DESIGN AND ANALYSIS OF AIR PREHEATING BY USING CONTACT PLATE IN DIESEL ENGINE

R.Karthik[1], P.Samivel[2], K.Suresh[3], V.Velukumar

[2]Assistant Professor,, Muthayammal College of Engineering,
[1,3,4] Pg ScholarMuthayammal College Of Engineering, Rasipuram
Namakkal, India-637018

[1]r.p.karthikraja1993@gmail.com
[2]samivel.2287@gmail.com
[3]sureshkanda91@gmail.com

Abstract
In a conventional IC engine a considerable heat is carried away by exhaust gases. To recover the waste heat, turbo charging is done. In this project, an attempt has been made to design and analyze contact plate for waste heat recovery from C.I. energy exhaust, by implementing contact plate between turbocharger and intercooler. It has been observed that the exhaust temperature of C.I. engine is more than 380 degree Celsius it can be used to reheat the air intake to the C.I. engine so that attempt can be made to improve its performance by using the waste heat recovery system .The main scope of this project is to design and analyze the contact plate which is to be implemented between the turbocharger and intercooler.Intercooler used to decrease the compressed air temperature, will also leads to deficiency in performance.The main objective of the project is to analyze the contact plate and the contact plate is modeled using modeling technique of Pro-E software.
Keywords: Contact plate ,Turbo charger
Intercooler

I. INTRODUCTION

The output of the engine exhaust gas is given to the input of the turbine blades, so that the pressurized air produced. This power, the alternate power must be much more convenient in availability and usage.

The next important reason for the search of effective, unadulterated power are to save the surrounding environments including men, machine

and material of both the existing and the next fourth generation from pollution, the cause for many harmful happenings and to reach the saturation point.The most talented power against the natural resource is supposed to be the electric and solar energies that best suit the automobiles.

The unadulterated zero emission electrical and solar power, is the only easily attainable alternate source. Hence we decided to incorporate the solar power in the field of automobile, the concept of many Multi-National Companies (MNC) and to get relieved from the incorrigible air pollution.

BMW was the first to use turbo-charging in a production passenger car when they launched the 2002 in 1973. The car was brilliantly packaged too and paved the way for a simply magnificent 'Turbo Era' in the automotive world. Swedish giant Saab took its cue from this and its ensuing 900 series was one of the most characteristic turbo cars of its time. Intercoolers the latest turbo's they are used by most of today's turbo-diesel engines to make the compressed air denser. It works like this - on starting, exhaust gases spin the turbine and thus activate a compressor that pressurizes the air. This pressurized air from the turbo-charger is then sent through a duct to an air-cooled intercooler, which lowers the temperature of the intake charge and thus increases its density.The unadulterated zero emission electrical and solar power, is the only easily attainable alternate source.The air-cooled intercoolers receive air through separate intakes and that explains the small scoops and louvers usually found on the hoods of turbo-charged cars.

Modern turbo-diesel engines also make use of a temperature-sensitive, motor-driven fan which boosts airflow at low engine speeds or when the intake air temperature is high. Though there are diesel engines that 'earn' a turbo-charger mid-way through their life, the usual practice is to design and develop an engine with a turbo-charger in mind. Then, as and when a turbo-charged model is added to the stable, the engine can adapt to it without any additional strengthening and cooling of engine parts. A well-engineered, turbo-charged diesel engine offers better fuel efficiency (at times by 15 per cent), better overall performance (better torque and high-end power), reduced noise (compared to normally aspirated diesel engines) and minimum engine maintenance (owing to better combustion of diesel fuel).Turbo loses steam Multiple valves and double-overhead camshaft designs developed reasonable performance without the complication of turbo-charging, and these methods were politically correct too since they consumed less fuel.

Engine management systems linked to fuel-injection systems meant getting more out of the engine was even easier. For example, one can buy chips that can boost power by 100 bhp for some Japanese cars, such as the Nissan Skyline. Moreover, on-road speeds were being restricted all over the world. Though most of the sports cars today are capable of doing more, they are restricted electronically not to exceed 250 kmph even in autobahn-blessed Germany. Turbo-charging lost its edge towards the end of the '80s and today this technology is used only in select performance cars. Porsche, for example, is all set to build a turbo-charged version of its all-new 911(water-cooled) with added performance. Turbo engines were banned in Formula One too with the idea of restricting the performance of the cars (and thereby making them safer too). There are many who consider this a backward step in the world of Formula One, which is considered to represent the 'tomorrow' of automotive technology.

