DESIGN AND STATIC THERMAL ANALYSIS OF EXHAUST VALVE USING VARIOUS MATERIALS WITH FEM

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ABSTRACT

In engines, valves are essential components for better working of the engine. The Intake and exhaust valves are used to control the flow and exchange of gases. These valves seal the working space inside the cylinder against the manifolds and are opened and closed with the valve train mechanism. Smooth-running of an internal combustion engine is possible because of the exhaust valve. The role of the exhaust valve is to pass on the exhaust gases to the exhaust manifold from the combustion chamber. During the operation of the internal combustion engine, exhaust valves are subjected to the axial stresses due to exhaust gas pressure, cyclic stresses due to return spring load, thermal stresses due to very high temperature inside the combustion chamber, and inertia forces arising on the account of the valve assembly. This project aims to design and do the static and thermal analysis of the poppet valve used in CT engines. Modelling of the valve was done with the help of Catia V5 and static-thermal analysis was carried out in the ANSYS Workbench. Here we are using four materials i.e, Ti-4.5Al-3V-2Fe2Mo, SILICON NITRIDE, AISI 4340, NIMONIC 80A. Finally we suggested the best material for poppet valve from these materials.

1. INTRODUCTION

Introduction to I.C Engine Parts

Introduction to I.C Engine Inlet and Outlet Valves:

Now a days I.C engine is being used for various applications such as the automobile industry, construction, machinery, trucks of the coalmine, industrial applications, etc. we know that the I.C. engine is a power generating system that is the reason which its applications are rapidly increasing. An IC engine consists of two types of valve Inlet valve and Exhaust valve. The diesel engine has several important components, which perform various functions and are subjected to different stresses, forces, and thermal loadings. Out of these many important components of engine Inlet & Exhaust, valves are most important and their operation should be particularly taken care of. The functioning of valves is well studied using a valve timing diagram. The function of the Inlet valve is to provide the path for air to now into the combustion chamber. The function of the Exhaust valve is to remove the combusted gases out of the cylinder i.e. when the fuel and air mixture has been ignited in the cylinder, the spent gases arc sent out of the engine through this valve. So these exhaust gases carry high temperatures with them. Due to the exposure to high-temperature gases after combustion, exhaust valve design is of crucial interest. During the power stroke, both the inlet and exhaust valves arc subjected to high temperatures of 1 930°C to 2200°C, therefore, it is necessary to take care of the materials of the valves such that they should withstand those higher temperatures.

The valves used in internal combustion engines are of the three types

1. Poppet or mushroom valve
2. Rotary valve
3. Sleeve valve.

Out of these three valves, the poppet valve is very frequently used. It consists of the head, face, and stem. The head and face of the valve are separated by a small margin to avoid sharp edges and also to provide provision for the regrinding of the face. The face angle varies from 30° to 45°generally. The lower part of the stem is provided with a groove in which a spring retainer lock is installed. The poppet valve derives its name from its popping movement up and down. This is also known as a mushroom valve because of its shape which is similar to a mushroom. It consists of a head and a stem. It possesses certain advantages over the other valve types because of which it is extensively used in automotive engines.

The advantages are

1. Simplicity of construction
2. Self-centering.
3. Free to rotate about the stem to the new position.
4. Maintenance of sealing efficiency is relatively easier.

Generally, inlet valves arc larger than the exhaust valves, because the velocity of incoming charge is less than the velocity of exhaust gases which leave under pressure. Further, because of pressure, the density of exhaust gases is also comparatively high. Moreover, a smaller exhaust valve is also preferred because of the shorter path of heat flow in this case and consequent reduced thermal loading. To study the thermo elastic behavior of the valve, the literature related to the thermo elastic analysis of engine components has been studied. Since in the past, most of the studies of automobile components were carried out for thermo elastic analysis by considering it as a case of two dimensional. A valve system is the main component of a diesel engine. A valve system controls the amount of air to be drawn into the cylinder and exhaust gas to be discharged from the exhaust manifold. The purpose of the valve in the cylinder of the engine is to admit the air in the C.I. engine and to force out the exhaust gases. Also, the valve opens and closes the connection between the cylinder and the exhaust manifolds during the work of the engine. The exhaust valve is subjected to complex thermo-mechanical loading. The mechanical load is acted by the spring force during the closing of the valve and the valve had to contact with hot exhaust gases which are at High temperatures due to which the non-uniform temperature causes the thermal loading on the valve. This reduces the fatigue and static Properties of valve material.

