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Performance Analysis of Turbocharger used in 4 Stroke, 4 Cylinder Petrol Engine

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ABSTRACT:

An integrated supercharger/turbocharger is an integral tool benefits high charging, turbocharging, and timely turbocharging to eliminate some of their individual problems. High boost, turbocharging and improved controls are key strategies for meeting future fuel savings requirements. Higher upgrades increase engine power while more losses remain always, to generate total efficiency profits. By harnessing multiple exhaust turbine output at high speed and torque, turbocharging improves engine efficiency. Supercharging boosts the high-torque vehicle's operating speed. FEM, or finite element analysis, Pro Engineer for complete design and modelling, and ANSYS for stress and CFD analysis on both turbine rotors and compressor impeller bottoms were the main programmes used in this study. The turbocharger's most essential metrics, including all stage parameters on both the turbine and compressor sides, are reported in the results section. This assignment was both a challenge and a learning opportunity. This allowed us to gain a better knowledge of the theoretical, conceptual, and practical aspects of turbomachinery design.

Keywords: CFD, ANSYS, VTG, Turbocharger, Finite Element Analysis

INTRODUCTION:

Ordinary I C engines take in the air that is required for fuel combustion on their own. The low-pressure zone within the cylinder created by the piston's downward movement during the suction stroke of the four-stroke cycle is used to accomplish this. These engines can deliver a maximum amount of power. Allowing more air into the cylinder, regardless of manner, enables for more fuel to be burned efficiently and hence more power to be generated. The device that will take over this job is Turbo Charger. The power of the exhaust gases is harnessed by the turbocharger. It increases the efficiency of the engine by repurposing the wasted power of the exhaust gases.A turbocharger is a little engine that produces a lot of power. A turbocharger is essentially a small centrifugal compressor with a turbine attached to it. Exhaust gases cause the turbine to spin at incredibly high speeds when they pass through it (between 80,000 and 10,000 rpm). The compressor is connected to the turbine and rotates with it, allowing atmospheric air to be taken in and compressed. This compressed air is delivered to the engine for burning. The exhaust gases are expelled through the exhaust pipe after passing through the turbine.

OBJECTIVE OF WORK

The main objective for this project is to design and Analysis a complete turbocharger based on a few parameters by using of software's. Specifically, the objectives include the following items:

1. Simulation and Analysis of all parameter of turbocharger by using of ANSYS Software.
2. Compressor performance Analysis by using of CFD Analysis (ANSYS).
3. Turbine performance analysis by using of CFD Analysis (ANSYS).

3. METHODOLOGY

The turbocharger analysis is performed using Finite Element Analysis, also known as FEA, which allows the user to analyze the model using the software according to the required environment and the necessary parameters needed to assemble the solution. The turbocharger analysis is blocked by the following two key elements:

- Compressor impeller and turbine must have the same outer diameters
- The turbine and impeller rotate at the same rotational speed

The reason for maintaining the exact same range of turbine and compressor impeller is based on the ease of operation and placement of the engine. Having two very different diameters can be difficult when planning other parts that go into the engine room. This is an example of application-based design considerations. The second limit is due to the fact that the impeller and turbine sit on the same shaft. This restriction is found in most turbo generators.

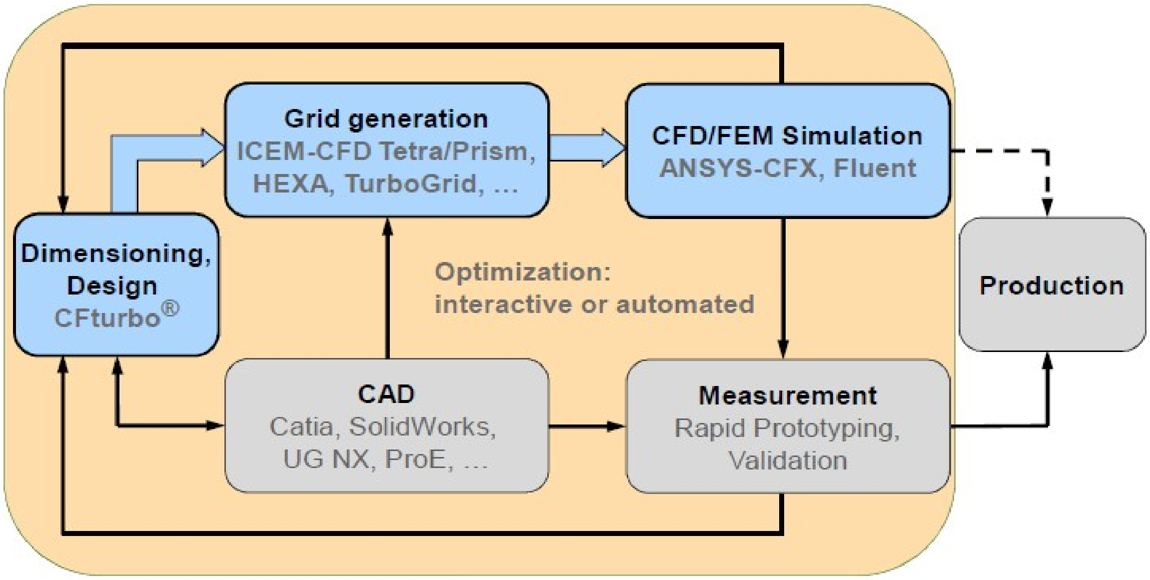

Figure 1: Flow chart for Design and Simulations of Turbocharger Components by using of design software

4 DATA COLLECTION AND ANALYSIS OF DATA

The analysis done in this project is in and around a turbocharged; four-cylinder spark-ignition engine, more data is given in the table below (Table 4.1). For the most part, the engine work is maintained by the use of a turbocharger. A turbocharger has been a successful device with single-entry and vane less turbines as is common in spark-ignition engines. The manifold is made up of cast-iron having a 4 2 1 joint design.