A. Supercharger

A supercharger is essentially a large pump that compresses air and forces it into the engine’s air intake. Turbochargers do the same thing, only they are run by exiting exhaust gasses, while superchargers are powered by the engine’s spinning crankshaft, normally via the accessory belt. Supercharging an engine often results in huge power increases in the range of 50% to 100%, making them great for racing, cross country flying, or just having fun. And because of the way superchargers work, they provide power only when the engine is under full throttle or under load not under normal cruising conditions. This means that the supercharger will not affect the engine’s reliability, longevity, or fuel economy under normal conditions. Most of the superchargers sold today are centrifugal-style superchargers, which are internal-compression superchargers, meaning they create the boost (compress the air) inside the supercharger head unit (blower) before discharging it into the engine’s air intake. External compression superchargers (roots or screw-type superchargers) have become less popular as centrifugal superchargers have evolved. Centrifugal superchargers (Aero Superchargers, Vortech and Paxton) are more reliable, especially at higher boost levels, and are capable of creating much more boost than external compression superchargers, while creating a much cooler intake charge (which results in an even denser intake charge). Boost is created at the point when the supercharger’s internal impeller pushes enough air through the blower to overcome the vacuum force naturally created by the engine's air intake, so air is being forced, rather than pulled, into the air intake. Boost is measured in Manifold Pressure, or MAP. More boost equates to a more dense air charge into the engine's combustion chamber, which allows the engine to burn more air and fuel and create more horse power.

B. Turbocharger

Turbo-charging, simply, is a method of increasing the output of the engine without increasing its size. The basic principle was simple and was already being used in big diesel engines. European car makers installed small turbines turned by the exhaust gases of the same engine. This turbine compressed the air that went on to the combustion chamber, thus ensuring a bigger explosion and an incremental boost in power. The fuel-injection system, on its part, made sure that only a definite quantity of fuel went into the combustion chamber.

The turbo-charger is simply increases the volumetric efficiency of the engine. To give you an example: a 1,500 CC engine that produced, say, 60 bhp when it was normally aspirated, benefited at times with a 10- to 20-per cent power boost depending on the kind of turbo-charger used. Normally, the manufacturer would have had to resort to a bigger displacement in the engine, or design and develop an all-new engine to get more power from the same unit. In most piston engines, intake gases are "pulled" into the engine by the downward stroke of the piston (which creates a low-pressure area), similar to drawing liquid using a syringe. The amount of air which is actually inhaled, compared with the theoretical amount if the engine could maintain atmospheric pressure, is called volumetric efficiency.

The objective of a turbocharger is to improve an engine's volumetric efficiency by increasing density of the intake gas (usually air). The turbocharger's compressor draws in ambient air and compresses it before it enters into the intake manifold at increased pressure. This results in a greater mass of air entering the cylinders on each intake stroke.

The power needed to spin the centrifugal compressor is derived from the kinetic energy of the engine's exhaust gases. A turbocharger may also be used to increase fuel efficiency without increasing power. This is achieved by recovering waste energy in the exhaust and feeding it back into the engine intake. By using this otherwise wasted energy to increase the mass of air, it becomes easier to ensure that all fuel is burned before being vented at the start of the exhaust stage. The increased temperature from the higher pressure gives a higher Carnot efficiency.

The control of turbochargers is very complex and has changed dramatically over the 100-plus years of its use. Modern turbochargers can use wastegates, blow-off valves and variable geometry, as discussed in later sections.The reduced density of intake air is often compounded by the loss of atmospheric density seen with elevated altitudes. Thus, a natural use of the turbocharger is with aircraft engines. As an aircraft climbs to higher altitudes, the pressure of the surrounding air quickly falls off. At 5,486 metres (17,999 ft), the air is at half the pressure of sea level, which means that the engine will produce less than half-power at this altitude.

