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Design and Thermal Analysis of IC Engine Valves using ANSYS

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ABSTRACT

In order to develop an exhaust valve with high thermal strength, experimental investigations are often costly and time consuming, affecting manufacturing time as well as time-to- market. An alternative approach is to utilizecomputational methods such as Finite Element Analysis, which provides greater insights on temperature distribution across the valve geometry as well as possible deformation due to thermal stresses. Thermal analysis is evaluating the thermal equilibrium of a system in which the temperature remains constant over time. In other words, thermal analysis involves assessing the equilibrium state of a system subject to constant heat loads and environmental conditions. This method significantly shortens the design cycle by reducing the number of physical tests required. Utilizing the computational capability, this research aims to identify possible design optimization of the exhaust valve for material and weight reduction, without affecting the thermal and strength.In this project we are using single metallic and bi-metallic valves in design and analysis of engine valves. Thermal and Total heat flux is determined in this analysis of different cases used for design of enginevalves.

KEYWORDS: Design Optimization 1, Exhaust Valve2, Finite Element Analysis3,Thermal Analysis4

INTRODUCTION

Exhaust valves are utilized in 4-stroke internal combustion engines to allow the exhaust gases to escape into the exhaust manifold. Due to the exposure to high temperature gases, exhaust valve design is of a crucial interest. Apart from high thermal stresses, these valves are also exposed to cyclic mechanical stresses during opening and closing, causing them to fail prematurely. It is quite evident that a common cause of valve fracture is fatigue. Valves fail due to cyclic loading at high temperatures. High temperature is also responsible for decrease in hardness and yield strength of valve material, and also causes corrosion of exhaust valves. As such, factors such as temperature, fatigue life, material strength and manufacturing processes are to be considered in order to design a valve that operates without premature failure. Exhaust valves with better material strength can provide significant benefits in cost reduction while also reducing its weight. Several material studies show that Magnesium alloy and Nimonic105A are some of the best suitable materials for exhaust valves. Modifyingthe exhaust valve by varying its position size and shape and with particular thermal and structural considerations, helps in increasing the rate of heat transfer from the seat portion of the exhaust valve, thereby reducing the possibility of knocking. Utilizing finite element analysis, exhaust valve design can be optimized without affecting its thermal strength.

A study is carried out on exhaust valve with and without air cavity using finite element approach. By creating an air cavity inside the valves stem, it acts as an insulating medium and prevents the heat flow; hence the need of providing insulation coating on valves is minimized. The main motive of this is to reduce the weight of engine and cost associated with thermal coating. Results observed in the engine valves revealed that after creating an optimized air cavity in the valve, thermal stresses and temperatures at all nodal points decrease lightly.

The exhaust valves open against pressure within the cylinder at the end of the working stroke. This pressure is considerably higher than against which the inlet valves have to open. Furthermore, the pressure of the exhaust gases assists, once the valve is open, in expelling the gasses through the open valve. Because of this consideration it is not unusual to find that exhaust valves are designed to be of a smaller diameter than the inlet valves. Both the inlet and exhaust valves may seat against the flame plate of the cylinder head. These valves seats become damaged during the operation and from time to time they have to be reconditioned by grinding-in the valves. This is required much more often in the case of the exhaust valves because they operate at higher temperatures and because the gases flowing through may contain particles of carbonaceous matter. These occasionally get trapped under the valve seat and cause pitting. The life of an exhaust valve between reconditioning can be extended if the thermal loads to which it is subjected can be evenly distributed around the valve.

This is accomplished by the rotating the valves slowly as the engine is working. Valve rotators which carry out this movement have a type of ratcheting mechanism the best known is the “Rotocap” type.

This indexes the valve round a smallamount every time it is operated by the rocker gear. In more recent designs the exhaust valves are rotated by the vanes fitted to the stem and driven by the gases expelled from the cylinder. The main advantage of this rotator is that the valve has still sufficient momentum to turn as the head comes to touch the seat, thus scraping off the deposit formed particularly in heavy oil fuel operation. Valves maybe assembled in cages which are removable from the cylinder head as separate units. Each valve cage, in addition of the valve itself, carries the seat ring, stem guide, and spring. When the seat ring wears, it may be renewed at low cost. The condition of the exhaust valve is influenced greatlyby the temperature at which it operates. To reduce its temperature the cage is cooled in the upper part near the guide and round the seat region as well. Water is conducted down an annular passage immediately behind the valve seat and back again. Cylinder heads are fitted with relief valves in order to draw attention to any abnormally high firing pressure. The setting of the spring is such that the pressure required to open the valve is 10% to 20%above the maximum combustion pressure. Provision is also made in the cylinder head to connect an indicator for measurement of cylinder pressures. Frequently this passage is combined with that of the relief valve. The starting air valve is also accommodated in the cylinder head. This is a non- return valve which will admit the compressed air required for starting purposes. It also prevents the high pressures which occur inside the cylinderduring the normal operation getting back into thestarting air system.

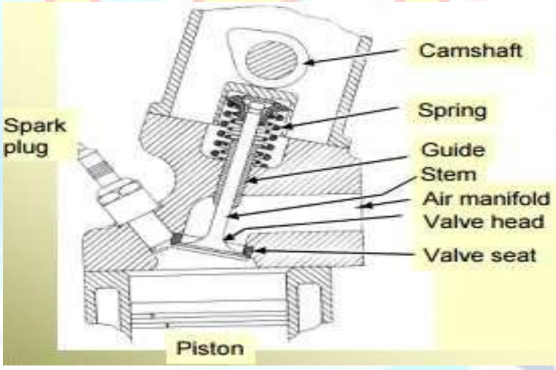


Figure:1. Exhaust valves

Internal combustion engines are without comparison, the most widespread transformer of chemical to mechanical energy. They were conceived and developed in the late 19th century and have had a significant impact on mankindand society since then. Although the understanding of engine processes has increased and new inventions as well as better materials have improved the design, the basic engine principle is still the same. Internal combustion engines can deliver power from 0,01 kW to 20 MW depending on engine size. The advantageswith internal combustion engines are their lowweight and small bulk compared to the output.

Basic principle, four-stroke engine

The four-stroke engine has as the name implies four distinctive cycles, and it takes two crankshaft revolutions to complete one four- stroke cycle. The cycles are: Intake stroke; a combustible mixture of air and fuel is drawn past the open inlet valve as the piston descends to bottom dead center, increasing the volume and creating negative pressure. Compression stroke; all valves are closed and the piston moves towards top dead center, compressing the charge before ignition takes place. Power stroke; as a result from the combustion of air- fuel mixture, the pressure pushes the piston towards bottom dead center. Exhaust stroke; the burned gases are released by the open exhaust valve. Figure 1 shows the four- stroke principle.

