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A Review of Tesla Turbine

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Abstract* – The tesla turbine was invented by Nikola Tesla in 1913, is a non-conventional bladeless turbine which works on the principle of boundary layer. It consist of a number of parallel discs fixed on a shaft with gap between the discs. The fluid is made to flow tangential to the discs inside a casing. Momentum is transferred from to the discs due to viscous and adhesive forces. Not much work has been carried out in the first half of twentieth century but decent amount of published research and study has been done in the latter half. Some papers suggests for modifications while some papers provide explanations for different performances and efficiencies at various parameters. This paper intends to review the principle, working, design modifications and the factors affecting the performance of Tesla turbine.

***Keywords* - Spacer, Boundary layer, Disc turbine, Tesla Turbine, Turbo machine.**

I. INTRODUCTION

Turbomachines are machines which convert fluid energy into rotational motion. Tesla turbine, also called as Prandtl turbine and boundary layer turbine, is a nonconventional turbomachine which operates on the principle of boundary layer. It does not use friction for its working, instead it uses adhesion (the Coanda effect) and viscosity for its functioning. Energy is transferred from fluid to the rotor by dragging discs mounted on the shaft due to boundary layer effect. Fluid flows tangentially to the discs, follows a spiral path towards the centre and exits axially of turbine. The fluid loses its kinetic energy to the discs, thus causing the rotation of rotor. Both compressible and incompressible fluids can be used. The manufacturing of Tesla turbine is much easier compared to the conventional turbines because of no blades are required to manufacturing.. Also, the turbine is unaffected by the quality of the fluid, thus can be used with fluids containing particulates. A tesla turbine is a reversible device therefore it can be used as pump. In case of pump, the fluid enters axially nearly to the centre. The discs provide energy to the fluid, following a spiral path and thereby exiting from the periphery. After its invention by Nikola Tesla in 1913, not much research was performed. But decent amount of study has been carried out after 1950s. Lots of literature was published in the last few years across the world. Commercialization has been attempted but has had little success due to its low efficiency at high power applications. Low power applications [1] [2] [3] have been proposed to be more efficient than conventional turbomachines.

II. PRINCIPLE

The Tesla turbine works on the boundary layer principle. It was defined by Ludwig Prandtl. According to this principle, when the fluid passes over the discs the fluid particles adhere on the disc thus causing a condition of no slip. Thus, the velocity of the fluid on the disc will be equal to that of the disc. In case of the disc being stationary, its velocity will be zero.

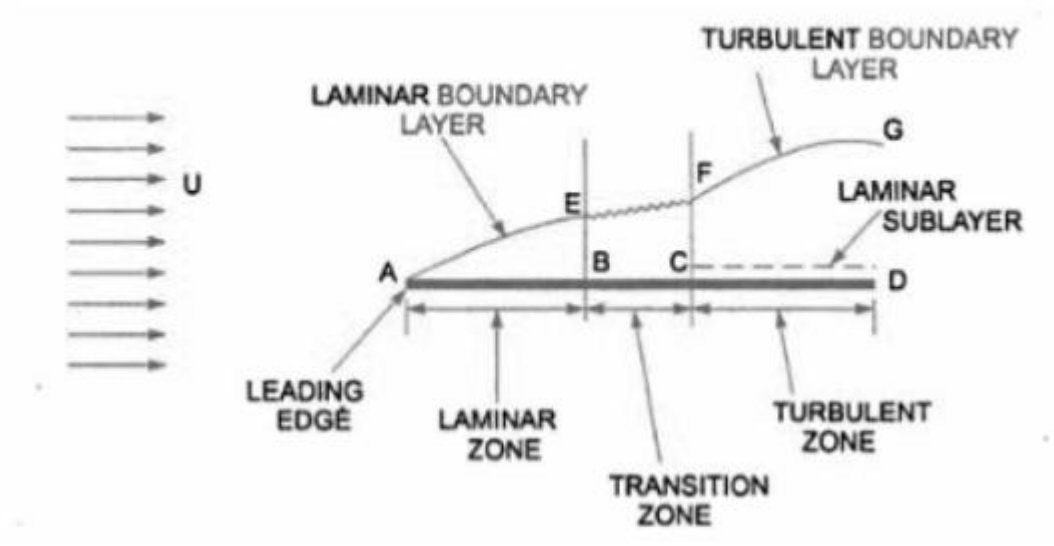

Figure 1 Boundary Layer[4]