The specification of turbo charger four-wheeler are given in Table1

Engine capacity (L)	Up to 7
Output range (hp)	100 to 310
Airflow (max)	0.46 kg/s

Length (mm)	250
Width (mm)	240
Mass (Kg)	16 to 17

Table 2 Temperature of inter cooler

	Water (°c)	Air (°c)
Inlet	48.89	110
Outlet	Unknown	82.22

II. OVERVIEW ABOUT SOFTWARE

A. CREO

Pro/Engineer, developed by PTC Corporation Ltd., is one of the world's leading CAD/CAM/CAE package. Being a solid modeling tool, it not only 3D parametric features with 2D tools, but also addresses every design through manufacturing process. Besides providing an insight into the design content, the package promotes collaboration between companies and provides them with edge over their competitors. In addition to creating solid models and assemblies,

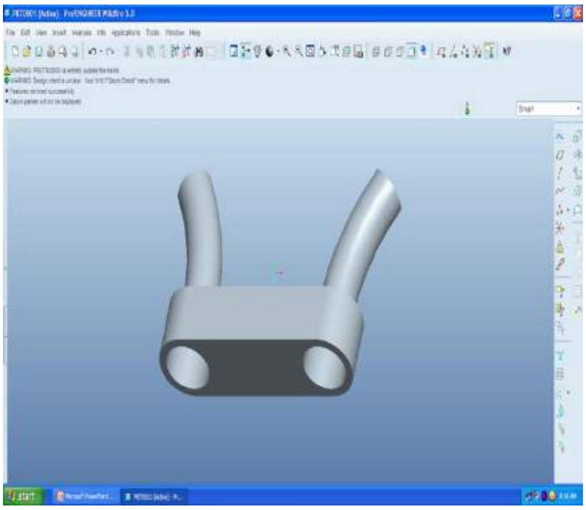

Fig.1. Modeling of contact plate in Creo software

2D drawing view can also be generated in the drawing mode of Pro/E. The drawing views that can be generated include orthographic, section, auxiliary, isometric or detail views. Pro/E uses parametric design principles for solid modeling. This modeling software provides an approach to mechanical design automation based on solid modeling technology. The essential difference between Pro/E and traditional CAD systems are the models created in Pro/E exist as 3D solids. Other 3D modelers represent only the surface boundaries of the model. Pro/E models the complete solid. This is not only facilitates the creation of realistic geometry, but also for accurate model calculations, such as those for mass properties. Dimensions such as angle, distance, and diameter control Pro/E model geometry. You can create relationships that allow parameters to be automatically calculated based on the value of other parameters. When you modify the dimensions, the entire model geometry can update according to the relations you createdPro/E is a fully associative system. This means that a change in the design model anytime in the development process is propagated throughout the design, automatically updating all engineering deliverables, including assemblies.

.