Poppet Valve

A poppet valve is a type of check valve often associated with kill and chokes lines or pressure control equipment. A poppet valve is a directional control valve and is typically characterized as being a high flow, fast-acting design due to the large flow paths through the main body of the valve. Usually, the poppet valve can be opened relatively quickly. The inlet valves are made from plain nickel, nickel-chrome, or chrome molybdenum. Whereas exhaust valves are made from nickel chrome, silicon chrome steel, high-speed steel, stainless steel, high nickel

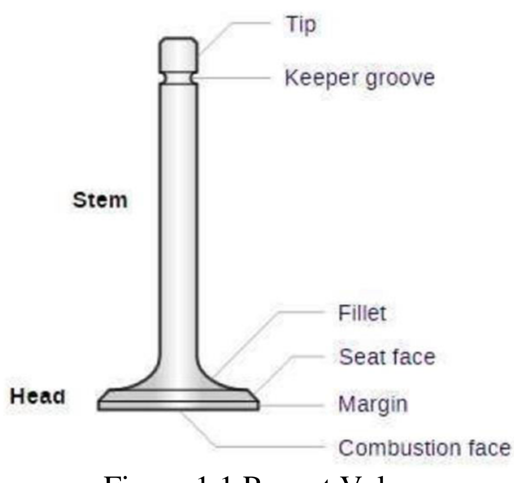

Figure 1.1 Poppet Valve

chrome, tungsten steel, and cobalt chrome steel. With the help of these parts, the valve performs its operation very accurately in the internal combustion engine. The valve spring, keeps the valve pressed against its seat and ensures a leakage-proof operation, and also brings back the valve very quickly during its closing. When the engine is started, it gets heated up gradually thereby causing the valve stem to expand. The clearance provided in the exhaust valve is slightly more than that of the inlet valve. This is due to slightly more expansion in exhaust valve because of higher temperature of hot exhaust gases produced during combustion. Valves are the most important part of every engine, So due care must be taken in the selection and maintenance of the valve.

Working Principle of Exhaust Valve

Both the inlet and exhaust valves are mounted on the cylinder heads. These are the very crucial parts of the engine. These valves play a vital role in the working of the engine. An Inlet valve is used for letting the air into the cylinder which operates by the action of Tappet movement, allows air and fuel mixture into the cylinder. The exhaust valve is used for the removal of burnt exhaust gases of high temperature after combustion to escape out of the cylinder. Generally, inlet valves are larger than the exhaust valves, because the velocity of charge entering into the cylinder is less than the velocity of exhaust gases that leaves out of the cylinder under high pressure. Because of the high pressure of gases coming out of the cylinder, the density of exhaust gases is also comparatively high. Moreover, a smaller exhaust valve is also preferred because of the shorter path of heat flow and consequent reduces thermal loading. Valve efficiency depends 011 many characteristics like Hardness, Face roundness, and sliding properties capable to withstand high temperature, etc. The pressures and temperatures that are induced using various types of fuels and their combustion characteristics will affect the valves because they will be exposed to different mechanical and thermal stresses. There are many types of valves out of which the Poppet valve is the more advanced valve. This type of valve used in our project is a poppet valve. lt is also called a mushroom valve. This valve is typically used to control the timing and quantity of gas or vapor flow into an engine'. The poppet-valve is most commonly used because this will offers reasonable weight, good strength, and good heat transfer characteristics. The most popular shape of the poppet valve is that it has a stem and head for automobile application. The valve stem is placed in a guide hole made centrally in a circular passage in the cylinder head. The positioning of Valves may be vertically or slightly inclined relative to the cylinder axis, matching the desired combustion chamber contour. Poppet valves have different configurations within the engine relative to the cylinders. The poppet valve derives its name from its popping movement up and down. It possesses certain advantages over other types of valves because of which it is heavily used in automotive engines.
The advantages are

1. Construction of valve is very simple
2. It is self-centered.
3. lt is free to rotate about the stem to the new position.
4. Sealing efficiency maintenance is relatively easy.

