DESIGN AND ANALYIS OF THERMOELECTRIC INTERCOOLER TO INCREASE THE EFFICIENCY OF I.C ENGINE

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Abstract:The exhaust from I.C Engine supplied to the turbo charger turbine. The turbine rotates the compressor by means of turbine shaft connected to the compressor. Then compressor compresses the air from the atmosphere and supplied to the thermo-electric intercooler which workers under peltier effect. The peltier module having hot face facing towards the atmosphere to transmit the heat and cold face facing towards the enclosed area of the peltier effect intercooler. The exit temperature of air from the thermo-electric intercooler will be reduce due to the peltier effect which increases the volumetric efficiencyand reduces the fuel consumption rate which results the complete combustion.

***IndexTerms*–Engine, Thermo-electric Inter cooler and Peltier Effect.**

I. INTRODUCTION

The main purpose of the project is to increase the efficiency of an IC engine. Nowadays turbocharger is used to increase the engine power by pumping air into the combustion chambers.When turbocharger application is used in engine, the suction air temperature increases in the engine and this cause the emergence of undesirable combustion conditions. To reduce this situation, application of intercooling in vehicle is used. For cooling the intake air we are placing an thermo electric inter cooler to reduce the temperature of an inlet gases to combustion chamber and hence the density of air is increased by increasing the temperature drop across the intercooler there by combustion takes place completely and reduce the emissions of an IC engine

This invention improve the efficiency of an IC engine by using a thermo-electric intercooler.

A.ORIGINS

The intercooler is modeled as a heat exchanger (figure 1) with fixed area, heat transfer coefficient and cooling volumetric flow. Decrease of charge air temperature is determined from heat exchanger effectiveness (i ε):

$$\varepsilon i = \frac{\mathrm{rtemp}(2) - \mathrm{hi}(3)}{\mathrm{rtemp}(2) - \mathrm{hi}(2)}$$

Where is:

rtemp (2), K – compressor discharge temperature, hi (3),
K – Intercooler discharge temperature and hi (2),
K – Coolant inlet temperature (is assumed to be fixed).

Schematic of intercooler:

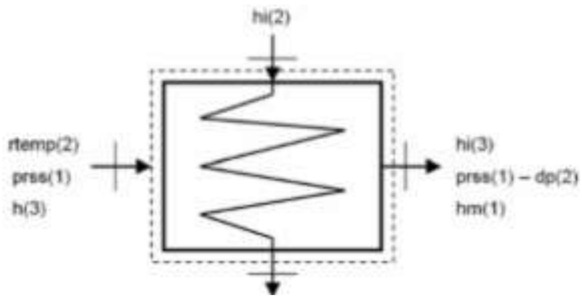

FIG1

The heat exchanger effectiveness can be derived from graphic correlations for the various types heat exchanger (6). Effectiveness can be determined with capacity ratio and the number of heat transfer unit, the expression for effectiveness is a simple form;

$$\varepsilon = 1 - e^{(-N2)}$$

B. COMPARISON OF MODEL PERFORMANCE RESULTS AND MANUFACTURERS DATA

In this paper through own worked out programmed code in MATLAB for model will presenting effect of intercooler (as a heat exchange device air-to-liquid with three different size and over – all heat transfer coefficient and one base) at e multi-cylinder engine performance for operation at a constant speed of 1600 RPM.

Effective Performance data (black for S.U= 1200 base) of the engine Cummins type N14-M are taken for the comparison with predicted by simulation same type of intercooler S.U=1200. Difference between data and prediction of simulation is 0.46 %.

C.TYPES OF INTER COOLERS:

1. Water or air inter cooler(normal inter cooler)

2. Thermo-electric Inter cooler

II. SOFTWARE

The software will start (by default) with all toolbars docked to the edges of the main window. The toolbars contain buttons, which when clicked, open the various information windows or operate features in the software. The toolbars and windows can be freely moved around inside the main program window, to create your own screen layout.