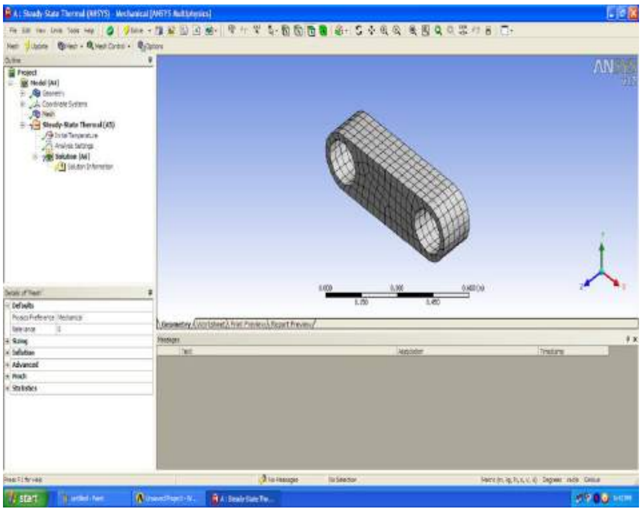

Fig.2. Mesh generated contact plate

B. ANSYS

ANSYS program is a general purpose program meaning that we can use it for almost any type of Finite Element Analysis virtually in any industry. General purpose also refers to the fact that the program can be suited in all disciplines of engineering Mechanical, Electrical, Thermal, Electromagnetic, Electronic, Fluid, Bio-Medical this is also used as an educational tool in universities and other academic institutions .ANSYS program has a comprehensive graphical user interface (GUI) that gives users easy, interactive access to program functions, commands, documentation and reference material. Intuitive menu system helper’s users navigate through the ANSYS program. User can input data using a mouse, keyboard or the combination of both. The ultimate purpose of a finite element analysis it to recreate mathematically the behavior of an actual engineering system. In other words, the analysis must be an accurate mathematical model of a physical prototype. In the broadest sense, this model comprises all the nodes, elements, material properties, real constants, boundary conditions, and other features that are used to represent the physical system. In ANSYS terminology, the term model generation usually takes on the narrower meaning of generating the nodes and elements that represent the spatial volume and connectivity of the actual system. Thus, model generation in this discussion will mean the process of defining the geometric configuration of the model’s nodes and elements.

Solid modeling is generally more appropriate for large or complex models, especially 3D models of solid volumes. With solid modeling, we have to describe the geometric boundaries of our model, establish controls over the size and desired shape of our elements and the instruct the ANSYS program to generate all the nodes and elements automatically. Solid modeling is usually more powerful and versatile than direct generation and is commonly the preferred method for generating our model.

It allows as working with a relatively small number of data items. It allows geometric operations (such as dragging and rotations) that cannot be done with nodes and elements. It supports the use of “Primitive” areas and volumes (such as polygonal areas and cylindrical volumes) and Boolean operations (intersections, subtractions, etc...) for “top down” construction of our model. Solid modeling facilities many design optimization features such as adaptive meshing, area mesh refinement after loads have been applied. It readily allows modifications to geometry; it facilitates changes to element distribution. However solid modeling can sometimes require large amounts of CPU time (for small and simple models).Sometimes be more cumbersome, requiring more data entries than direct generation. Can sometimes “fail” (the program will not be able to generate the finite element mesh) under certain circumstance. Direct generation is convenient for small or simple models. Provides as with complete control over the geometry and numbering of every node and every element . However, direct generation is usually too time consuming for all but the simplest models; the volume of data we must work which can become overwhelming. It cannot be used with adaptive meshing. It makes design optimization less convenient, difficult to modify the mesh (tools such as area mesh refinement, Smart sizing, etc.. cannot be used).It becomes tedious, requiring as to pay more attention to every detail of our mesh, tedium can sometimes cause as to become more prone to committing errors. With the direct generation method, we have to determine the location of every node and the size, shape and connectivity of every element prior to defining these entities in our ANSYS model. Although some automatic data generation is possible, the direct generation method is essentially hands-on,” manual” method that requires as to keep track of all our node numbers as we develop our finite element mesh.

III. RESULTS AND DISCUSSION

The contact plate six different materials are model is produced in CREO software and the inlet temperature is given in the ANSYS software. the outlet air temperature is plotted. In each and every different types of materials are having different range of temperature variation

The six different material are

1.Copper alloy
2.Diamond
3.Gold
4.Graphite
5.Silver
6.Slicon carbide

A. Temperature distribution of copper plate

The temperature distribution analysis of copper plate is given in the fig. The temperature distribution of exhaust pipe is 922.03K. The temperature distribution in turbocharger outlet pipe 856.14K.The copper plate has a high thermal conductivity. It has more corrosive resistance. Copper material are maintained high electrical conductivity and toughness.The contact plate is made with two passages and linings.The one passage is connected between engine exhaust and turbocharger inlet.The other passage is connected between intercooler outlet and engine air inlet.