Exhaust Valve Material Requirements: The material of the exhaust valve should have the following properties if consider operation conditions:

1. To resist tensile loads material should have high strength and hardness.
2. To avoid excessive thermal stresses in the head the coefficient of thermal expansion should be of the least value.
3. High hot strength and hardness to combat head cupping and wear of seats.
4. There should be high corrosion resistance.

Aim of The Project

1. Designing the poppet valve by considering the CI engine specifications.
2. Obtaining design of poppet valve using CATIAV5 and then importing it in Ansys 16.2
3. Meshing of design model using ANSYS 16.2.
4. Analysis of poppet by using static analysis and thermal analysis method.
5. Comparing the performance of four different materials Ti-4.5Al-3V-2Fe2Mo, SILICON NITRIDE, AISI 4340, NIMONIC 80A poppet under structural and thermal analysis process.

Methodology

1. Analytical design of Exhaust valve, using the specification of CI E G INE
2. Creation of a 30 model of exhaust valve using CATIA VS and then imported in ANSYS 16.2
3. Analysis of poppet valve using the FEA method.
4. Comparing the performance of different materials used for analysis.
5. Selecting the Best Material for exhaust valve material.

Problem Identification

Improper material leads to the material exhaust valve is a major component in engine sometimes the heavy load is not sustained in static and thermal conditions some materials Specification of the problem In exhaust valve, there is a sudden change in cross-section due to presence of valve stem as a small shaft and valve head as a small disc, which is a functional requirement of the exhaust valve. Such a discontinuity in the cross of the exhaust valve generates maximum stress concentration at the junction where there is an abrupt change in cross-section. It is impossible to eliminate the presence of stress concentration but its reduction is possible to some extent. Thus problem statement is "to design the valve with modeling & static-thermal analysis by selecting suitable material for exhaust valve finally select suitable material for exhaust valve based on static and thermal results.

2. LITERATURE SURVEY

2.1 Background Information

Sanoj.T et al.2014 [l] analyzed the stress-induced in a valve due to high thermal gradient and high pressure inside the combustion chamber. In the first stage of analysis, the temperature distribution across the valve was determined. In the second stage found displacement.

Deepak Bhargav et al. 2016 [2] evaluated uncoated and coated engine valve with and without the application of bond coat. From the results decrease in heat flux, mechanical stress, and total deformation with coated engine valve with a bond coat while increases in stress were observed. Bond coat gave better wear and corrosion resistance. **Sagar.S Deshpandeet al. 2014 [3]** analyzed the effect of varied materials and geometric parameters on mechanical properties of poppet engine valve to improve its performance over life and fatigue life using ANSYS software. B Seshagiri Rao et al (2014) had designed the exhaust valve for four wheeler petrol engine using theoretical calculations. 3 D model and transient thermal analysis are to be done on the exhaust valve when the valve is open and closed. Study state condition is attained at 5000 cycles at the time of when the valve is closed is 127.651 seconds valve is opened 127.659 seconds. The material was used for the exhaust valve is EN52 steel.