A.INRODUCTION TO CATIA

CATIA started as an in-house development in 1977 by French aircraft manufacturer Avion Marcel Dassault, at that time customer of the CADAM software to develop Dassault's Mirage fighter jet. It was later adopted by the aerospace, automotive, shipbuilding, and other industries. Initially named CATI (*conception assistée tridimensionnelle interactive* – French for *interactive aided three-dimensional design*), it was renamed CATIA in 1981 when Dassault created a subsidiary to develop and sell the software and signed a non-exclusive distribution agreement with IBM. In 1984, the Boeing Company chose CATIA V2 as its main 3D CAD tool, becoming its largest customer. In 1988, CATIA V3 was ported from mainframe computers to UNIX. In 1990, General Dynamics Electric BoatCorp chose CATIA as its main 3D CAD tool to design the U.S. Navy's Virginia class submarine. Also, Lockheed was selling its CADAM system worldwide through the channel of IBM since 1978.In 1992, CADAM was purchased from IBM, and the next year CATIA CADAM V4 was published. In 1996, it was ported from one to four UNIX operating systems, including IBM AIX, Silicon Graphics IRIX, Sun Microsystems SunOS, and Hewlett-Packard HP-UX. In 1998, V5 was released and was an entirely rewritten version of CATIA with support for UNIX, Windows NT and Windows XP (since 2001).

B. INTRODUCTION TO ANSYS WORKBENCH CFD

Computational fluid dynamics (CFD) is a branch of fluidmechanics that uses numericalanalysis and datastructures to solve and analyze problems that involve fluidflows. Computers are used to perform the calculations required to simulate the interaction of liquids and gases with surfaces defined by boundaryconditions. With high-speed supercomputers, better solutions can be achieved. Ongoing research yields software that improves the accuracy and speed of complex simulation scenarios such as transonic or turbulent flows. Initial experimental validation of such software is performed using a windtunnel with the final validation coming in full-scale testing, e.g. flighttests.

III.DESIGN

A.THERMO ELECTRIC INTER COOLER:

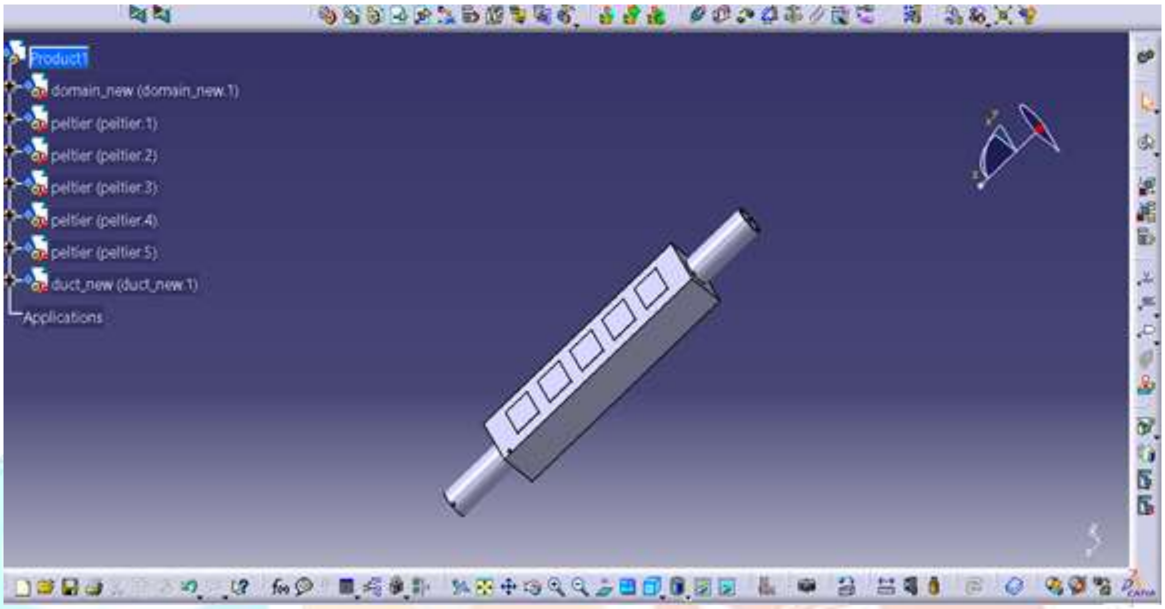

FIG 2

B.CFD ANALYSIS:

i.Temperature analsys

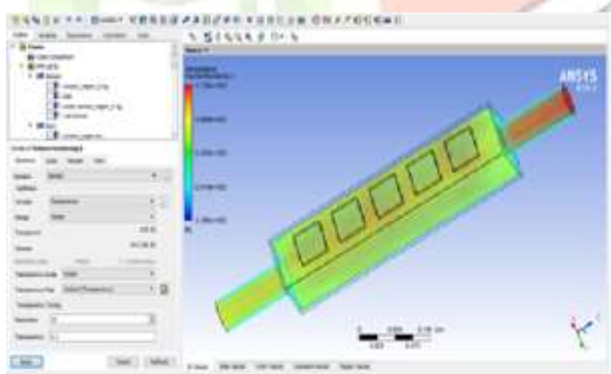

FIG 3

ii.Pressure analsys

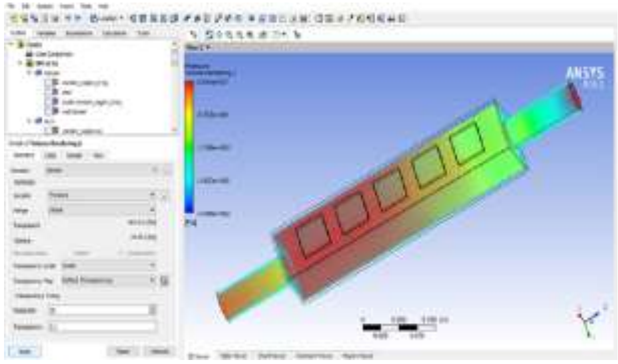

FIG 4

iii.Velocity Analsys

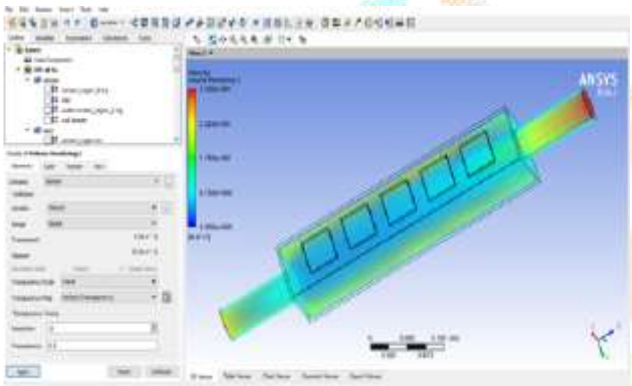

FIG 5

IV.LITERATURE SURVEY

1. **Mohd Muqeem, Dr. Manoj Kumar**hadused the intercooler to cool down the compressed hot air from turbo compressor fails when the summers are very hot and the speed of the vehicle is lowered. By designing a turbocharger with proper heat transfer area to increase this mass flow rate by mixing some additional amount of conditioned air into the atmospheric air entering into the intercooler to cool the hot air delivered by the turbo compressor.

2. **Mohd Muqeem** had designed intercooler in which air will run as hot fluid and refrigerant, of the air conditioning system coming from cooling coil fitted in the dashboard, will run as cold fluid. The intake air will be cooled down by the air flowing through the fins of the intercooler and the refrigerant coming from the evaporator. And hence the density of air is increased by increasing the temperature drop across the intercooler. Finally they compared result between normal intercooler and designed refrigirated intercooler

3. **Dr. sc. Naser B. Lajqi, Dr. sc. Bashkim, I. Baxha ku, Mr. sc. Shpetim B. Lajqi** had prepared the own programmed code in MATLAB for model will presenting effect of intercooler (as a heat exchange device air-to-liquid with three different size and over – all heat transfer coefficient and one base) at a multi-cylinder engine performance for operation at a constant speed of 1600 RPM **.** Compared the performance results and manufactures data.