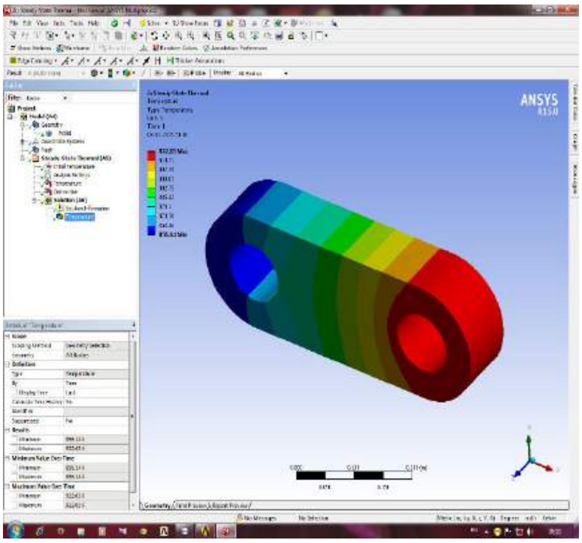

Fig.3.Temperature distribution copper plate

B. Temperature distribution of diamond plate

The temperature distribution analysis of diamond plate is given in the figure is modeled by Pro-E software and temperature analysis done by ANSYS software. The temperature distribution of exhaust pipe of the engine is 922.03K. The temperature distribution in turbocharger outlet pipe 860.68K. More amount of temperature distribution is takes place compared to copper plate.

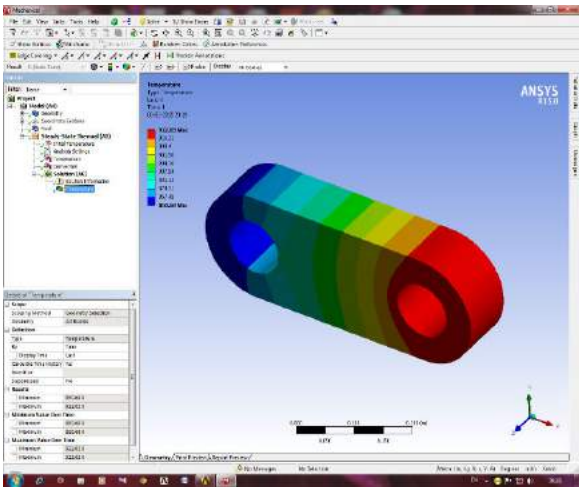

Fig. 4.Temperature distribution diamond plate

C. Temperature distribution of gold plate

The temperature distribution analysis of gold plate is given in the figure is modeled by Pro-E software and temperature analysis done by ANSYS software. The temperature distribution of exhaust pipe of the engine is 922.03K. The temperature distribution in turbocharger outlet pipe 849.18K. Less amount of temperature distribution is takes place compared to copper plate and diamond plate. The material cost is higher than the copper plate.

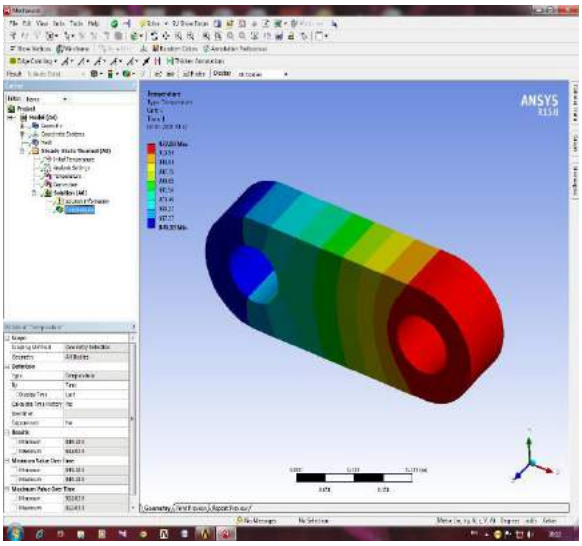

Fig.5. Temperature distribution of gold plate

D. Temperature distribution of graphite plate

The temperature distribution analysis of graphite plate is given in the figure is modeled by Pro-E software and temperature analysis done by ANSYS software. The temperature distribution of exhaust pipe of the engine is 922.03K. The temperature distribution in turbocharger outlet pipe 866.88K. More amount of temperature distribution is takes place compared to copper plate, diamond plate and gold plate. The material cost is higher than the copper plate.

