# A REVIEW ON BLADELESS TESLA TURBINE

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## ABSTRACT

*The first bladeless turbine, also known as a friction turbine, was designed and manufactured by a Serbian engineer and inventor Nicola Tesla in 1913 (Tesla, 1913). It is a non conventional bladeless turbine. This turbine works on the principle of boundary layer effect. It consists of a number of parallel discs fixed on a shaft with gaps between them. Fluid enters tangentially on discs inside casing. Energy in terms of momentum is transferred from fluid to discs due to viscous and adhesive forces. There is much work has been covered in first half of twentieth century but research publication work and study has been done in later half. Some papers suggest modifications while some provide explanation for different parameters and efficiencies. This paper gives introduction, principle of operation, construction and working.*

**Keyword: -** *Pressure reduction, low pressure recovery, bladeless turbine, reliable.*

## 1. INTRODUCTION

The Tesla turbine is a bladeless centripetal flow turbine patented by Nikola Tesla in 1913. It is referred to as a bladeless turbine. Tesla turbine, also called as Prandtl turbine and boundary layer turbine, is a non- conventional 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 towards the discs, follows a spiral path towards the centre and exits axially. 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. 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 turbomachine therefore it can be used as pump. In a pump configuration, the fluid enters axially near the centre. The discs provide energy to the fluid, following a spiral path and thereby exiting from the periphery. This unusual device makes use of viscous effects which occur in the boundary layer flow. Opposite to classical bladed turbines, where viscous effects in flow are undesirable as a source of efficiency loss, these effects enable rotational movement of the rotor. The rotor consists of up to a few dozens of thin disks locked on a shaft perpendicular to its axis of revolution. In theory, the disks should be as thin as possible. The distances, or gaps, between the disks should also be very small. According to Rice (1991), the highest value of efficiency appears when they are approximately equal to the double boundary layer thickness. Therefore, the gaps between the disks should depend on the occurring flow conditions and physical properties of the working fluid. On the other hand, the thickness of the disks and the distances between them are also limited by the material strength and the technology of manufacture and assembly. An example of the multidisk rotor construction of the Tesla turbine found in the patent documentation (Hicks, 2005) is shown in Fig. 1.
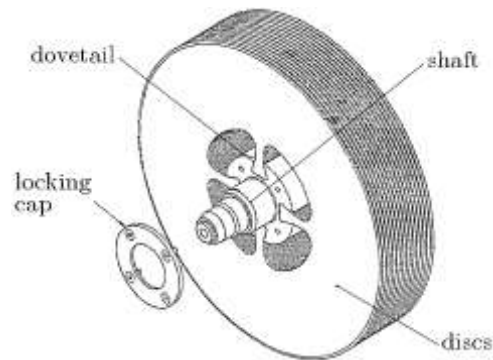
**Fig-1** Rotor of a multidisc Tesla bladeless turbine (Hicks, 2005)

The supply of the Tesla turbine is accomplished by one or several nozzles discretely located along the circumference. The nozzles are tilted under a certain angle to the disk tangent. The working fluid flows between the disks spirally from the outer to inner radius and transfers energy to the rotating disks. The medium flows out in the axial direction through a number of holes in the disks situated near the turbine shaft. The efficiency of the Tesla turbine depends on many parameters, namely on: pressure, temperature and velocity conditions between the disks, number, diameter, thickness and distance between the disks as well as on the state of the disk surface, rotational speed of the rotor, number and arrangement of the supply nozzles, etc.
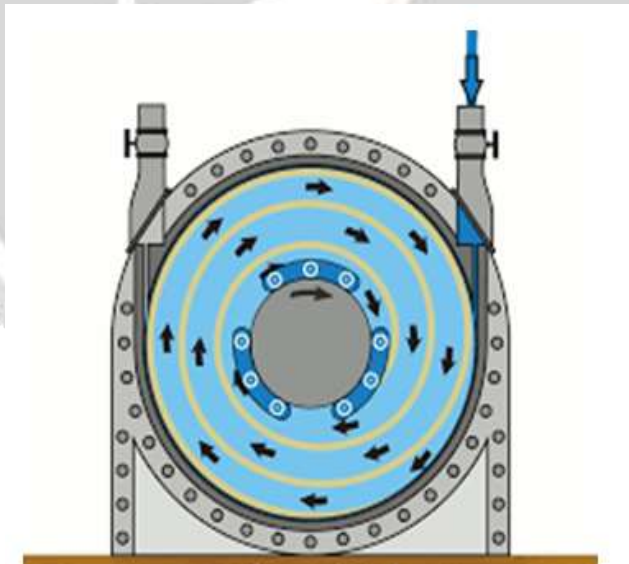
## 2. PRINCIPLE OF OPERATION