Karan Soni et al. 2015 [4] concluded valve design can be optimized to reduce its weight, without affecting permissible stress and deformation values. Reduction in strength improves the valve strength. The different works arc performed on the exhaust valve for different parameters in recent years. **LucjanWitek et al. [5]** worked on Failure and thermo-mechanical stress analysis of the exhaust valve of diesel engine. In this work the failure analysis of the exhaust valve of diesel engine was performed. To explain the reason for premature valve damage, the non-linear finite element analysis was utilized. The results of stress analysis performed for the valve with the carbon deposit showed, that in the valve stem high bending stress occurred. **Kum-Chui et al. [6]** presented a Study of Durability Analysis Methodology for Engine Valve Considering Head Thermal Deformation and Dynamic Behavior the authors describe the problem of exhaust valve fracture of gasoline engines. From the results, it was found thatthe maximum stress occurred at the stem region and that the stem region is the same region at which higher temperatures occurred. The stress at the valve head is similar to the stress under the combustion pressure condition, but the stress on the valve neck goes up to a high level where the failure occurred. **Yuvraj K Lavhale et al. [7]** had studied the overview of failure trends of inlet and exhaust valves. There are different causes for the failure of the exhaust valve such as fatigue failure, wear, thermal loading, failure due to corrosion-erosion which leads to degradation of mechanical properties of valve material and its performance. **B.E. Gajbhiye ct al. [8]** done Vibration Testing and Performance Analysis of IC Engine Exhaust Valve Using Finite Element Technique Author had performed the Modal analysis of valve using FEA software. It was found that the Stem of the valve is the most affected zone. The deformation is observed at the bottom side of the valve. The reason for exhaust valve damage may be high vibrations at resonance frequency values which arc slightly greater than the natural frequency of the exhaust valve. **Naresh Kr. Raghuvanshi et al. [9]** had studied the failure analysis of internal combustion engine valves. According to the authors, the main reasons for valve failure are overheating, decrease the strength of the material at high temperature, oxidation, and impact load **A.S.More et al. [10]** presented the analysis of valve mechanism and in that; they performed the kinematic and dynamic analysis of engine. **M. H. Shojaefard et al. [11]** carried out an analysis of heat flow between the seat and valve of ICE. **Nurten Vardar et al. [12]** performed an investigation of exhaust valve failure in heavy-duty diesel engines. **T.T.Mon et al. [14]** carried out t1nite element analysis on thermal effect of the vehicle engine. In this work, the focus is given to the thermal and mechanical behavior of exhaust valves made of different materials. The analysis suggests the best material among them, which can be used for the construction of an exhaust valve. **Ch. Mani Kumar et al. [15]** carried Valves in LC. for input and exit. The motors are known as valves for a poppet. These valves are regulated by the mechanism of the valve. When these valves are subjected to thermal stress, they are designed to be extremely critical in theprediction and prevention of failures in the valves, so that thermal analysis can be carried out with the intention of modeling and simulating 99.3cc thermal analysis of poppet valves. **S.K. Rajesh Kanna et al. [16]** concluded Valve output was improved in this research by coating alloy Al-Si on the engine valve's surface. Testing for alloy-covered valves, Al-Si has shown that mechanical characteristics have improved without affecting their performance. **B Seshagiri Rao ct al. [17]** studied by theoretical calculations, the exhaust valve for a four- wheel gasoline engine. The 2D drawings method is measured, and the 3D model and transient thermal analysis arc performed on the exhaust valve when the valve is opened and closed. Analysis in ANSYS is performed.

3. PROPOSED SYSTEM

Overview of Project

1. Have sufficient mechanical strength and stiffness.
2. Design of poppet valve by using CATIA software and analysis using Ansys software.
3. Can effectively block the heat reached the Poppet surface.
4. High-temperature corrosion resistance.
5. Finally concluded the suitable material for poppet valve on these materials Ti-4.5Al- 3V-2Fe2Mo, SILICON NITRIDE, AISI 4340, NIMONIC 80A

Specification of the Problem

Improper material leads to failure A exhaust valve is a component of engines. It is the moving component valve head as a small disc, which is a functional requirement of the exhaust valve. Such a discontinuity in the cross of the exhaust valve generates maximum stress concentration at the junction where there is an abrupt change in cross-section. It is impossible to eliminate the presence of stress concentration but its reduction is possible to some extent. Thus stress concentration levels can be reduced by selecting suitable material. Thus problem statement is "to design the valve with modeling & structural -thermal analysis by selecting suitable material based on static-thermal values for which stresses are less and recommending the best alternative material.

Valve Drawing with Design Dimensions

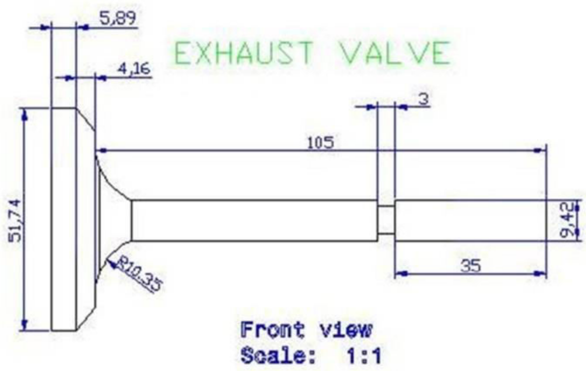

Figure 3.1 Poppet Valve

Force Calculations

Force acting on exhaust valve	Formula	Values
Force due to gas pressure (F_G)	$F_G = \frac{\pi}{4} d_2^2 P_c$	946.14 N
Inertia force (F_A)	$F_A = m \times \alpha' = 2m \pi^2 \omega^2 h / \Theta cam^2$	36.15 N
Initial spring force (F_I)	$F_I = \frac{\pi}{4} d_2^2 P_s$	52.56 N
Total force (F_T)	$F_T = F_G + F_A + F_I$	1034.85 N