Table 4.1. Data of a four-cylinder engine.

Number of Cylinders	04
Cylinder Valves	04
Bore/ Stroke	90 mm/78mm
Maximum-Power	151 kW
Maximum-Torque	280 Nm
Maximum Inlet Pressure	1.8 bar

The initial parameters are given in table 4.2.With these initial parameters, it is possible to start the analysis by employing the correct equations in FEA.

Table 4.2: Parameter list for compressor and turbine

Parameter	Compressor	Turbine
Volume Flow Rate V [m^3/s]	0.33	NA
Mass Flow Rate *m*[kg/s]	NA	0.55
Inlet pressure	$P_{01} = P_{02}$ = 1.8bar	$P_{in} = P_{ce} - \Delta P_{loss}$
Design rpm	60,000	60,000
Isentropic efficiency □□□	87%	83%
Hub Diameter station 2:	D_{h2} = 24mm	NA

Tip diameter station 2:	D_{t2} = 67:8mm	NA
Tip diameter station 3:	D_{t3} = 102mm	NA
Relative inlet angle	β2 = 143°	NA

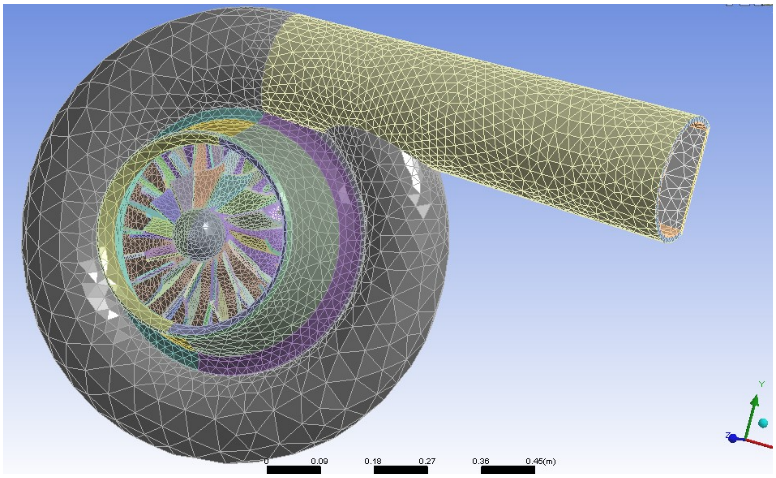

Figure 4.1 the meshing picture of compressor part

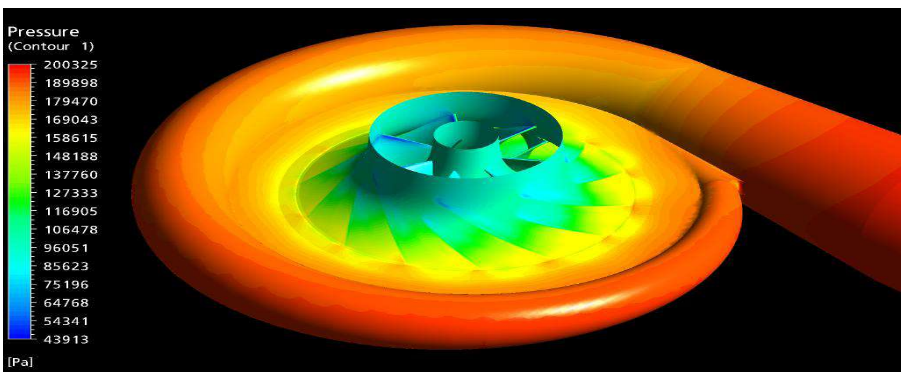

Figure 4.2 Housing of compressor with result of pressure-effect analyze by using of CFD Analyze

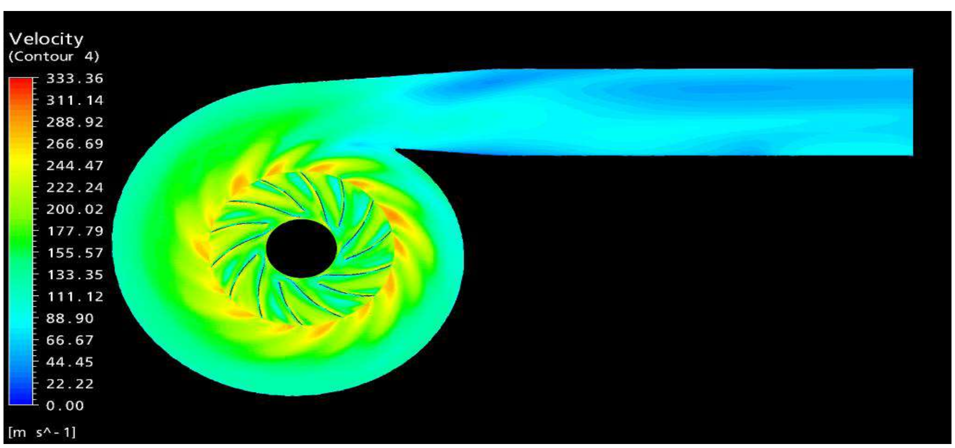

Figure 4.3 Housing of compressor with result of velocity effect analyse by using of CFD Analyze

CONCLUSION:

Power output can be increased considerably in two-wheelers with the use of turbochargers. An engine equipped with a good turbocharger can develop 20% + more power compared to the normal one, with an increase in specific fuel consumption. As exhaust coming from the engine is utilized for useful work which would have been wasted to increase the thermal efficiency of engines over natural engine or supercharged engines.

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