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Vehicle Exhaust Gas Operated AC Compressor by Using Turbocharger

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ABSTRACT

The main work of this project is to use of turbocharger instead of using belt drive mechanism from engine to AC compressor. As we all know that when we use AC system at the same time when engine is started because of that the engine fuel efficiency get decreases. So to maintain the fuel efficiency of engine we were developing this system for cars as well as for the commercial vehicle.

Keywords: Turbocharger, AC compressor, fuel efficiency, exhaust gas, Engine

I. INTRODUCTION

The power essential for the working of the AC system is usually driven from the automobile engine, which in seizure results in increased fuel consumption. A recent inclusive study of fuel consumption for vehicle AC on a state-by-state basis using thermal comfort based approach shows that US uses an estimated 7 billion gallons of gasoline every year for air conditioning vehicles. This is equivalent to 6% of domestic petroleum consumption, or 10% of US imported crude oil. The study further shows that vehicle air conditioning loads are the most significant auxiliary loads and outweighs even other significant loads such as rolling resistance, aerodynamic drag or driveline losses. The fuel economy of vehicle drops substantially when the AC compressor load is added to the engine. The AC increases the fuel consumption of a conventional gas-fuelled car by approximately 35% and significantly higher for hybrids. These situations led us in a search for an alternative powering solution for the automobile year round air conditioning system, which does not extract power directly from the engine power.

II. CONCEPT OF TURBO AC SYSTEM

In the engine after developing the brake power (i.e., only about 20-30% of fuel energy supplied).about 70- 80% of the energy is wasted in the exhaust gas. Exhaust gas contains two main forms of energy.

1. Pressure energy
2. Thermal energy

The outline of turbo-Air conditioning system shown in Fig.1, the pressure energy of the exhaust gas is improved by using a gas turbine. The power produced by the gas turbine is transmitted to the AC compressor by a new type of contact-shaft mechanism.

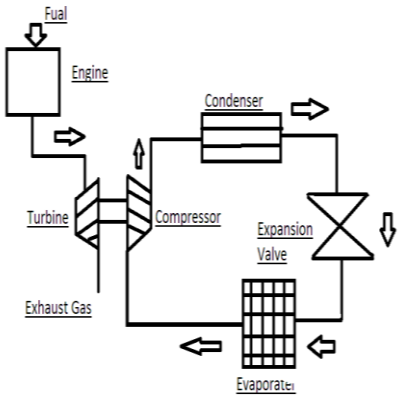

Figure 1. Layout of System

The fuel is burn in engine cylinder and throw exhaust gas from exhaust to outside. That exhaust gas enter in turbocharger with pressure. Turbine in turbocharger will start rotating due to Pressurized exhaust gas. Turbine is connected with compressor by means of shaft. Turbine rotates the compressor and the set system is as same as normal car AC.

III. METHODOLOGY

An AC system contains of a compressor, condenser, expansion valve and evaporator. Here in this project a turbocharger to the system which is driven by the engine

exhaust. Turbocharger runs the centrifugal compressor. That is drop in enthalpy gain in kinetic energy of the exhaust is used to run the gas turbine which in turn runs the compressor by a shaft. The high pressure and compressor temperature vapour refrigerant from the compressor is transferred to the condenser. Condensed refrigerant is in the form of liquid, slight drop in pressure (negligible), change in its phase from vapour to liquid. The refrigerant then made to expand in the hand operated expansion valve to ensure pressure drop drastically very close to atmosphere pressure. The low pressure and expansion temperature liquid refrigerant then enter into the evaporator absorb heat from the cooling space their by undergoing the change from liquid to gaseous state. This change of phase equals the amount of heat absorbed resulting in cooling of the space (refrigerating effect).

Figure 2. Design & Implemented system

IV. CFD Analysis of the exhaust gas turbine

A four cylinder, 4-stroke, turbocharged, SI engine is used in this study. The turbocharger measured exhaust heat are listed in Table. Firstly here a turbine or exhaust section model by using CAD software is designed and it is imported to ANSYS 18.1 to complete the CFD analysis.

Pre-processor contains of input of a flow problem by means of an operator friendly interface and subsequent transformation of this input into form of suitable for the use by the solver.