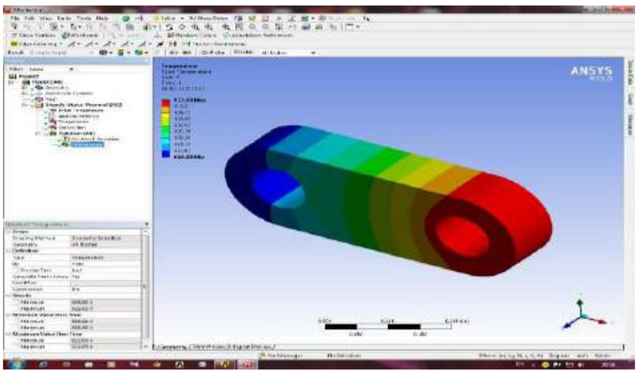

Fig.6. Temperature distribution of graphite plate

E. Temperature distribution of silver plate

The temperature distribution analysis of silver plate is given in the figure is modeled by Pro-E software and temperature analysis done by ANSYS software. The temperature distribution of exhaust pipe of the engine is 922.03K. The temperature distribution in turbocharger outlet pipe 856.85K. More amount of temperature distribution is takes place compared to copper plate, and gold plate Less amount of temperature distribution diamond plate and graphite plate. The material cost is higher than the copper plate. The properties of the silver plate is the thermal conductivity is higher. It corrosive resistance is higher compare to gold , diamond and copper .The temperature distribution difference is small variation of result compared between copper plate and silver plate. The temperature distribution figure of silver plate is given bellow.

.

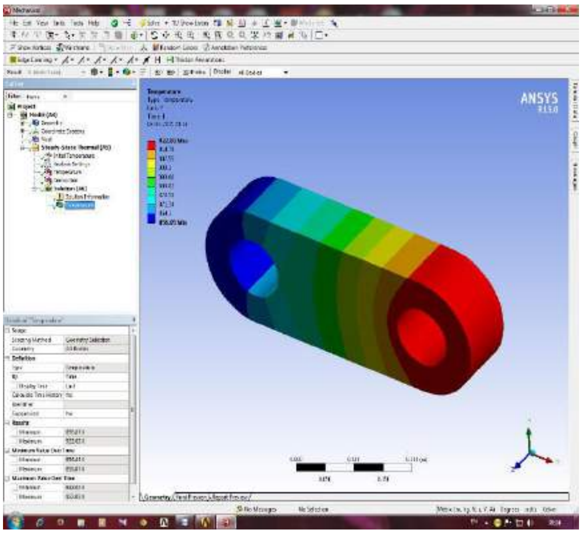

Fig. 7. Temperature distribution of silver plate

F. Temperature distribution of silicon corbide plate

The temperature distribution analysis of silicon corbide plate is given in the figure is modeled by Pro-E software and temperature analysis done by ANSYS software. The temperature distribution of exhaust pipe of the engine is 922.03K. The temperature distribution in turbocharger outlet pipe 860.06K. More amount of temperature distribution is takes place compared to copper plate, and gold plate Less amount of temperature distribution diamond plate and graphite plate. The material cost is higher than the copper plate. The properties of the silver plate is the thermal conductivity is higher. It corrosive resistance is lesser than compare to gold , diamond and copper .The temperature distribution difference is small variation of result compared between copper plate and silver plate. The temperature distribution figure of silicon carbide plate is given bellow.

.

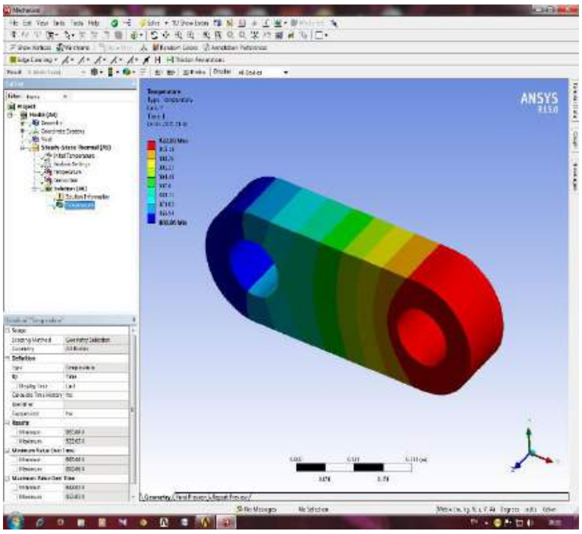

Fig. 8. Temperature distribution of silicon carbide plate

IV. ANALYSISCOMPARISONS

The contact plate six different materials are model is produced in CREO software and the inlet temperature is given in the ANSYS software. Among these six-different materials we chosen the copper alloy material. The thermal conductivity of copper material is 394W/mK. This is about twice that of aluminum and thirty times that of stainless steelmaterial.This means that copper is used for components where rapid heat transfer is essential. Thecopper alloy material is highresistance to corrosion. The temperature distribution of the copper plate has been 856.74K. Compare to the other material like gold, diamond and silver cost is low so copper plate is chosen.The thermal conductivity of copper is 394W/mK. This is about twice that of aluminium and thirty times that of stainless steel.This means that copper is used for components where rapid heat transfer is essential.Resistance to corrosion.