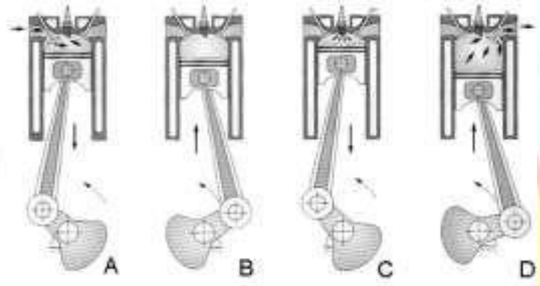


Figure Shows (A) Intake stroke, (B) Compression stroke, (C) Power Stroke, (D) Exhaust stroke

LUBRICATION SYSTEM

The purpose of the lubrication system is to reduce friction, avoid contact between surfaces, take away heat and protect materials from oxidizing. In engines different kinds of oil can be used to fulfil that task.

The oil film is usually very thin and the thickness of these films range from 1- 100 μm .

The most significant property of a lubricant is the viscosity and it is strongly dependent on the temperature, the shear rate and the pressure. Different fluids will have different dynamic viscosity and the relationship can be written as in equation 2.1.

$F = \eta \times A \times u/h$

Where F is the force needed to move one surface,η is the dynamic viscosity, u is the speed of separation between the surfaces, and h is the distance between the surfaces. With increasing temperature the viscosity falls rapidly and from an engineering viewpoint it is important to know the viscosity value at operating temperature, since it determines the film thickness separating the two surfaces. The lubricants are dilute polymer solutions, consisting of approximately 80% base oil and 20% additives. The additives can be wear and friction improvers, anti-oxidants, corrosion control additives and viscosity improvers. In the journal bearing the mechanisms of hydrodynamic film generation is known and was first presented by Osbourne Reynolds in 1886. Today, loads of several thousands of tons are carried at sliding speeds of 10 m/s to 50 m/s. The sliding surfaces are fully separated by a thin lubrication film and the friction coefficient is very low that is between 0,001 and 0,0005. In engine design the journal bearing in the crankshaft and the camshaft itself has to be examined to minimize friction and fulfil safe operating conditions. In the piston assembly and cam/ tappet the elastohydrodynamic lubrication have to be examined and appropriate materials and surface finishes and coatings must be chosen to minimize wear and friction. In most automotive engines the lubrication system consists of a pressure pump to feed the engine with sufficient oil during all running conditions. Some type of oil cooler to take away heat and keep the properties of the oil consistent is also needed, as well as an oil filter to protect bearings and surfaces from contamination and minimize wear.

COOLING SYSTEM

Due to the nature of internal combustion engines a vast part of the fuel energy is transformed to heat [4]. Coolant flow absorbs heat generated from engine combustion and engine friction. It is crucial to have continuous heat transfer to provide maximum efficiency and durability during all running conditions. The heat needs to be removed from the engine, and in vehicles that is done with air, water or oil. Air cooling is a simple and cheap way to cool the engine but it has some shortcomings regarding efficiency and running tolerances, and has therefore found application in less powerful engines. Water-cooling is the most common way of take away heat and is often mixed with some type of anti-freeze and/or anti-oxidation components. To further increase the heat transfer some type of additives can be added, for instance nanoparticles. Oil cooling is often used in engines to cool the pistons but it can also be used to cool the cylinder head as well .

In most engines the cooling system consists of a water pump, a radiator, a thermostat and a reserve tan

CRANK TRAIN

To transform the power from the gas pressure in the cylinder to a rotating motion, some type of mechanical device is used. In internal combustion engines the most common way is by using a crank train consisting of the crankshaft, the connecting rod, and a piston assembly. In this way the motion and acceleration of the piston gives rise to forces and torques that are transmitted to the engine block.

To minimize these, appropriate counterweights are often used. The layout of the engine, regarding the number of cylinders and angle between the cylinders has a big influence on the engine balance. To calculate the engine balance a separation between reciprocating and rotating masses is done.

VALVE TRAIN

The breathing capacity of the four-stroke engine is controlled by opening and closing areas into the cylinder where the poppet valve is now the universally used device. Sleeve and piston valves, rotary valves, slide valves etc. has so far never proved commercially successful [5]. The poppet valve is usually controlled by a camshaft, but there are other solutions like electro hydraulic, electromechanical or pneumatic hybridisation etc. that gives great freedom to control the valve events.

The valve motion with its high acceleration, raise the need for some type of valve return system, usually it is done with a steel spring but pneumatic or desmodromic devices have been used successfully. The camshaft can be located either below the valves or above the valves. Intake and exhaust valve lift profiles andtimings can be defined in order to take full advantage of pressure waves and dynamic pressure effects, while providing large gas exchange areas to improve the efficiency.

INDUCTION SYSTEM

The gas flow into the engine is unsteady and when controlled by a valve whose area changes with time, the intake pipe pressure alters because the cylinder pressure is affected by the piston motion causing volumetric change within space. Since thespeed of the air molecules is around 500 m/s at room temperature [11], the engine speed is always relatively much slower. This makes the filling of the cylinder very fast, and explains why even high rpm engines keep their efficiency. Because the performance characteristics of an engine are controlled by this unsteady gas motion, it is important to understand this flow mechanism thoroughly to improve efficiency.

The pressure wave in the intake is caused by the intake stroke of the piston and the rapid closure of the valve that gives a sudden stop to the gas column. The resulting pressure is reflected and will be reflected again, when it comes to a sudden area change like the bell mouth, but this time with opposite sign, there is now both expansion and compression waves in the inlet during the time thevalve is closed.

The pressure wave strength is depending on how many times it has travelled up and down the intake, as well as the design of the intake path. When the intake valve is open, the wave is still present and there will be some superposition of waves. If the design of the intake is made to benefit from these waves a volumetric efficiency over 100 % will be the result. To take full advantage of these waves, the inlet length should be fully variable to suit different engine speed.

The cross sectional area in the intake is responsible for the kinetic energy and pressure amplitude that takes place when the inlet valve closes. The common way to quantify the port quality is to test the intake port on a steady state flow rig. Higher flow is not always better since it can prevent the incoming air from creating a tumble motion, less charge motion and lower kinetic energy inside the cylinder affects the air/ fuel mixture and combustion efficiency.

Part of the induction system is the air- box and since it also has an unsteady flow, it will have some influence on the efficiency. The resonance inside the air-box is depending on engine configuration, volume and inlet design. It is essential with an even flow distribution between the cylinders.

EXHAUST SYSTEM

The purpose of the exhaust system is to minimize the required work to push out the residual gases and scavenging the cylinder from burned gases.

By designing the exhaust valve, exhaust port and pipe in order to get low backpressure and create an expansion wave that can be used at valve overlap, efficiency is improved.