Table1. Measured exhaust heat

Table.2 Turbocharger Specification

Power (KW HP PS)	56 KW@4000rpm
Torque Nm LB/Ft)	190 Nm@ 1750rpm
Weight	3 kg
Cooling	Oil
Compressor Inducer	22.63 mm
Exducer	32 mm
A/R	0.32
Turbine Wheel	30 mm
A/R	0.18

V. ENGINE ANALYSIS

Air inlet & exhaust pressure

- Air inlet pressure into air cleaner & in engine = 0.3 bar
- Air inlet pressure into air cleaner & in engine = 0.2 bar (Turbocharged Condition)
- For our analysis it is 0.25 bar or 25000.0 Pa
- Engine exhaust gas pressure = 4 bar or 400000.0 Pa
- Air inlet through Air filter = .35 Atm or 35000.0 Pa

Specific condition

- Engine Ideal RPM = 1500 RPM
- Maximum Engine RPM = 12000 RPM
- Turbocharger RPM = 1800.03 RPM

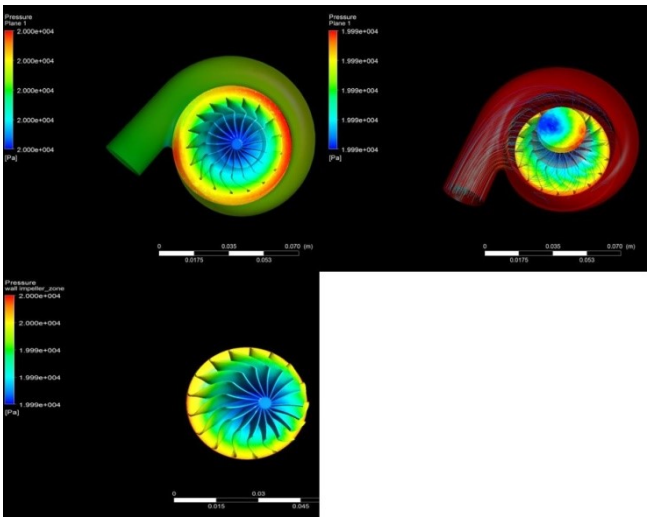

Figure 3. Analysis of exhaust turbine

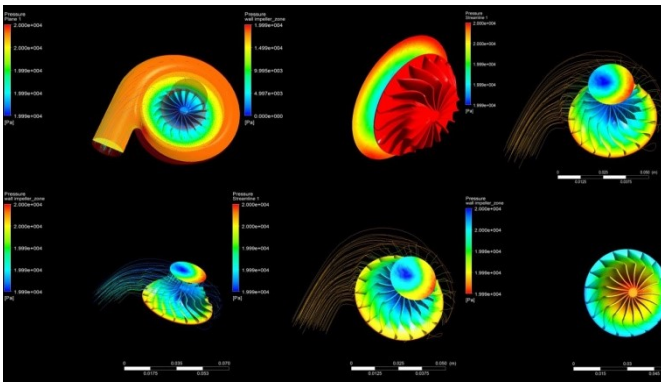

Figure 4. Effect on turbine

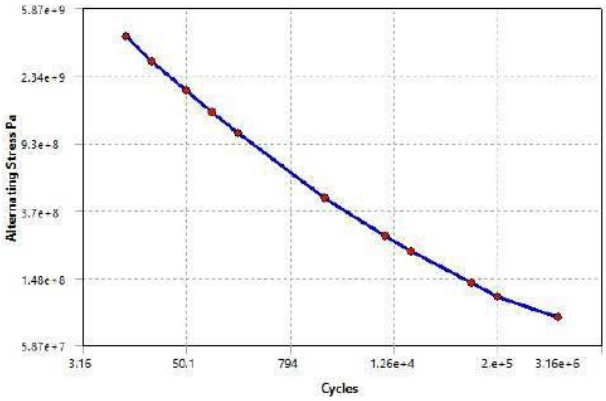

Figure 5. Stress on turbine

Table. 3 Technical Data

Force on turbine X direction	0.0122663 [N]
Force on turbine Y direction	0.000271847 [N]
Force on turbine Y direction	0.000257182 [N]
Mass flow of gas	1.56314e-006 [kg s^-1]
Torque generated	2.16399e-006 [N m]
Angular Velocity	188.496 [rad s^-1]

VI. CONCLUSION

Some of the main advantages of this concept is that it can be easily working on low power engine and can confirm high capacity air conditioner. It offers better consumption of exhaust gas energy. The essential torque is attained as per CFD analysis. Further the use of an eco friendly refrigerant viz. HFO-1234yf can convey a greener AC system on automobiles. The use of an exhaust Rankine cycle to recover the exhaust thermal energy can further result in a best fue utilizing engine.
Main Advantages of Turbo-AC System are:-

- AC running without any consumption of fuel.
- NO direct load on engine.
- Mileage of car and Life of engine will increase.
- Cabin temperature will decrease.
- Waste exhaust gas will be used, that will reduce air pollution.
- Increase in pressure in compressor because of turbocharger.

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