretical values of the tesla's efficiency. The angle of the nozzle providing the fluid to the rotor of tesla turbine is very important. Nozzle must be easily adjustable so that it can adjusted any time to any angle according to the conditions and requirements. The space between the discs of the rotor are also an important factor and it must be properly adjusted depending upon the size and the area of the turbine. Another important factor is the exit way of the fluid. The torque of the turbine is very much dependent on the exit way of the turbine.

Here is an example of the implementation technique which has also been used in the experiments on the prototype model of the tesla turbine.



**Figure 6.** Implementation technique for the application of tesla turbine in canal and rivers (top view)

The tesla turbine can be used in the way of the water flow like canals and river but to increase the speed and torque some special measures are to be taken. A proper place should be made where turbine can be adjusted such that the maximum water flows through the rotor discs of the turbine and that too

on the most suitable angle with an appropriate speed. Some arrangement are necessary to increase the speed of the water. For this the way of the water can be narrowed near the turbine and also the path of the water can be made in a slope shape to increase the speed and thus the energy of the water. A group of tesla's rotor discs can be connected in series on a common shaft for the generation of electricity at higher level. In a single canal this turbine can be used as many times as the requirement of power generation. For this purpose the system of tesla turbine must be arranged at different places on certain distance so that the performance of one turbine will not affect its subsequent turbine.

## 5. Conclusion

Rapidly increasing demands of the power generation are asking for fast development in the area of renewable energies. The generation of home level energy and use of distributed generation system is the key necessity of the present age. So the idea to return back the out of market turbine again to the practical implementation will be a great milestone in the way of achieving the green energy. For the revival to tesla turbine it was necessary to withdraw its limitation. The new design of tesla turbine which uses both the pressure pull and the boundary layer effect, has been proved very economical and efficient design and it can be used in the future to get rid of the polluted power generation.

## 6. References

- [1] Rice W and Emiritus P 1991 Tesla turbo machinery, *Proc. IV international Nikola Tesla Symposium* (Belgrade: Org. of Serbia)
- [2] Luis San Andres L 2006 Introduction to Pump Rotor dynamics *In Design and Analysis of High Speed Pumps* (France: RTO) Paper 9 pp 1-26
- [3] Yan B P Ho 2011 Tesla Turbine for Pico Hydro Applications *Guelph Engineering Journal* **4** 8
- [4] Cairns W M J 2003 *The Tesla Disc Turbine* vol 2 (England: Camden Miniature Steam Services)
- [5] 2011 *Key World Energy Statistic 2011*, (Paris: international energy agency)
- [6] Lampartand P Jędrzejewski Z 2011 Investigations of Aerodynamics of Tesla Bladeless Microturbines *Journal of theoretical and applied mechanics* **49** pp 477-499
- [7] Hayes J A 1994 *Tesla's Engine, A Dimension for Power* (Wisconsin: TEBA)
- [8] Breiter M G and Pohlhausen K 1962 *Laminar Flow between Two Parallel Rotating Disks* (US Air force: Applied Mathematics Research Branch)