At the exhaust valve opening, burnt gases exit the cylinder, and a compression wave starts to move to the open end where it will be reflected back as an expansion wave. With a tuned length of the exhaust pipe, there will be an expansion wave arriving at valve overlap that remove burnt gases and introduce fresh gases through the inlet valves, even if the piston motion is very low

The time needed for the wave to travel downstream and backwards depends on pipe lengths, the speed of sound (at that temperature) and the actual flow velocity. When the exhaust valve opens, the in-cylinder pressure is relatively high and sonic speed occurs inside the seat gap for a while and then become sub-sonic.

By introducing some stepping or tapering in the exhaust pipe, modulation of the wave will take place. In multi-cylinder arrangements it is common to have a branched collector with a secondary pipe that can further improve the scavenging of burnt gases to have an expansion wave arriving back at the collector junction just in time to meet the next exhaust pulse from another cylinder arriving down its primary exhaust pipe.

The secondary pipe length and diameter together with branch angle in the collector have some influence on the efficiency.

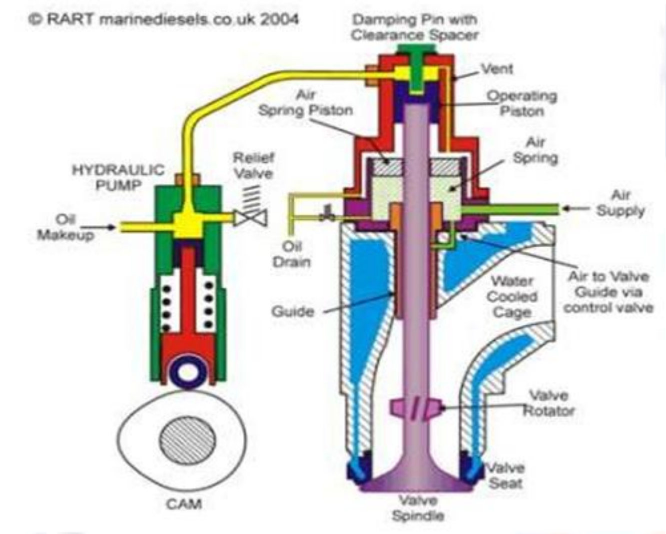


Figure: 2.valve train

When designing a valve train there is a general conflict between the demands for fast opening and closing of the valve at specific points that gives large valve accelerations. It is also important notto exceed the load limits.

To optimize the design within these constraints, consideration has to be made regarding not only the weight of the components but also the kinematics and dynamic characteristics of the components involved The valve spring is usually the softest component with the lowest frequency in the valve train. The contact between the windings gives a non-linearity of the spring, another phenomena is coil-clash, which has negative durability on the spring. By combining two or more springs there are more parameters available to satisfy the overall design requirements The cam profile was designed with full acceleration and jerk control together with the lift/area factor to improve durability and lessen vibrations and Hertz stresses.

From the calculated valve lift data, ADAMS/ Engine powered by FEV converted these to a cam profile that was used to machine a cam master for the cam grinder. Figure 6 shows the W-9 valve train layout from ADAMS/Engine.

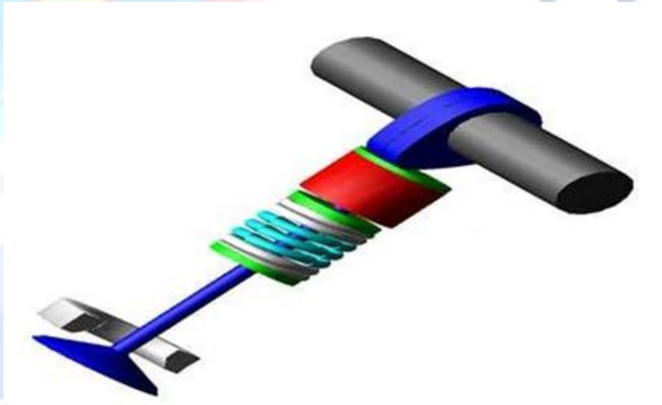


Figure: 3.engine valve of an IC engine

The induction ought to be free flowing and be able to maintain high kinetic energy to improve efficiency; it also has to mix the fuel to a homogenous gas before combustion takes place. With a large bore to stroke factor there is plenty of room for big inlet valves that leads to improved breathing capacity at high engine speed

The intake channel is convergent/ divergent to increase the kinetic energy and lessen the flowloss at the valve, tuning of the intake waves is also done by the design of the intake.

By making the intake downdraft, flowing is increased and a tumble motion of the incoming charge can take place inside the cylinder. A downdraft intake is also the choice in a W-engine, to clear the exhaust system from adjacent exhaust pipe.The optimum intake length from the valve to the bell-mouth can be calculated, and Blair hasproposed equation

$$Lit = a0 \times Crp1 / Np$$

Where L_{it} is intake duct length where intake ramming peak, a_0 is the local reference speed of sound in the intake duct, C_{rp1} is intake ramming factor, and N_p is engine speed where intake ramming takes place.

SPECIFICATIONS:

In the present work the stress concentration of exhaust valve is reduced using suitable fillet radius based on optimization of fillet radius. Because past research and experiences had indicated that during the operation of the internal combustion engine, the axial stresses are produced in exhaust valve due to cylinder gas pressure (compressive only) and the inertia force arising in account of valve spring action. At the same time it is subjected to overheating due to a very high temperature It results into the development of maximum stresses at the fillet section of the exhaust valve. Hence the problem statement is "To design the valve with modeling & structural analysis and to optimize it based on valve fillet radius. So, that it can withstand to given operating conditions. Further material selection is to be done based on analysis

LITERATURE SURVEY

The literature survey regarding use of additive with fuel in-cylinder turbulence inducement aspect investigated are reviewed and discussed in this chapter The increase in demand for petroleum fuels and consequent depletion of their reserves has given rise to the need for investigating new energy resources or finding the optimum way of using the present resources. In this regard, two approachesare pursued Improving refining processes for producing better quality fuel from different crude oils, that is, tailoring fuel at the refining stage, and Using some additives for improving the quality of existing fuels to a desired level, which is, improving performance of available fuel The effects of fuel quality variations on diesel engine emissions is complicated by the wide variation of the engine response to the fuel quality changes and the extent of inter-correlation of the various fuel variables. In engine literature, many investigators have reported.

Kouremenous et al. (1999) examined the effect of the fuel composition and physical properties on the mechanism of combustion and pollutant formation. A number of fuels having different density, viscosity, chemical composition, (especially aromatics type), are used in their investigation and found that the fuel properties namely density and viscosity are more important than fuel composition (aromatics) in respect of engine performance and emissions. The total aromatic content, however, has more influence on engine performance and emissions rather than the individual aromatics.

