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Performance Optimization of Engine by Enhancing the Cooling Effect of the Exhaust Gas Recirculation Cooler

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ABSTRACT

NOx emissions have been greatly decreased thanks to Euro 6 requirements. When compared to Euro 5 standards, the NOx limit is reduced from 0.18 g/km to 0.08 g/km, a 56% reduction. This has important consequences for control systems, mandating the inclusion of NOx emission control aftertreatment, such as better exhaust gas recirculation (EGR) coolers, for the first time. Due to the significant temperature differences between the hot exhaust gas and the coolant, EGR coolers must tolerate considerable thermal loads. The CFD approach is used to assess the effectiveness of five different designs of EGR coolers.The EGR cooler is a shell and tube design with a single coolant entry in the first design and multiple coolant entries in the subsequent design, with the coolant travelling through the shell to cool the exhaust gas inside the tubes. Using the CFD code ANSYS CFX 14.0, the thermo-flow characteristics inside the EGR Cooler as well as the surface temperature were investigated. The standard k-epsilon turbulence model is used for analysis. The EGR cooler's mathematical validation is complete, and the results are compared to each design.

Keywords- Emission, Thermal stress, EGR, CFD, $NO_{x,}$

1.INTRODUCTION

Today, it is normal practise to add after treatment systems to exhaust systems in order to minimise a vehicle's emissions. These structures reduce the amount of dangerous gases and PM in the exhaust gas before it is released into the environment. An oxidation impetus, a diesel particulate filter (DPF), and a specific reactant decrease (SCR) impetus are common segments for a diesel engine. The oxidation catalyst is really quite simple; it uses the excess air in the exhaust gases to oxidise unburned hydrocarbons. CO is turned into harmless CO2 through oxidation. Particulates from the gases of the fumes are sifted via the DPF. It needs to be retrieved regularly, which leads to increased alignment efforts and fuel consumption. The SCR drive reduces NOX outflows to N2 and H2O by using urea, a kind of smelling salts. The treatment of urea involves adding a second tank and an infusion system to the motor since the urea the board causes demands increased adjustment effort. Regular urea tank refilling by the client results in increased operational costs. All three of these ways typically increase the weight of the motor's exhaust gases, which makes syphoning work easier.

2.OBJECTIVES

The main objectives in this research work are

1. CAD modelling of EGR cooler using CREO 2.0.
2. CFD analysis of EGR cooler base design using ANSYS CFX.
3. Design optimization using multiple inlet entries (1, 2, 3, 4, 5) for shell.
4. CFD evaluation of numerous designs with varying inlets.
5. Validation via mathematics.
6. Plotting velocity, temperature, and pressure data.
7. Comparison study on basis of parameters like temperature and pressure.

3.RESEARCH METHODOLOGY

The original component (EGR Cooler) is modelled using a CAD program and analyzed using ANSYS in this process. Based on that, a new component drawing is created, and using ANSYS, the old and new designs are compared.

