

Stability Analysis of Turbocharger Impeller: A Review

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Abstract: Turbochargers are very essential to incorporate in diesel engine. Turbocharger will feed compressed air to engine which produce more power and torque than natural aspirated engine. This eventually downsizes the engine. The impellers are most important in the turbocharger unit as it has to withstand high temperature and pressure force. This **paper is to analyse impeller's structural, modal and thermal stability with various boundary conditions and blade parameters**

Keywords: Analysis, Diesel Engine, Design, Turbocharger

1. INTRODUCTION:

Turbocharger is force induction system. It compresses the air flowing into the engine in order to produce more power and torque than natural aspirated engine. More compressed air and fuel mixer means more power efficient engine, when compared it to its power to weight ratio. Various new technologies in Turbocharging will increase the volumetric efficiency, so compressed air/fuel has advantage increased volumetric efficiency than that of non-turbocharged engine. In order to achieve boost the turbocharger needs power, and this is provided by the exhaust gas which will spin the turbine impeller and with common shaft compressor wheel will compress air and feeds it in to same engine. Turbocharger spins speed up to 15000rpm (revolution per minute) that is about 30 times faster than car engine. Impeller wheel has to with stand high exhaust gas temperature and stress induced force and external pressure.

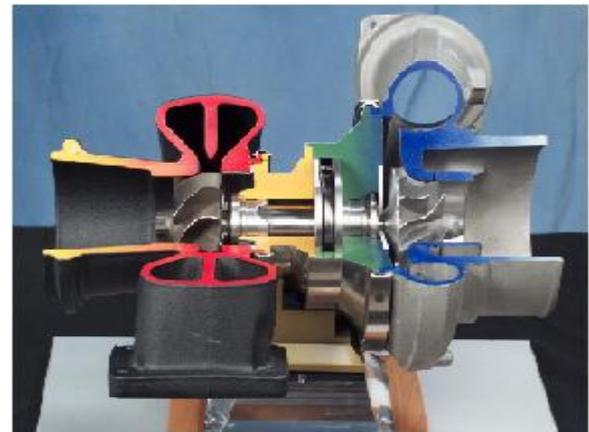


Fig-1. Sectional view of Turbocharger

2. LITERATURE REVIEW:

Hiroshi Tange[1] .The new variable geometry diffuser whose vanes can be put in and out at the diffuser passage was developed for the turbocharger compressor. By this variable geometry the compressor gets both the large capacity of the vane less diffuser and high efficiency of the vaned diffuser at the low flow range, and the engine torque or fuel economy is improved at low speed. The number of variable geometry turbo charger turbines which are used for diesel engines instead of conventional fixed geometry or waste gated turbine has increased. The flow range VGT. Expands by changing nozzle exit angle around the turbine wheel.

Vishal.[2] The report has proved, for a wide range of operating speed with a low speed peak torque, conventional turbocharger systems may not be sufficient. The parallel sequential turbocharger system provides a right solution for wide flow range and near constant pressure ratio demands. The control system for the switch from the low speed turbocharger to the high speed one needs to be calibrated to ensure that during the switching,

there is no loss of pressure boosted and therefore loss of torque.

Wladyslaw.[3] Studied the medium capacity Toyota Yaris 1300cc SI engine equipped with Variable Geometric Turbocharger (VGT). VGT has the nozzle its geometry can be changed depending on the speed of the engine. At lower speed nozzle will squeeze exhaust gas and increase its velocity, and at lower speed nozzle will open wide as exhaust gas itself has high velocity. With Variable Geometric Turbocharger turbo lag is considerably reduced.

Kusztelan[4]. In this author studied and compares the single entry and modified twin entry turbocharger. The model was reconstructed by AVL boost consider parameter. Single stage entry turbocharger model was analyzed for maximum power and torque. By comparing both twin entry turbocharger will linear and better transient response for the given engine. The drivability of the engine and characteristic also improved.

Muqem[5]. Turbocharger pressurizes the air which is about to feed intake of IC engine. When air is compressed temperature of air will increase, and if same air is fed to engine pre combustion may occur leading to knocking. So to avoid this turbocharger are fitted with intercooler to cool down the compressed air temperature to ambient temperature. Oxygen being fed to engine becomes 1.43 times before cooler, when using after cooler is used its oxygen saturation will increase to 2.618 times. Increased oxygen saturation means faster and meaner combustion.

Ghodke[6] Due to high emission norms the CO₂ emission for vehicle has to reduce. The only feasible solution for this is to downsize engine capacity and turbocharger it to meet required power and torque need. Just simple charging unit is not sufficient, instead if that complex charging unit is needed. The problem with small capacity engine is that power produced is low, but with advanced technology in Turbocharging manufactures had overcome this issue.

Tim Lake[7] The author have investigated five alternative approaches on the turbocharger DI gasoline engine. Conventional stoichiometric operation, with reduced compression ratio

- ⇒ Lean boost DI (LBDI) with lean operation at full load to control octane requirement while maintaining the high compression ratio

- ⇒ Exhaust gas recirculation boost with cooled EGR dilution rather than excess air to control octane requirement
- ⇒ Concept of Miller cycle, where valve timing strategies are employed to reduce the effective compression ratio at high load.
- ⇒ Dual injection strategies to control octane requirement.

Tsuyoshi and Takaaki[8]. Are tried to develop the Turbocharger for small engines. Turbocharged cars generally have worst response than non-turbocharged because it takes a few seconds to get Turbocharger rotate **up high speed, usually called as "Turbo-lag"**. Here in this paper the focus on the development of the following turbocharger technology to reduce Turbo-lag and to achieve better transient response is done.

Shaaban[9]. In this author explains the advantage of insulation on the turbine casings. Turbocharger performance greatly influenced by its thermodynamic property. Heat transfer takes place under all circumstances during turbocharger operation. Power production of turbine is affected by this heat transfer, the engine volumetric efficiency and the power consumed by the compressor. He done experiment on insulated casing, and showed heat transfer take place in all circumstance on compressor. Despite of complex heat transfer process, compressor appears to be adiabatic at high rotation speed. Results shows insulated casing has reduced considerable amount of turbo lag.

Yashvir[10]. Project is carried out to increase the power and torque by super charging the stock LML freedom 125cc. This vehicle was analysed for its performance with stock engine, and later analysed it after super charging it. The test results revealed power increased by 9bhp to 13 BHP and torque by 7 to 9NM at 7500 and 9000 RPM respectively.

Jianhua Shao[11]. An axial movable vane turbocharger has been modified based on the basic aerodynamics design principles, and good performance is obtained. The details of design and engine bench testing results of several vane variation are presented, and most suitable assembly nozzle with two separate vanes is then developed. Experiments have shown new Turbocharger efficiently expands the effective torque band and get the low fuel consumption.

3. CONCLUSION:

Understanding the difficulties in manufacturing and testing of turbocharger, CAE is very useful to analyze. The various iterations of turbine impeller with varied blade thickness, varied blade number are made and they are compared with stock model. Structural analysis of impeller to find stress deformation and strain, modal analysis to find natural frequency and finally thermal analysis is carried out for effect of exhaust gases on impeller turbine.

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