METHODOLOGY

Two and four-stroke engines have different capabilities that may be desirable to combine. For a same engine volume, fourstroke generate a better part load consumption while two- stroke engines give higher specific power and torque output. For this to happen in four-stroke operation, the engine volume needs to be at least double of that of the two-stroke mode. This requires more fuel consumption, greater and heavier parts that may not be economically produced. For a similar engine displacement although two-stroke operation consumes more fuel than the four-stroke option, this is effectively lower than increasing the engine displacement. On the negative side, two-stroke Poppet valve ported engines produce higher levels of pollutants than the four-stroke ones, which is obtained at the expense of having more engine components. A possibility of overcoming their problems is to run a poppet valve spark ignition internal combustion engine configuration. In this case the main problem is the camshaft timing operation and configuration to allow for the increase/decrease of the camshaft speed when varying between the firing operations. Intake and outlet valves are very essential engine elements that are utilized to regulate the flow and interchange of gases in internal combustion engines. They are utilized to close the functioning area within the cylinder as per the manifolds and are opened and closed through what is identified as the valve train apparatus. valves of Internal combustion engine are the accuracy engine elements. They open and close as and when required. The newfuel mixture is enters through inlet valves and the parts of burning fuel get discharged to atmosphere during exhaust valves. There are variouskind of engine valves utilized by the manufactures; some common kinds of valves being poppet valves, slide valves, rotary valves andsleeve valve.

POPPET VALVE:

A poppet valve is a directional controller valve and is usually considered as presence a high stream, fast performing design because of the large stream paths through the main form of the valve. Usually, the poppet valve can be opened relatively rapidly. The inlet valves are designed from plain nickel, nickel chrome. While outlet valves are crafted from nickel chrome, silicon chrome steel, excessive velocity metal, stainless steel, high nickel chrome, tungsten metallic and cobalt stainless steel. With the assist of these elements, valve performs its function precise as it should be in internal combustion engine. The valve spring, keeps the valve pressed towards its seat and make sure a leakage proof operation and additionally convey again the valve right away throughout its ultimate. When the engine is started out, it receives heated up step by step thereby inflicting the valve stem to expands. The clearance placed in outlet valve is barely extra than that of inlet valve. This is because of barely greater growth in exhaust valve due to higher temperature of hot exhaust gases producedat some stage in combustion.

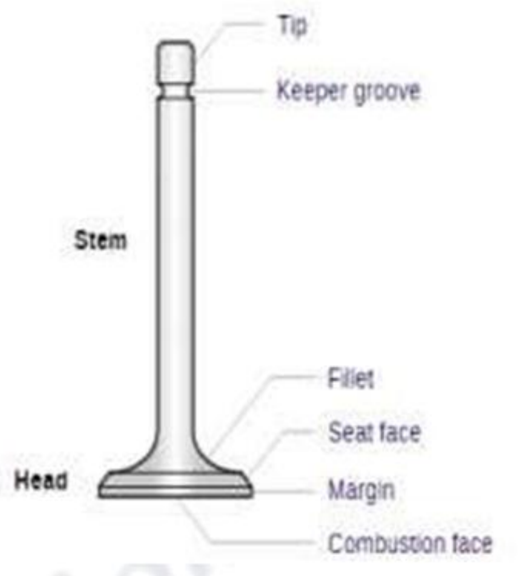


Figure: 4.Nomenclature of Poppet valve

FILE COMPATIBILITY AND CATIA V4/V5 /V6 CONVERSION

`Dassault Systèmes provides utilities to convert CATIA V4 data files so they are accessible to CATIA V5 and CATIA V6. Still, cases show that there can be issues in the data conversion from CATIA V4 to V5 from either difference in the geometric kernel between CATIA V4 and CATIA V5 or by the modelling methods employed by end users. The percentage loss can be minimized by using the appropriate pre-conversion clean-up,choosing the appropriate conversion options, and clean-up activities after conversion. Conversion from CATIA Version 4 to Version 5 created construction problems for the Airbus A380 which caused to in additional costs due to years of project delays when aircraft wiring was too short to make connections.

Figure shows the design of the engine valve using CATIA

Case1: Single Metallic Valve:

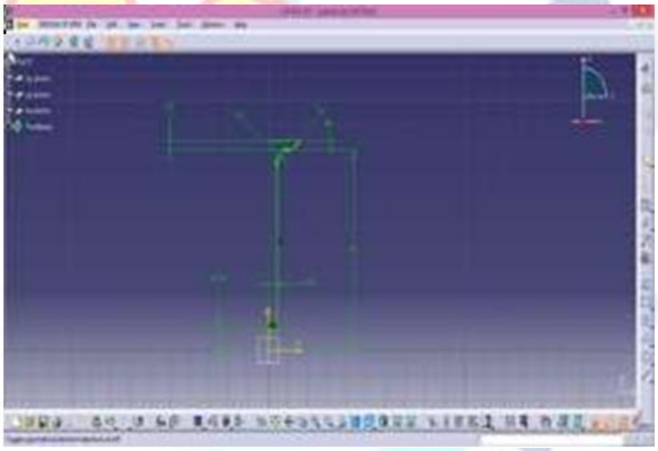


Figure:5.Single Metallic Valve

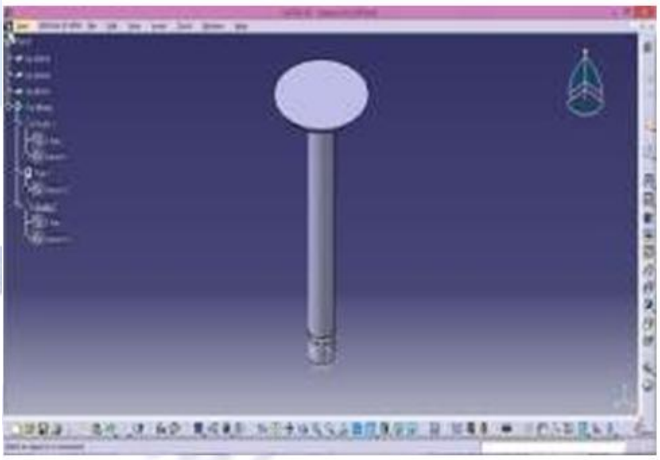


Figure:6.Bi-Metallic Valve:

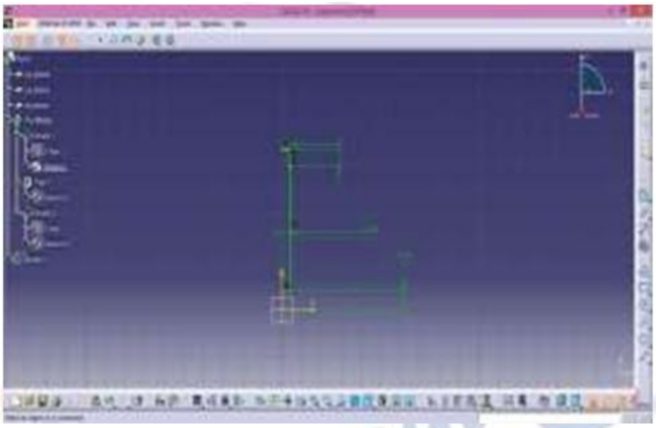


Figure:7.Bottom Part

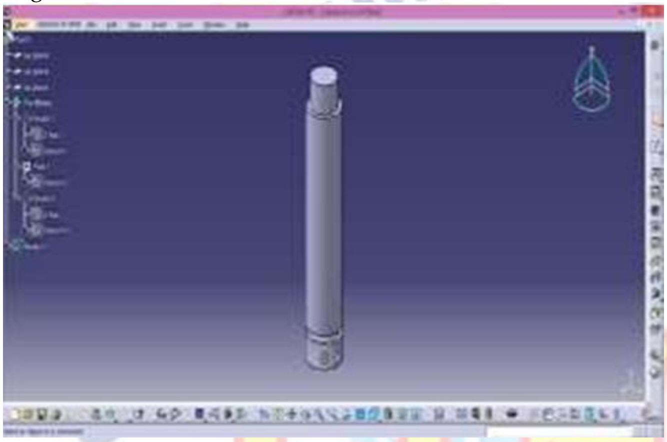


Figure:8.Top Part

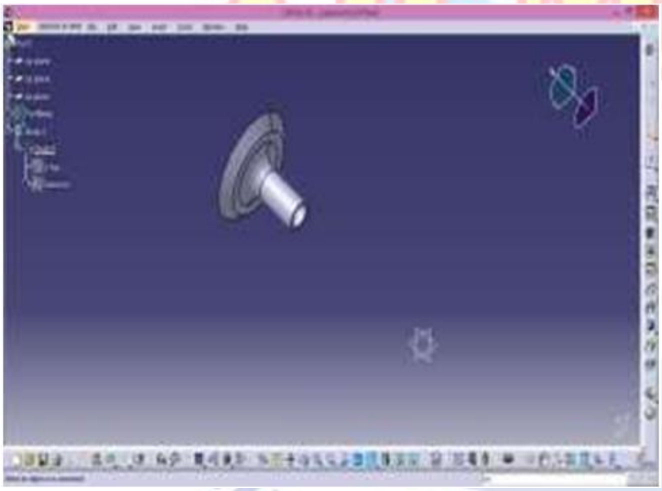


Figure:9. Complete Part

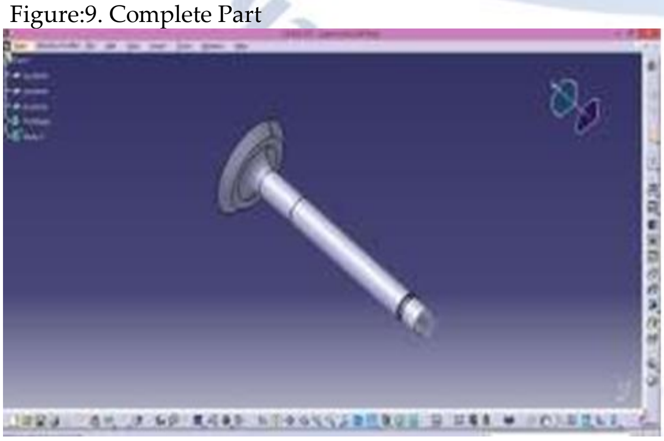


Figure:10. overall view

MESHING

- The Figure shown is the meshed model of rigid flange coupling in the ANSYS analysis for the static structural process. To analyse, the FEM triangular type of mesh is used for the rigid flange coupling in the ANSYS environment.
- The number of elements used in this meshing is 71441and the number of nodes is 122228.In this process regular type of meshing is done to analyse the process.
- Using the working condition of the coupling a relative rotational movement between the shafts comes into picture consequently.
- The determination of the shear stress along the contact region is essential. So, the model is meshed and then analysed to get the detail and authentic result of the stresses of the contact region.

Figure shows the total meshing of the engine valve

Case1:

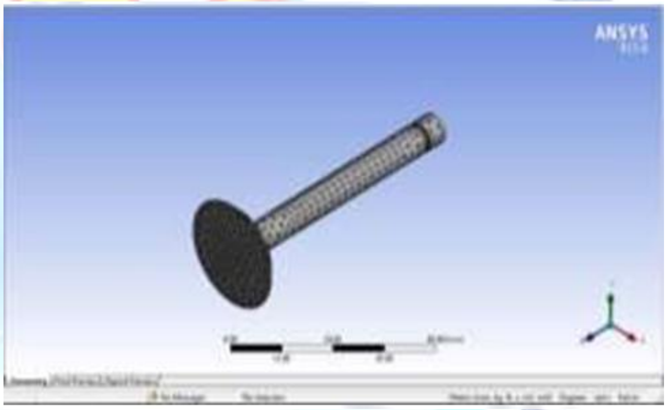
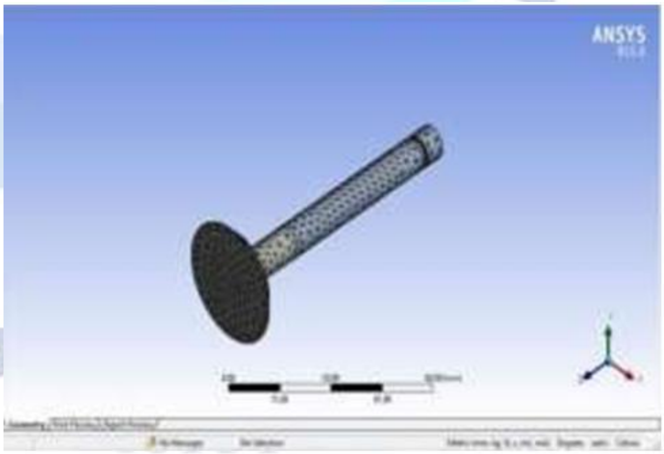


Figure:11. meshing model case-1



Mathematically, the Poppet Valve model to be investigates is subdivided into a mesh of finite sized elements of simple form. Within each component, the difference of displacement is assumed to be calculated by simple polynomial profile functions and nodal movements. Equations for the strains and stresses are generated in terms of the unidentified nodal deflections. From this, the equations of equilibrium are assembled in a matrix form which can be easily programmed.

MATERIAL PROPERTIES:

Structural steel considered as material in presentstudy. Properties of material are described below.The various boundary conditions and load is imposed on the FEA model and three different kinds of the stress field, named as thermal stress field, mechanical stress field can be obtained. Here two type of poppet valve designed for study i.e poppet valve with chamfer and poppet valve with fillet. the dimension of fillet or chamfer varies

Table: Material Properties for Structural steel

Structural Steel	
Density	7850kg/m^3
Poisson ratio	0.3
young's modulus	200000 MPa
tensile ultimate strength	460mpa
tensile yield strength	250mpa
thermal conductivity	60.5w/m/c
coefficient of thermal expansion	1.20e-05

Analysis of Poppet valve with variations of fillet radius The purpose of this fillet is to streamline the gases so they will pass freely out of the exhaust manifold. Most poppet valves are made at an angle of forty-five degrees, and being round they permit, the exhaust gases to rush towards each other in a circle and under terrific pressure at an enormous velocity. This actually creates a vacuum that completely scavenges the cylinder. Poppet valve analyzed in ANSYS with fillet radius of 3 mm, 6 mm and 10 mm.

