Design Development Fabrication of Bladeless Turbine For Waste Pressure Recovery

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Abstract- *Project work includes the design, analysis and development of a bladeless turbine, Decrease in the weight of the energy generating mechanism is the major factor driving the global bladeless wind turbines market. The construction cost of traditional wind turbines is significantly high as high quality machinery is required to avoid structural damage. As bladeless wind turbines oscillate when responding to vortices, the risk of heavy structural damage is comparatively low. Moreover, as bladeless wind turbines contain few parts, they emit less noise and also pose no threat to birds, eliminating two of the major complaints that consumers have from traditional wind turbines. The inclusion of fewer moving parts also makes construction of bladeless wind turbines more reliable than the conventional ones. Bladeless wind turbines are also less expensive than traditional wind turbines and are easy to install. These factors together are likely to drive the growth of the global bladeless wind turbines market.*

Keywords: *Design Analysis and Development of Bladeless turbine, Waste Low Pressure Recovery System*

I. INTRODUCTION

There are many instances and applications in process industry where the processing of a fluid stream (gas / air) requires its pressure to be reduced. This pressure reduction is usually accomplished through use of a throttling valve. In this method the energy of fluid stream is lost, currently; emphasis is being placed on more three effective energy usages in processing industry. As a consequence, areas in which energy is wasted are being closely monitored and methods of energy recovery are being investigated this calls for developing of effective low pressure recovery systems. Project work includes the design development analysis of a bladeless turbine. Decrease in the weight of the energy generating mechanism is the major factor driving the global bladeless wind turbines market. The construction cost of traditional wind turbines is significantly high as high quality machinery is required to avoid structural damage. As bladeless wind turbines oscillate when responding to vortices, the risk of heavy structural damage is comparatively low.

Waste Heat to Power (WHP) is the process of capturing heat discarded by an existing industrial process and using that heat to generate power. Energy intensive industrial processes such as those occurring at refineries, steel mills, glass furnaces, and cement kilns all release hot exhaust gases and waste streams that can be harnessed with well established technologies to generate electricity. The recovery of industrial waste heat for power is a largely untapped type of Combined Heat and Power(CHP), which is the use of a single fuel source to generate both thermal energy (heating or cooling) and electricity. CHP generally consists of a prime mover, a generator, a heat recovery system, and electrical interconnection equipment configured into an integrated system. CHP is a form of distributed generation, which, unlike central station generation, is located at or near the energy-consuming facility. CHP’s inherent higher efficiency and its ability to avoid transmission losses in the delivery of electricity from the central station power plant to the user result in reduced primary energy use and lower greenhouse gas (GHG) emissions.

1.1 Problem Statement:

The turbines used in the waste heat and pressure recovery systems operate in the range of 60 bar to 25 bar and pressure energy in the range of (20 to 4 bar) is wasted due to lack of a efficient device to tap this energy and convert it to electricity.

1.2 Solution:

Tesla turbine is a bladeless turbine with minimum moving parts, simple design and low cost of manufacturing that can be applied to derive power from low pressure gases (12 to 4 bar) and convert it into electricity in minimum space and in a clean environment friendly manner.

1.3 Objectives of Project:

1. Design , development and derivation of turbine dimensions for operating range of 12 bar to 4 bar by theoretical method, drawing and modelling of Turbine

using Unigraphix Nx-8 , Analysis of turbine components using ANSYS Workbench 16.0

2. Development of Tesla turbine, development of test rig to derive the performance characteristics (Speed/torque/ Power/efficiency) of turbine at various input pressures in range of 12 to 4 bar.

II. METHODOLOGY AND DEVELOPMENT OF PROTOTYPE

2.1 Methodology

2.1.1 Design and Development:

System design as to and theoretical derivation of dimensions of the TURBINE section for three stage roll EXPANSION by theoretical method, Turbine profile geometry by graphical method.

a. System Design and theoretical derivation of power derived from the low pressure expansion in turbine, determination of casing, turbine and outlet side and to get desired turbine speed during waste energy recovery operation.

b. System Design and theoretical derivations of critical components of the system as to shaft, bearings, casing, turbine blades, etc

c. Design, modeling, drafting and analysis of turbine system and critical machine components of turbine by use of Unigraphix NX 8 and Ansys Workbench 16.0 Validation of result of strength of turbine parts using ansys

2.1.2 Actual Construction

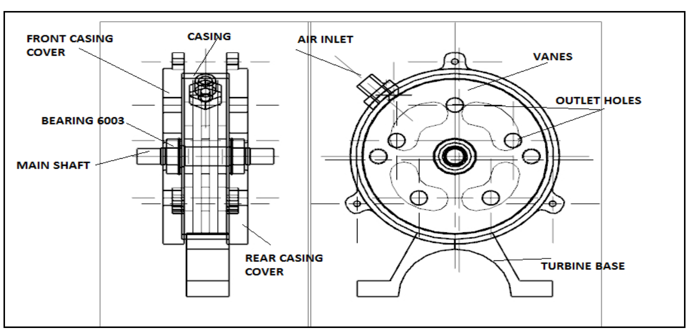


Fig 1: Conceptual Model

The fig.1 shows conceptual model of bladeless turbine.