The fluid velocity is gradually increases as fluid move away from the disc surface, thus a velocity gradient is observed. This velocity gradient exists in a direction normal to the surface, in a narrow region in its vicinity. This region is called boundary layer. The boundary layer consists of two major regions: Laminar boundary layer and turbulent boundary layer. If U is the velocity of the fluid, in the laminar boundary layer, the velocity gradient dU/dy exists. Thus flow in this region is perfectly laminar. In the region between the laminar and turbulent boundary layers, the flow transitions from laminar flow to turbulent flow and hence its name. In turbulent boundary layer, the flow is completely turbulent.

III. CONSTRUCTION AND WORKING

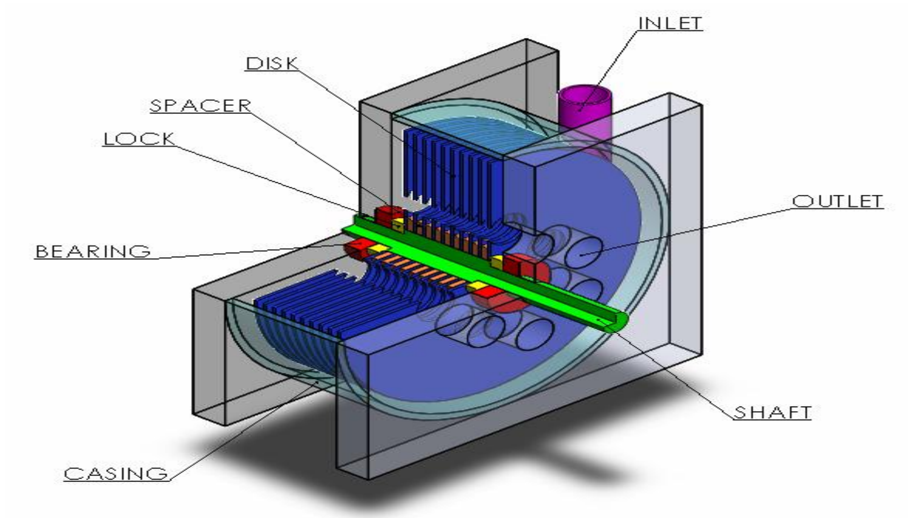

Figure Error! No text of specified style in document. **Tesla turbine with parts name[5]**

The Tesla turbine consists of a number of discs mounted parallel to each other on a shaft. Nozzles are placed at the periphery of cylindrical casing and tangential to the shaft, pointing toward the inside. The discs are separated by them gaps for the fluid to pass through it. Exhaust ports are located near the centre of the turbine.
Figure 2 In Tesla Turbine [5] Fluid enters tangentially into the turbine from the periphery of casing. It is made to enter the gap between the discs. The moving fluid causes drag force on the discs in the direction of the flow. Due to this there is a transfer of kinetic energy from the fluid is transffered to the discs. This transferred energy causes the discs to rotate with the shaft. The fluid thus slows down as it moves to the centre in a spiral path exiting from the exhaust ports.

IV. DESIGN AND METHODOLOGY

In this chapter modeling of tesla turbine by the given dimensions in research by Borate H.P., Misal N.D.[6]. By this dimensions modeling is carriedout in creo software

Here taken the data of tesla turbine from an effect of surface finish and spacing between discs on the performance of disc turbine by Borate H .P & Misal N.D.[6] Here using the similarity law of model and prototype of turbine.