**Fig-2** Operating Principle of a bladeless turbine

Fig. shows the operating principle of the bladeless turbine. This turbine operates on the boundary layer effect. Boundary layer effect is the effect which produces drag force on the adjacent surface, due to this contact surface layer of the flow get turbulent and outer layer of the flow in laminar motion. In this turbine air molecules or air/stream flow get cyclone movement.

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 to the disc thus causing a condition of no slip. Thus, the velocity of the fluid near to the disc will be equal to that of the disc. In case of the disc being stationary, its velocity will be zero. The fluid velocity gradually increases as we move away from the disc surface, thus a velocity gradient is observed. This 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.

## 3. CONSTRUCTION AND WORKING

The Tesla turbine consists of a number of discs mounted parallel to each other on a shaft. Nozzles are located at the periphery of cylindrical casing and tangential to the shaft, pointing toward the inside. The discs are separated by thin gaps for the fluid to pass through it. Exhaust ports are located near the centre of the turbine.
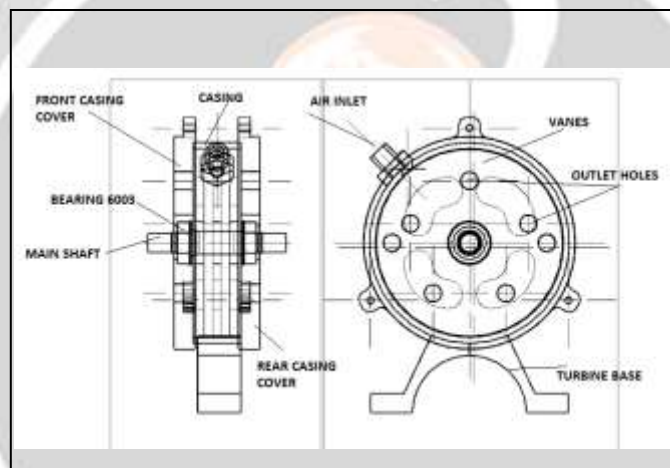


**Fig. 3** Construction of bladeless Tesla turbine

Fluid enters tangentially into the turbine from the periphery. It is made to enter the gap between the discs. The moving fluid drags the discs in the direction of the flow. Due to this there is a transfer of kinetic energy from the fluid to the discs. This transferred energy causes the discs to rotate with the shaft. The fluid thus slows down as it moves towards the centre in a spiral path exiting from the exhaust ports.

## 4. PERFORMANCE AFFECTING FACTORS

### 4.1 Number of Inlet nozzles-
The torque obtained will be increased if the number of nozzles increased.

### 4.2 Velocity of the flow-
The velocity of the fluid causes the kinetic energy which is transferred in the turbine.

**4.3 Reynolds number-**
The laminar boundary layer thickness depends upon the Reynolds number.

**4.4 Number of discs-**
The number of discs can be increased to increase the torque obtained.

**4.5  Size of the gaps between the discs-**
The thickness of the gap should be equal to twice the boundary layer thickness.

## 5.  APPLICATIONS

1. Power generation and regeneration.

 2. Low pressure machine tool operations

 3. High speed tools and pneumatic tools

## 6.  CONCLUSION

With the use of low pressure recovery Tesla turbine, industry waste can be effectively used to run a small generator thereby producing electricity. This turbine has less moving parts also construction is more reliable than traditional ones. This turbine is less expensive than conventional wind turbines and also they are easy to install.

## ACKNOWLEDGEMENT

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