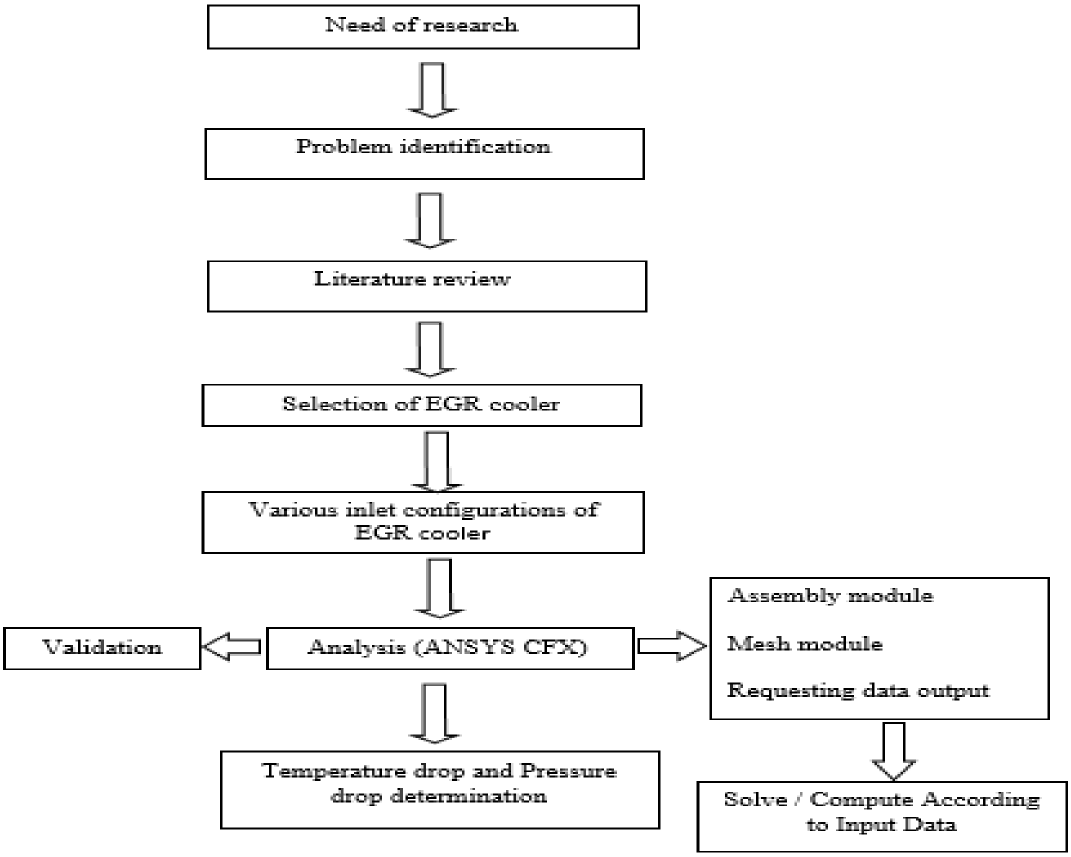

Figure 3.1 Methodology Flow Chart

RESULT

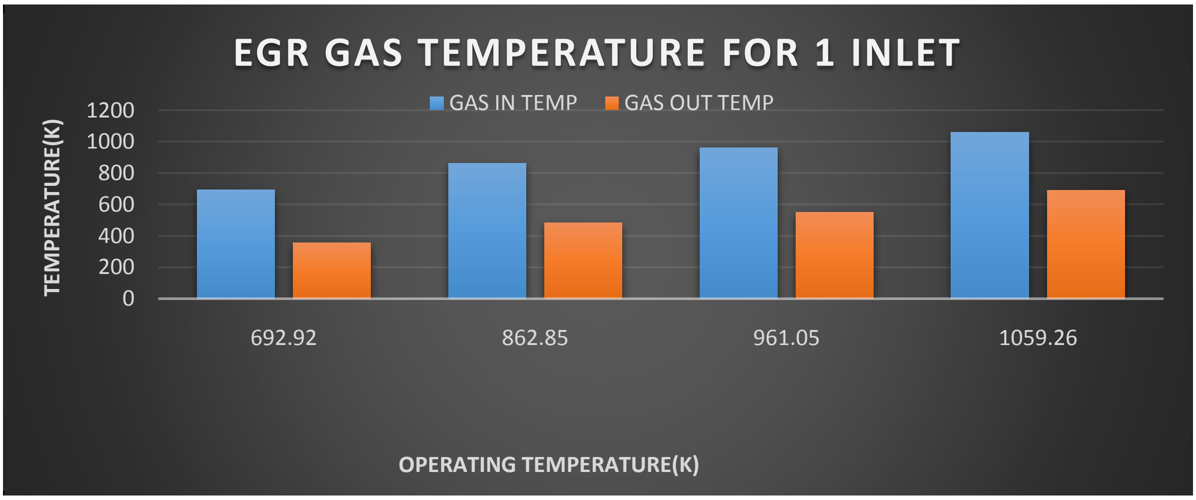

Figure 4.1EGR gas temperature for 1 inlet

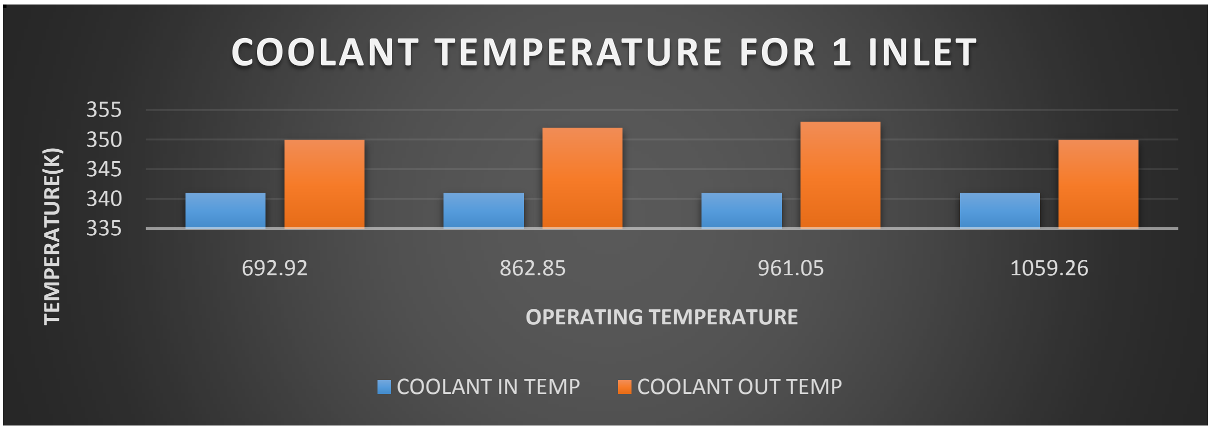

Figure 4.2Coolant temperature for 1 inlet

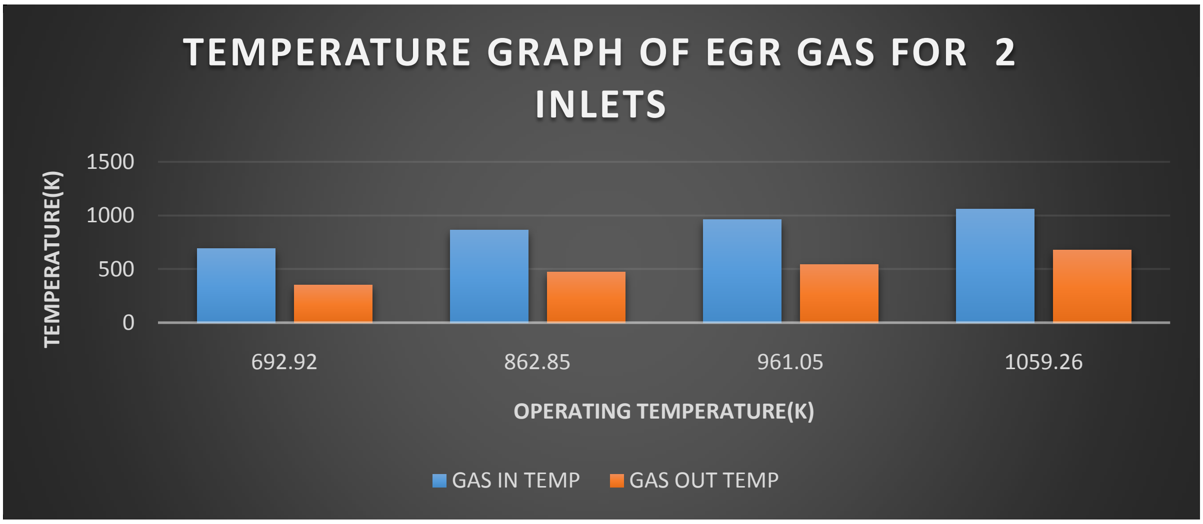

Figure 4.3EGR gas temperature for 2 inlets

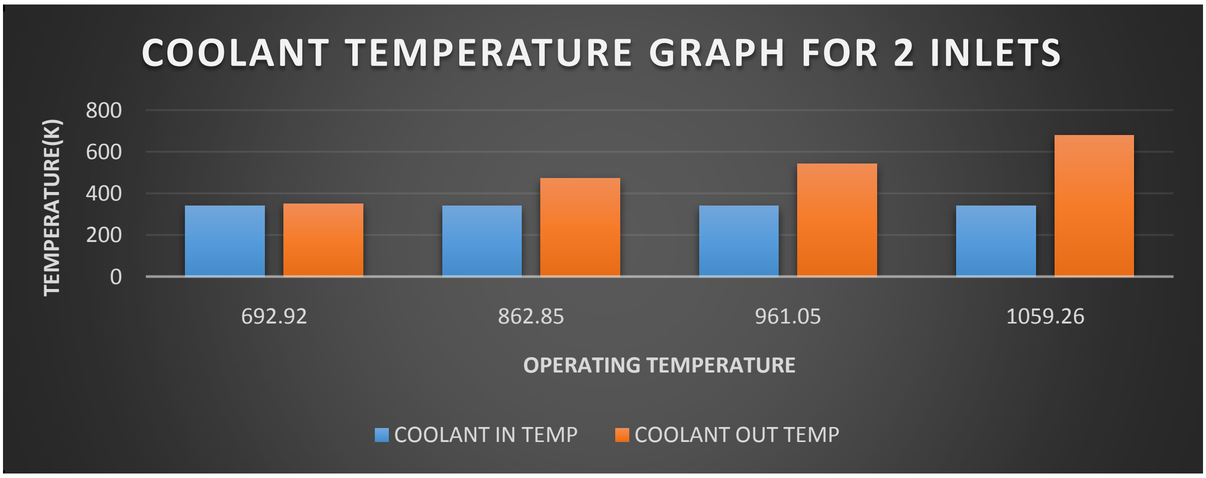

Figure 4.4Coolant temperature for 2 inlets