Dimensions given in paper

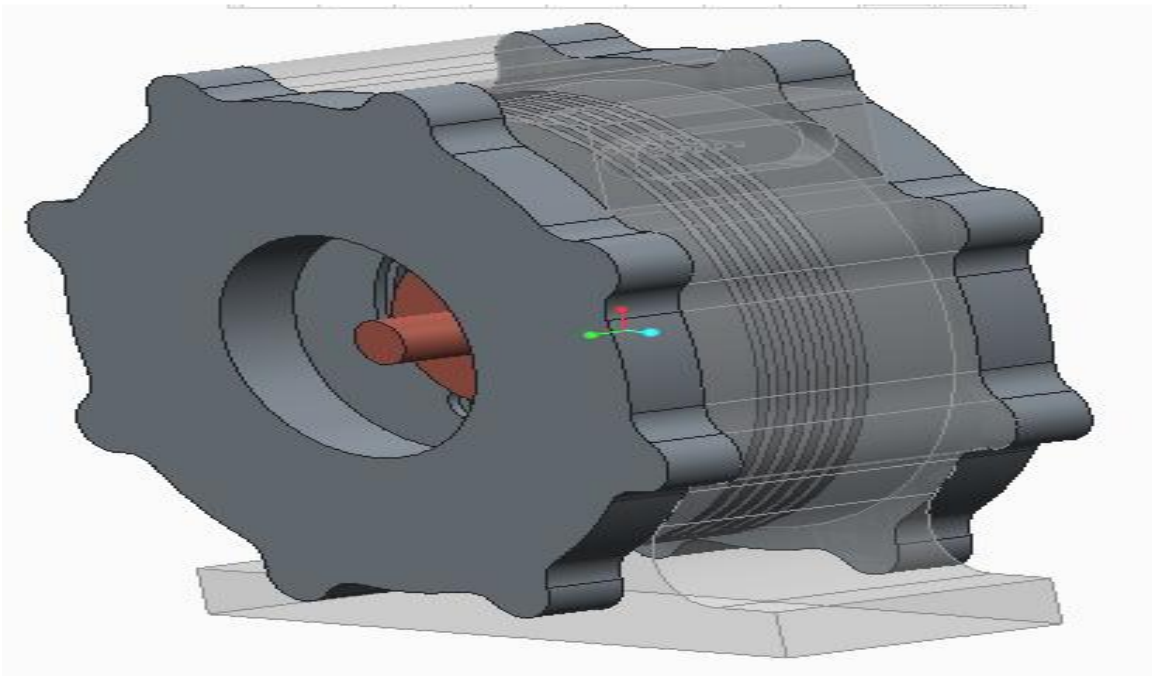

Figure 3 Asslembly of tesla turbine

Disc thickness: 2 mm

Disc outer diameter: 152 mm

Disc inner hole dia: 30 mm

Spacing between discs: 2 mm

Shaft dia: 15 mm

Clearance: 2 mm

V. FACTORS AFFECTING PERFORMANCE

Performance of tesla turbine is affected by various parameters. Few of them are:

5.1. Number of discs The number of discs can be increased to increase the torque obtained. [7]
5.2. Dimension of the discs The inner and outer radius determine the length of the spiral path followed by the fluid. The larger the area of the discs the longer path will be travelled by the fluid.
5.3. Size of the gaps between the discs The thickness of the gap should be equal to twice the boundary layer thickness. [7]
5.4. Number of nozzles The torque obtained will be increased if the number of nozzles are increased.
5.5. Reynolds number The laminar boundary layer thickness depends upon the Reynolds number. [4]
5.6. Velocity of the flow The velocity of the fluid causes the kinetic energy which is transferred in the turbine.

VI. APPLICATIONS

Tesla turbine was designed to rotate by fluid as a motive agent. It is found to be useful in low power applications but lacks in performance in high power applications [8]. Lots of experiments have conducted using tesla turbines for various applications such as steam turbines, turbo for automobiles.
particulates such as salt water or impure water. It also has applications when working with low and high viscous fluids. Though Tesla turbine has not been successful in finding commercial purpose since its inception, Tesla pump on the other hand has been widely used in applications which require pumping abrasive fluids such as industrial waste etc. Tesla pumps for blood transfusion have become widespread.

VII. CONCLUSION

The tesla turbine is a nonconventional promising technology that is yet to be fully researched and optimized. Much applications are yet to be studied and developed. Complete optimization of tesla turbine performance is beyond the scope of this paper.

VIII. ACKNOWLEDGEMENTS

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