SNO	MATERIAL	TEMPERATURE DISTRIBUTION IN EXHAUST PIPE(K)	TEMPERATURE DISTRIBUTION IN TURBOCHARGER ONLET PIPE(K)
1	GOLD	922.03	849.18
2	SILVER	922.03	856.85
3	COPPER ALLOYS	922.03	856.14
4	DIAMOND	922.03	860.68
5	GRAPHITE	922.03	866.88
6	SILICON CORBIDE	922.03	860.06

V. CONCLUSION

From the study, the following conclusions can be deduced:

1. In this project an attempt has been made to design and analyses contact plate for waste heat recovery from C.I. energy exhaust, by implementing contact plate between turbocharger and intercooler.

2. Contact plate has been observed that the exhaust temperature of C.I. engine is more than 380 degree Celsius it can be used to reheat the air intake to the C.I. engine so that attempt can be made to improve its performance by using the waste heat recovery system.

3. The contact plate six different materials are model is produced in CREO software and the inlet temperature is given in the ANSYS software. The outlet air temperature is plotted. From the six material copper alloy material is choose as a contact plate because of their properties compare to other material.

4. Temperature distribution of exhaust pipe is 922.03K. The temperature distribution in turbocharger outlet pipe through the copper alloy contact plate is 856.14K.

5. In the diamond contact plate the temperature distribution of exhaust pipe of the engine is 922.03K. The temperature distribution in turbocharger outlet pipe 860.68K

6. In the gold plate the temperature distribution of exhaust pipe of the engine is 922.03K. The temperature distribution in turbocharger outlet pipe 849.18K.

7. In the graphite plate temperature distribution of exhaust pipe of the engine is 922.03K. The temperature distribution in turbocharger outlet pipe 866.88K.

8. In the silver plate temperature distribution of exhaust pipe of the engine is 922.03K. The temperature distribution in turbocharger outlet pipe 856.88K.

9. Silicon corbide plate the temperature distribution of exhaust pipe of the engine is 922.03K. The temperature distribution in turbocharger outlet pipe 860.06K.

References

[1] Chirtravelan.M ,Duraimurugan.k and venkatesh “design and fabrication of air pre heater for diesel engine”- ICMET 2015.

[2] Abhinay Nigam, Vishal Gehlot and Rishabh Samariya “Fabrication and Analysis of Regenerative Air-Preheater in Diesel Engine for Fuel Economy” – IJIEASR 2015

[3] Rajesh Kumar Sahu, Sidhartha Shankar Rat, Prabhas Beheramali and Gopabandhu Das “Performance Analysis of an Engine by Fabricating an Air Pre Heater for Petrol and Diesel Engine” – IJESTA 2016

[4] M.M.Z. Shahadat, M.N. Nabi, M.S.Akhter
and M.S.H.K. Tushar “Combined Effect of EGR and Inlet Air Preheating on Engine Performance in Diesel Engine”

[5] Saurabh Chaurasia1, Jitendra kumar Pandey and Mahendra Dawande “Performance investigation of four stroke diesel engine using preheated inlet air” – IJATES 2016

[6] Selvam S and Rajasekaran S “Performance and Emission Characteristics of PreHeating Diesel by Using Shell and Co-il Heat Exchanger in CI Engine” –JCPS 2016 [7] A.Rameshbabu and K.Arunkumar ”Increase Engine Efficiency Using Inlet Air Preheating Method through Exhaust Gas Temperature With Convective Mode of Heat Transfer” IJSER 2016.

[8] J.S.Jadho and D.G.Thombare “Review on Exhaust Gas Heat Recovery for I.C.Engine.”- IJIEASR2015