RESULTS

Modelling of Poppet valve Modeling of the Poppetvalve of I.C. Engine done using Solidwork has been explained in detail. The intention of finite element investigation is to reconstruct the mathematical behavior of an actual engineering structure. Here two type of poppet valve designed for study i.e. poppet valve with chamfer and poppet valve with fillet. the dimension of fillet or chamfer varies. The model includes all the nodes, elements, material functions, real constants, boundary circumstances and extra features that are used to characterize the physical system. First model be generated then specific boundary conditions will be applied on the specific nodes then final analysis will be conducted.

Analysing the model in ANSYS After designing the model in Solid work, the. IGS FILE has been converted to IGES format. This configuration allows the design to be compatible in the ANSYS software. After importing the design in ANSYS,the process of analysis begins The Poppet valve is designed following to the process and requirement which are specified in machine design and datareference books

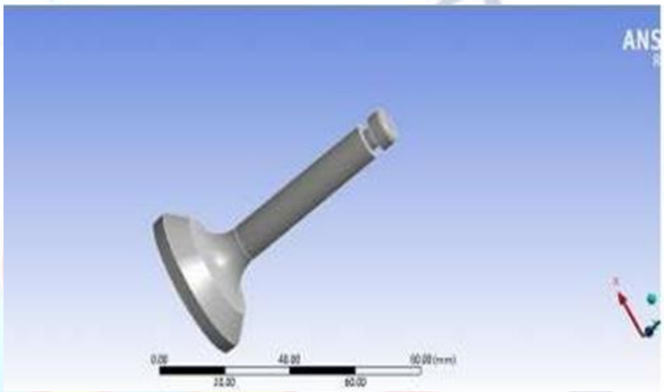
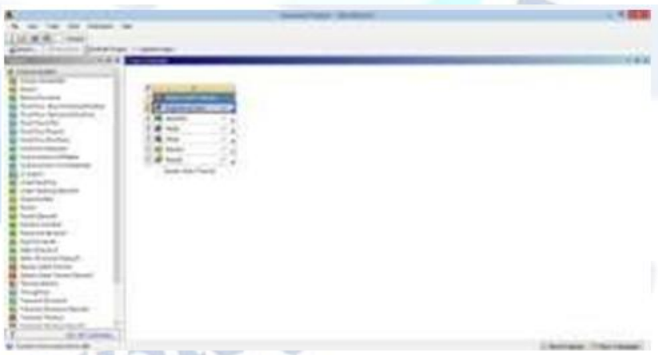
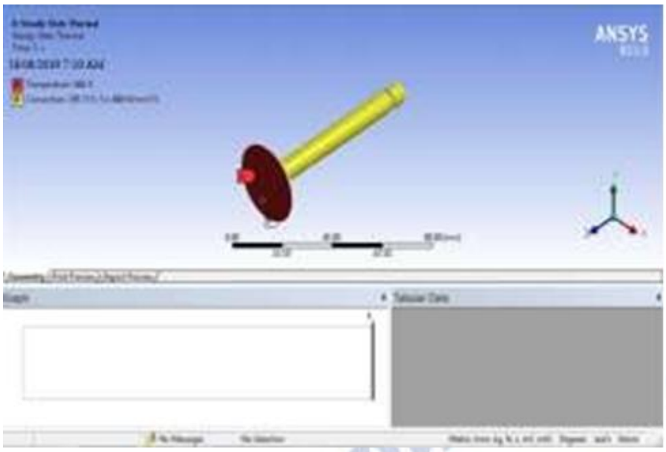


Figure : 12.Model of Poppet Valve

The following are the analysis part of the engine valves of different types. This shows the temperature and heat flux analysis of the enginevalve



Boundary Conditions:



Case1: Single Metallic Valve:

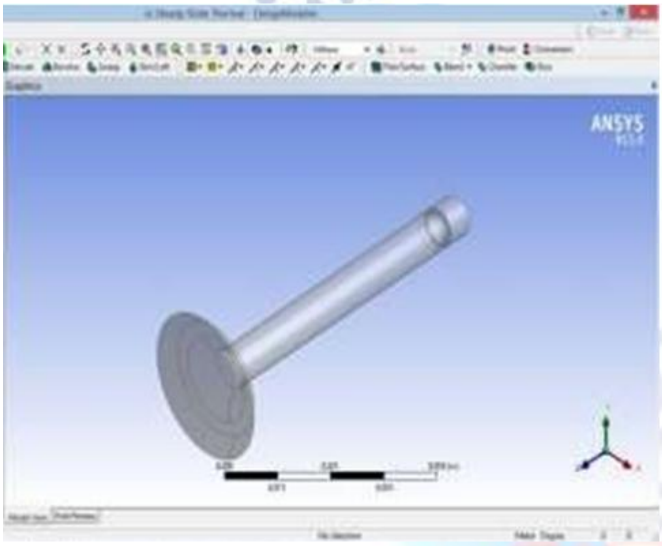


Figure:13.Design Modeller

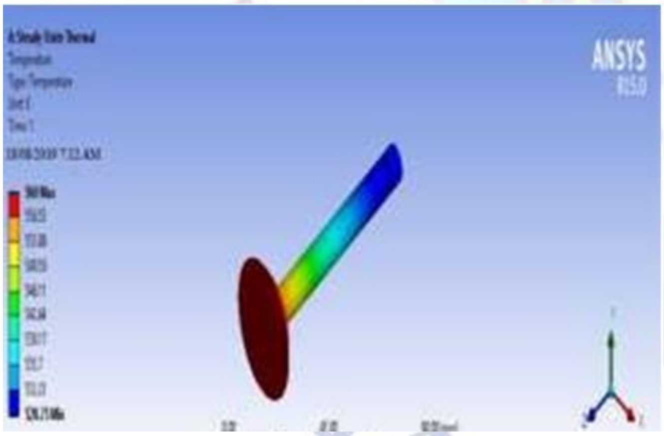


Figure:14.Temperature

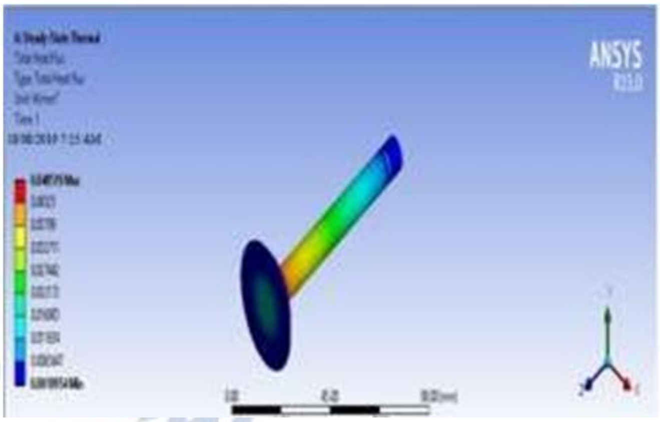


Figure: 15.Total Heat Flux:

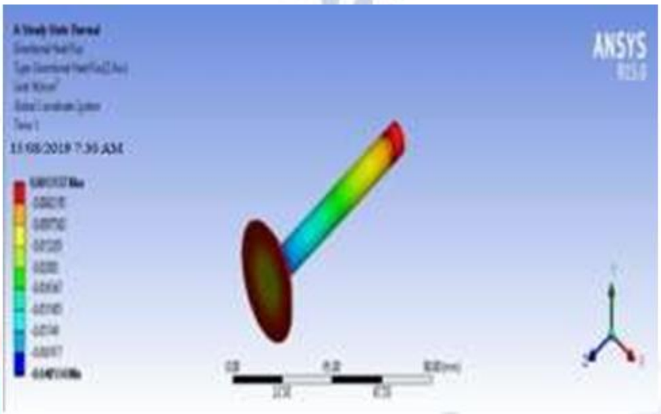
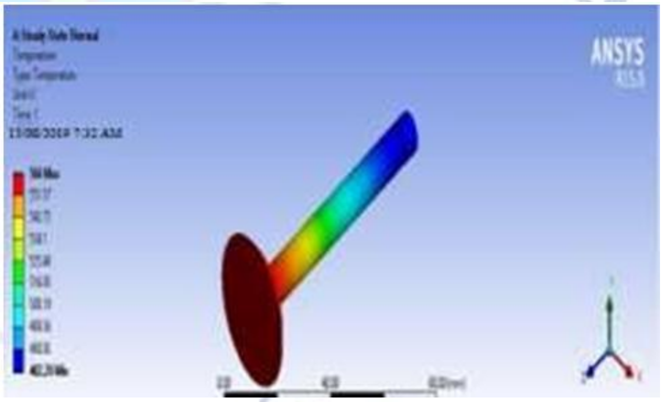


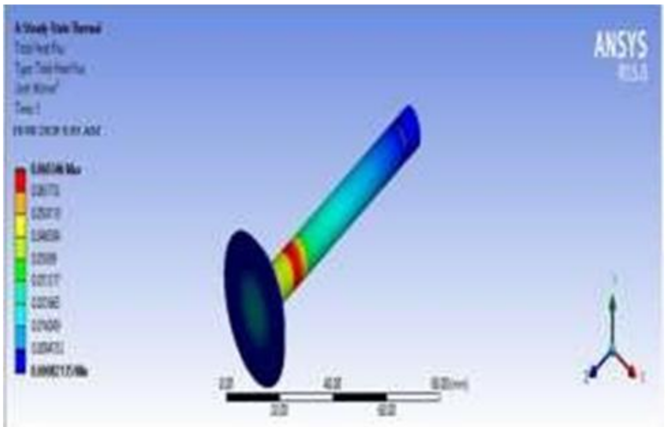
Figure: 16.Directional Heat Flux

Case2: Bi-Metallic Valve:

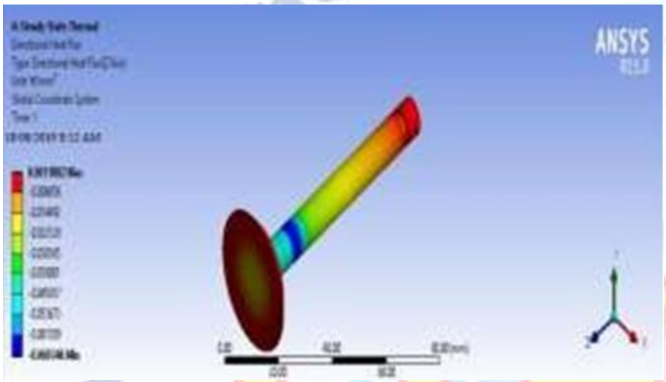
Temperature:



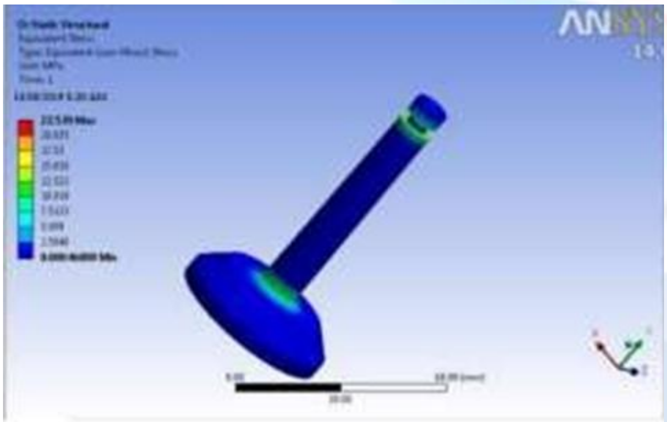
Total Heat Flux:

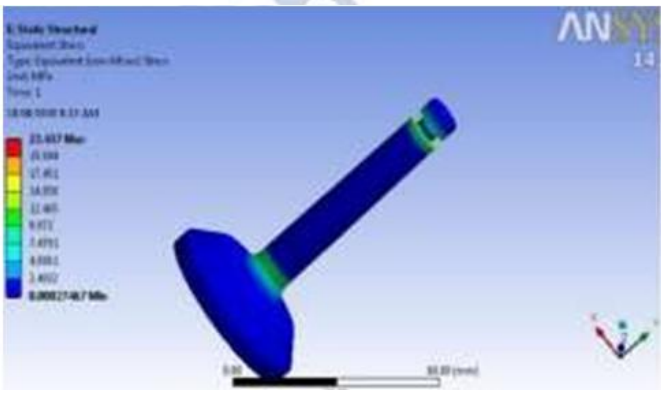


Directional Heat Flux:



Thermal stresses analysis in ANSYS of Poppet valve with fillet radius:





Poppet valve with 3mm fillet radius(b) Poppet valve with 6 mm fillet radius

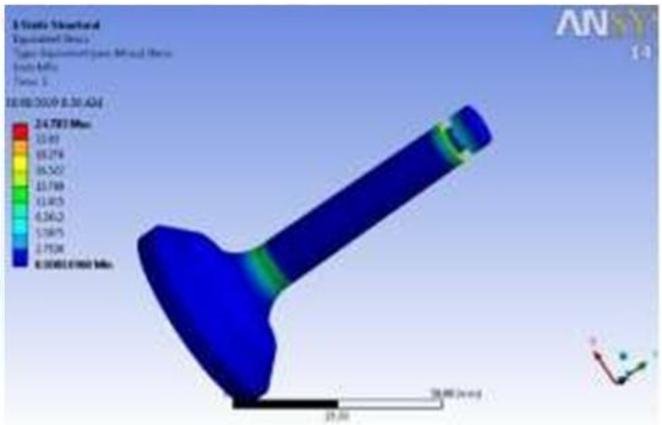
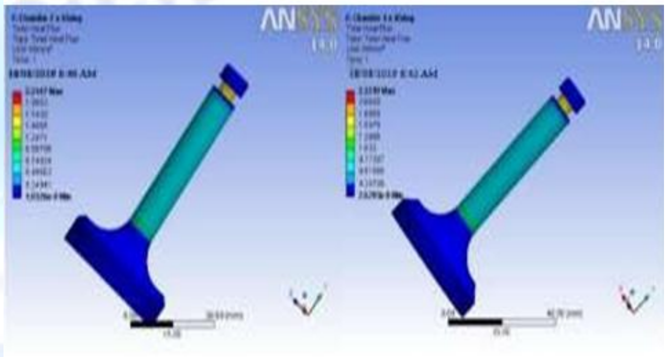