4. **Nilesh Pawar** had compared the theoritical and analytical results of charged air cooler. In CFD the design is analysed.Finally they conclued that the power output of vehicle can be increased by two ways

5. By increasing the size of combustion cylinders and burning the more fuel.

6. By supplying more air in existing cylinders so that we can burn more fuel to obtain more power.
7. **Rajan Lad** had designed and analysed the performance of the intercooler. Analysis parameters such as heat transfer coefficient, fluid velocity, pressure drop, and others are calculated using standard operating values.
8. **Ebieto, C.E and Eke G.B.** had carried out the performance analysis of shell and tube heat.

V.CALCULATION:

Formula:

BP = (2Πnt/60) × ω

T = (ω-s) × 9.81 ×R WHERE R=RADIUS OF BREAK DRUM (P+ (2d/2))

TFC = (10 × 0.8 × 3600) / T × 1000 Kg/hr

SFC = TFC / BP Kg/Kwhr

ɳ = (BP/IP) × 100%

WHERE

BP-brake power

T-torque

PERFORMANCE TEST WITH INTER COOLER:

S.NO	LOAD (IN Kg)		Time taken for fuel consumption (sec)	SPEED RPM	Manometer reading(cm)	
	W	S			h1	h2
1	0	0	74	740.3	8.1	14
2	7	5	70	720.2	8.1	14
3	10	8	69	702	8.1	14
4	11	9	66	691.3	8.1	14
5	12	10	61	685	8.1	14
6	14	12	59	670	8.1	14

Table1

S.NO	B.P (KW)	TFC(Kg/hr)	SFC (Kg/Kwhr)	IP(KW)	ɳIT
1	0	0	0	0	0
2	3.3	0.4881	0.1479	3.95	83.5
3	3.2	0.4721	0.1475	3.8	84.2
4	3.29	0.4363	0.1326	3.9	84.35
5	3.4	0.4173	0.1227	4	85
6	3.5	0.4114	0.1175	4.08	85.6

Table 2

Calculation with normal intercooler:

Inlet temp of engine T =28℃

=301°F

Inlet pressure of engine P =1.11325*10^5 N/M

Density of an inlet air (ρ) = P/RT

=1.313 kg/ m^3

Sweep volume (vc) $=\frac{\pi}{4} D_B^2 * SL*2$

$=8.59*10^{-4}$ m^3

Mass of air at engine inlet without Intercooler (m_t) $=\rho_t * v_c$=1.128g

Mass of air at atmospheric condition (m_a) =1.5644g

$$\eta_{vol} = \frac{mass\ of\ air\ drawn\ into\ cylinder}{mass\ of\ air\ ideally\ present\ in\ atmospheric\ condition}$$

Volumetric efficiency without inter cooler =1.128/1.5644

$\eta_{vol} with\ inter\ cooler$ =72.1%

Calculation with thermo electric inter cooler:

Temperature of air at engine inlet with Intercooler (T_t) = 34.6℃

= 307.6 K

Pressure of air at engine inlet with Intercooler (P) = 1.378*10^5N/m

Density of air at engine (ρ_i) = $P_i/(R\ T_i)$

= 1.56Kg/m^3

Swept volume of the cylinder (V_c) $=\frac{\pi}{4} D_B^2 * SL*2$

$=8.59*10^{-4}$ m^3

Mass of air at engine inlet without inter cooler (mt) $=\rho_t * v_c$

=1.34g

Mass of air at atmospheric condition (ma) =1.5644g

$$\eta_{vol} = \frac{mass\ of\ air\ drawn\ into\ cylinder}{mass\ of\ air\ ideally\ present\ in\ atmospheric\ condition}$$

η_{vol} without inter cooler = 84.53%

VI.CONCLUSION

We hope that the above provided information is best suited and cleared for you and we also abide that this project is definitely useful in increasing the efficiency of the IC engine.

From the result it state that when using the intercooler the efficiency increases and total consumption of fuel decreases.

S.NO	TYPE OF COOLER	EFFICIENCY
1	Normal intercooler	72.1%
2	Thermo electric inter cooler	84.53%

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