2.1.3 Actual CAD Model

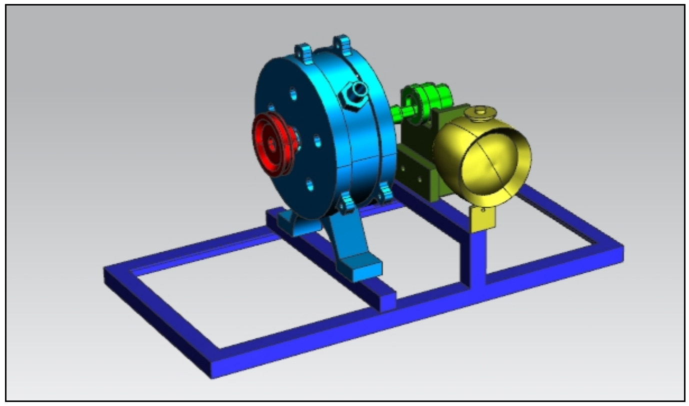


Fig 2: CAD Model

The fig.2 shows actual CAD model of bladeless turbine.

2.1.4 Working

The actual working of bladeless turbine is as follows,

1. Air Hose supply air pressure to hex.
2. Air inlets from hex into turbine.
3. Front cover having five exhaust ports on its periphery for exhaust of air.
4. Turbine disc with holes in center for air flow to exhaust air.
5. Rear cover with five exhaust ports on its periphery for exhaust of air.
6. As the air enters the turbine housing it is forced to create vortex due to the shape of the turbine.
7. Remember that the front cover would also be in place so the air has no choice but to exit through the front or rear exhaust ports.
8. As the air molecules pass the discs they create the drag on them this drag pulls the disc with the air, this is basic explanation of boundary layer effect.
9. At low speed and air pressure the profile of the air vortex might look as shown in figure.
10. The centrifugal force of spinning disc is trying to force the air outwards, while air has no choice but to make it to the exhaust port.
11. This battle between the air flow and the centrifugal force enables the vortex to become so tight that virtually 100% of the air flows power is going to rotating the discs.
12. At this point the speed of the disc is equal to the air flow.

2.2 Development of Prototype

Fig 3: Experimental Setup

The fig.1 shows conceptual model of bladeless turbine.

III. RESULTS AND DISCUSSION

- Maximum No Load Speed at 6 Bar Pressure = 7500 rpm
- Maximum Voltage at 6 Bar Pressure = 12 Volt
- Maximum Current at 6 Bar Pressure = 0.6 Ampere
- Maximum Power at 6 Bar Pressure= 7 Watt
- Flow Rate is Constant = 0.0006862 m^3/min
- Power (KW) = Pressure (bar) * Flow Rate (cfm)

Converting the above values

1. Power (KW) = Pressure (N/m^2) * Flow Rate (m^3/min) * 1.70
 = 7* .0006862 * 1.70
 = 8.16 * 10^{-3} KW
 = 8.16 Watt

2. Power (KW) = Pressure (N/m^2) * Flow Rate (m^3/min) * 1.70
 = 8 * .0006862 * 1.70
 = 9.33 Watt

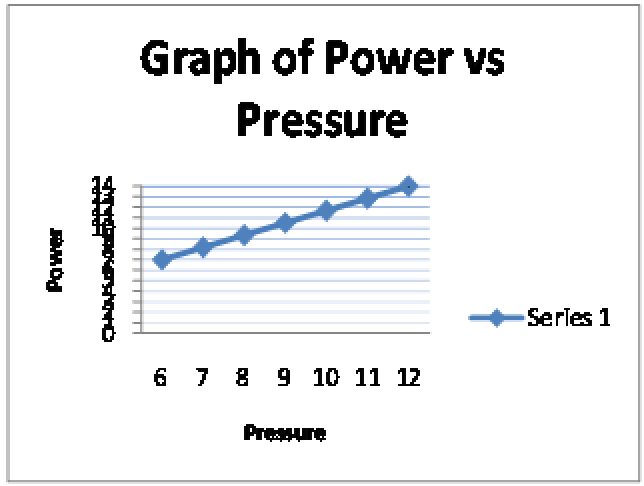
3. Power (KW) = Pressure (N/m^2) * Flow Rate (m^3/min) * 1.70
 = 9 * .0006862 * 1.70
 = 10.5 Watt

4. Power (KW) = Pressure (N/m^2) * Flow Rate (m^3/min) * 1.70
 = 10 * .0006862 * 1.70
 = 11.6654 Watt

5. Power (KW) = Pressure (N/m^2) * Flow Rate (m^3/min) * 1.70
 = 11* .0006862 * 1.70
 = 12.83 Watt

6. Power (KW) = Pressure (N/m^2) * Flow Rate (m^3/min) * 1.70
 = 12 * .0006862 *1.70
 = 14 Watt

3.1 Graph Result



Graph.3.1. Power Vs Pressure

The Above graph 3.1 plotted between pressures against the power.

IV. CONCLUSION

4.1 Conclusion

The concept of group project was included in our engineering syllabus with the view to inculcate within us the application ability of the theoretical concept of design and production engineering to practical problems. So also to help us to learn to work more as a team rather than an individual.

In completing our project titled 'TESLA TURBINE' as per our time estimate gives us immense pleasure and a feeling of achievement. During the course of project we encountered numerous problems which we overcame with the able guidance of our project guide.

This project report presents a brief mention of our efforts. Project work has given us good exposure to the practical field which in the future is definitely going to help us.

The above graph 3.1 shown as the pressure increases then the power also increases i.e. pressure is directly proportional to the power.

4.2 Future Scope

1. Can be used for high temperature low pressure gas recovery.
2. Waste heat recovery from waste in industry.
3. Waste heat recovery from agriculture waste.

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