Figure:17. Thermal stresses of Poppet valve with 10 mm fillet radius

Heat Flux analysis in ANSYS of Poppet valve with various chamfers:

Heat flux analysis on ANSYS shows for poppet valve with chamfer of 2 mm, 4 mm and 6 mm at 45 degrees of each and in figure 10 and 11 with 2 mm chamfer shows maximum heat flux found 2.2447 W/mm2 . Minimum heat flux found 1.9326e-9 W/mm2 .



valve with 2x 450 mm chamfer (b) Valve with 4 x 450 mm chamfer

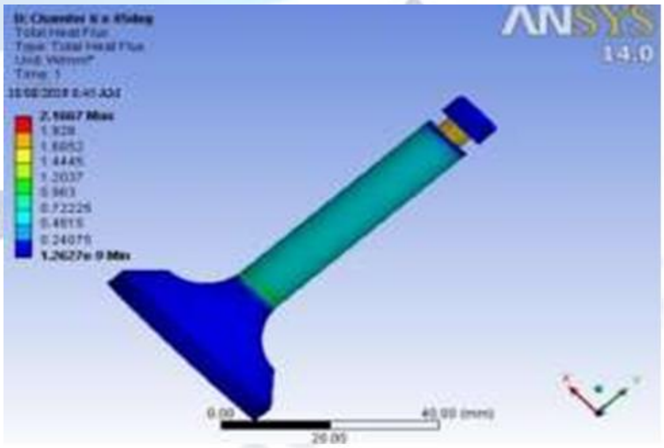
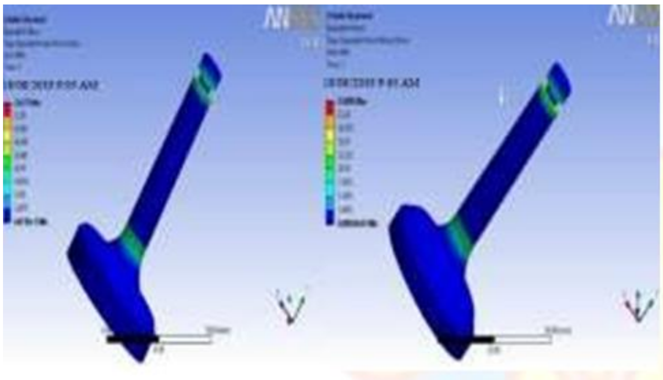


Figure:18. Heat flux of Poppet valve with 6x 450 mm chamfer the Thermal stresses distribution with 2 mm, 4 mmand 6 mm at 45 degrees of each.



Valve with 2x 450 mm chamfer (b) Valve with 4x 450 mm chamfer

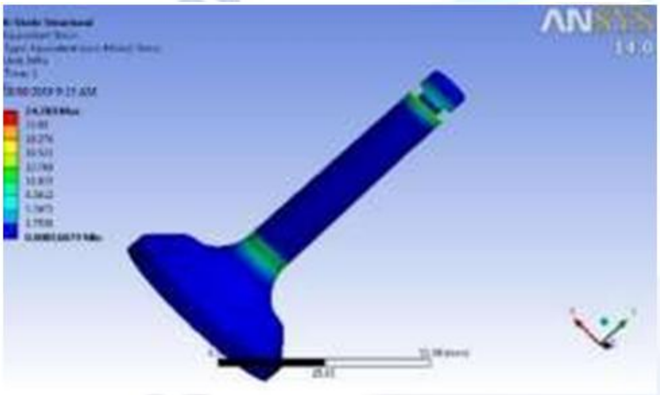


Figure: 19.Thermal stresses of Poppet valve with 6x 450 mm chamfer

The Inlet outlet valve plays a major role in the engine performance; The maximum stress intensity is on the bottom surface of the valve surface in both fillet and chamfer are studied in this analysis. Highest value of maximum temperature found in Poppet valve is due to thermal conductivity of the materials and the total maximum heat flux is absorbed in both the Poppet valve materials. Thus, further research can be carried with the advance materials and different designing, analysis tools.

Table : Thermal stresses and heat flux variations due to various fillet Radius

Fillet	Maximum Thermal Stress (Mpa)	Maximum Heat Flux (W/mm^2)
3mm	22.539	0.853
6mm	22.437	1.94
10mm	22.783	0.899

Table: Thermal stresses and heat flux variationsdue to various Chamfers

Chamfer	Maximum Thermal Stress (Mpa)	Maximum Heat Flux (W/mm^2)
2*45deg	24.277	0.932
4*45deg	23.805	0.964
6*45deg	24.783	0.899

As per above study it is concluded that higher thermal stresses found in chamfer profiled poppet vales and fillet radius valve having low thermal stresses and higher heat transfer so that is it concluded that fillet applied design is best for valve for designing in IC engine

CONCLUSION

In this analysis, the thermal simulating of poppet valve and its function in thermal conditions of engine and without establishing of combustion in cylinder was considered. We have done the model for the designed model by using Solid work software. We conducted Steady State thermal analysis at inlet and outlet condition using Single metal for the Poppet valve with applying fillets and chamfers. We have also conducted thermal analysis

- In this project we are using single metallic and bi-metallic valves in design and analysis of engine valves.
- Thermal and Total heat flux is determined in this analysis of different cases used for design of engine valves.
- By comparing temperatures in both cases bi-metallic valve is having more temperature drop.
- By comparing total heat flux in both cases bi-metallic valve is having more heat flux than single metallic valve.

As per study following conclusions are made.

- Valve basics and materials and its operating are studied in detail which will be useful in further part of work.
- Design of valve is done based on given specifications with study of valves and its failure modes.
- Maximum thermal stress found 24.783 MPa at 6 mm chamfer at 45 0 angle.
- Minimum thermal stresses found 22.437 MPa at 6 mm fillet radius.
- Maximum heat flux found at 6mm fillet radius of

poppet valve.

- Hence it is clear that 6 mm fillet radius of poppet valve is best and safe for designing of I.C. Engine inlet and outlet valve

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