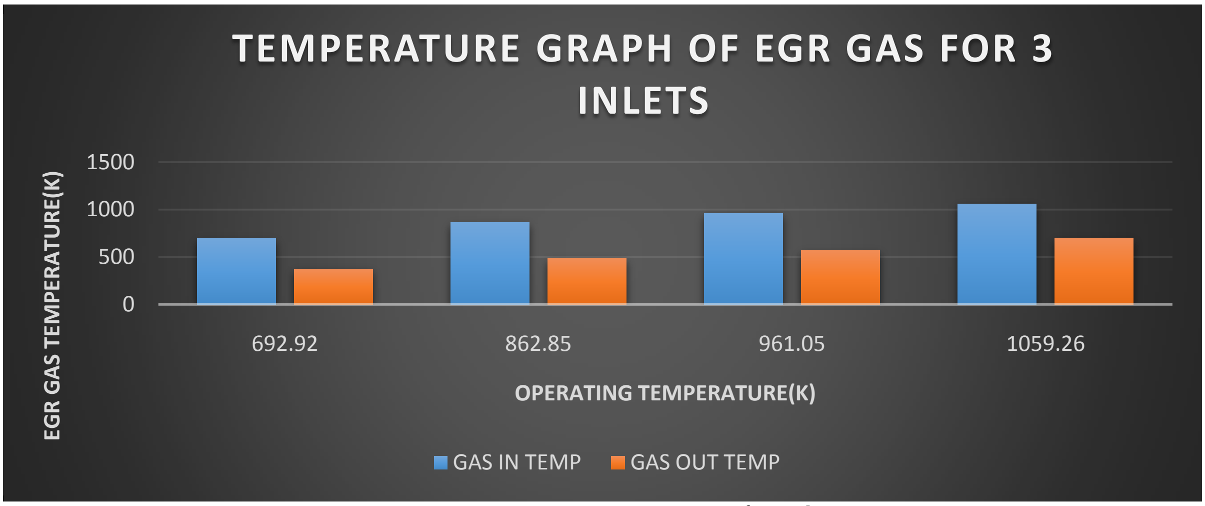

Figure 4.5EGR gas temperature for 3 inlets

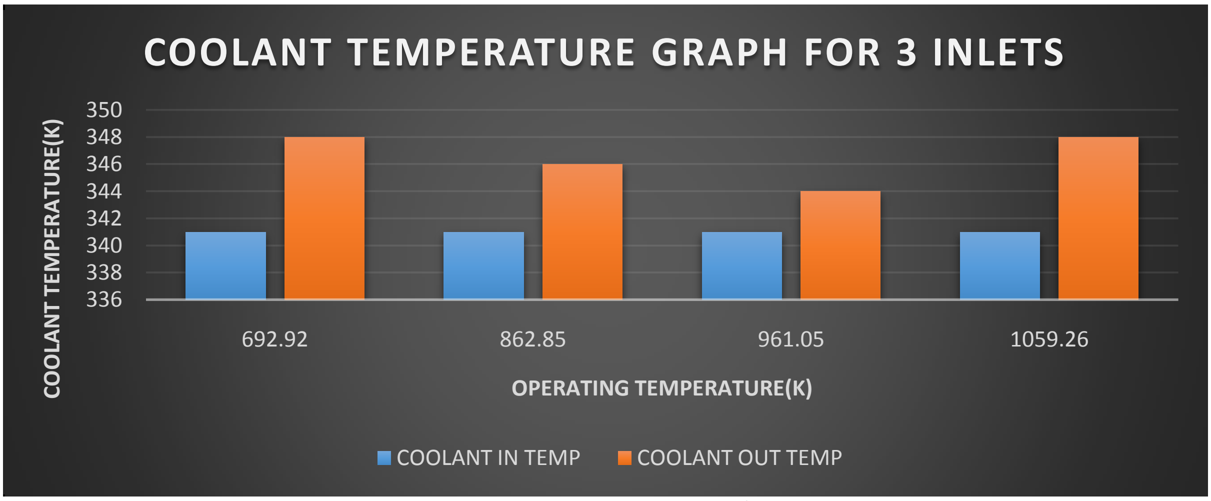

Figure 4.6Coolant temperature for 3 inlets

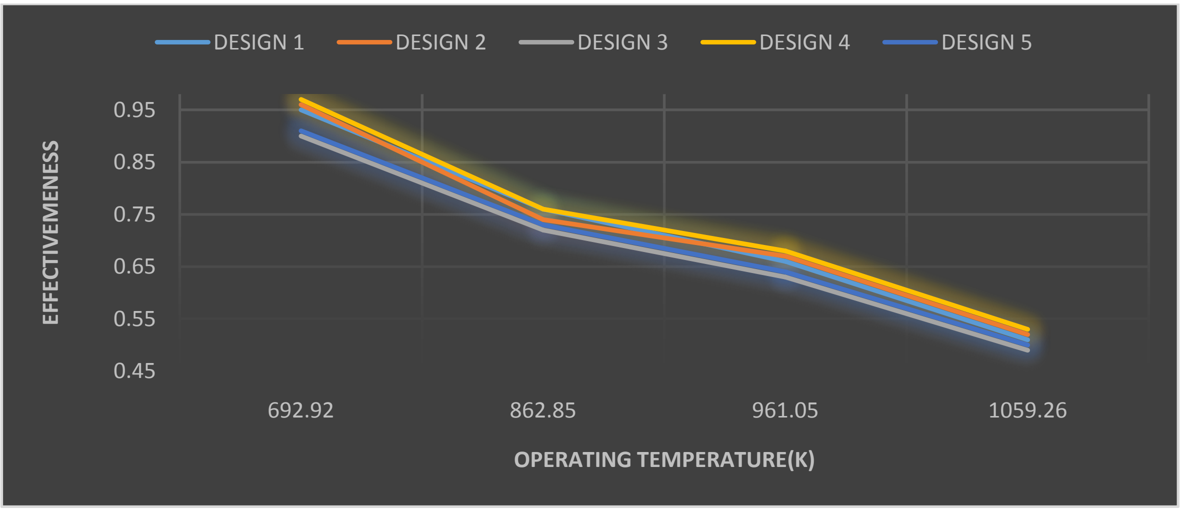

Figure 4.7Effectiveness comparison for all designs.

CONCLUSION

Following is a discussion of conclusions based on a numerical investigation.:

1. Pressure drop is found to be maximum for four inlet design configurations for shell side with value of 555Pa and minimum value of 480Pa for double entry design.

2. Pressure drop is found to be maximum for four inlet design configurations for tube side with value of 365Pa for four entry design and minimum value of 253Pa for triple entry design.
3. EGR gas outlet temperature is found to be maximum (701 K) for 3 inlets design with operating temperature (1059.26 K).
4. In comparison to previous designs, the minimum EGR gas outlet temperature for a four-inlet system with an operating temperature of 1059.26 K is found to be 677 K.
5. Effectiveness decreases with increase in operating temperature
6. Effectiveness is found to be maximum for EGR cooler with 4 inlets for all operating temperature and minimum for EGR cooler with 3 inlets for all operating temperature.

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