Figure 3.2 Force Calculations

Forces Acting on the Valve The tensile force generated due to inertia (F1,=36. I 5 N) and compressive force due to gas pressure and initial spring force (FG + F1 = 946.14+52.56 = 998.7)

Material Selection

NIMONIC 80A Material

Nimonic 80A Super alloy is a nickel-chromium-based material that offers excellent corrosion and oxidation resistance. The alloy is precipitation hard enable with additional alloying elements of aluminum, titanium, and carbon. The product is a wrought, age-hardenable material developed to operate in service temperatures up to 815° C (1500°F). Nimonic 80A performs well in any application where high temperature and continual stresses is a significant consideration. Traditionally, it is used in applications requiring these characteristics such as gas turbines and in nuclear generators; in the motorsport sector, material applications include exhaust valves in rac111g engines and spindles and fasteners. Supplied in the solution treated condition, which makes it easier lo machine, subsequent aging treatment results in very high mechanical performance properties with outstanding resistance to creep and fatigue. The corrosion resistance of Nimonic 80A in oxidizing atmospheres is excellent - this includes heating and cooling conditions. This protection is due to the chromium oxide film formed on the surface of the alloy, which also offers resistance at elevated temperatures. The machinability of the alloy is also improved; it can be readily formed and welded using conventional welding methods.

AISI 4340 Material

AISI 4340 is nickel-chromium-molybdenum alloy steel known for its toughness and its ability to attain high strengths in heat-treated conditions. It has very good fatigue resistance. This alloy, 4340, may be heat treated to high strength levels while maintaining good toughness, wear-resistance, and fatigue strength levels, combined with good atmospheric corrosion resistance, and strength. Commercial and military aircraft, automotive systems, forged hydraulic and other machine tool applications, forged steel crankshafts. Forging should be carried out between 2250 and 1800°f (1230 and 980 ° C.). Parts should be slow cooled after forging in ashes or sand etc. AISI 4340 steel is a medium carbon, low alloy steel known for its toughness and strength in relatively large sections. AISI 4340 is also one kind of nickel-chromium-molybdenum steel. 4340 alloy steel is generally supplied hardened and Tempered in the tensile range of 930 - 1080 Mpa. Pre hardened and tempered 4340 sheets of steel can be further surface hardened by flame or induction hardening and by nitriding. The 4340 steel has good shock and impact resistance as well as wear and abrasion resistance in
hardened conditions. AISI 4340 steel properties offer good ductility in the annealed condition, allowing it to be bent or formed. Fusion and resistance welding is also possible with our 4340 alloy steel. ASTM 4340 material is often utilized where other alloy steels do not have the hardenability to give the strength required. For highly stressed parts it is an excellent choice. AISI 4340 alloy steel can also be machined by all customary methods.

Silicon Nitride Material

Silicon Nitride is a man-made compound synthesized through several different chemical reaction methods. Parts are pressed and sintered by well-developed methods to produce a ceramic with a unique set of outstanding properties. Silicon nitride (Si_3N_4) was developed in the 1960s and '70s in a search for fully dense, high strength, and high toughness materials. A prime driver for its development was to replace metals with ceramics in advanced turbine and reciprocating engines to give higher operating temperatures and efficiencies. Although the ultimate goal of a ceramic engine has never been achieved, silicon nitride has been used in several industrial applications, such as engine components, bearings, and cutting tools. Silicon nitride is a man-made compound synthesized through several different chemical reaction methods. Parts are pressed and sintered by well-developed methods to produce a ceramic with a unique set of outstanding properties. The material is dark gray to black and can be polished to a very smooth reflective surface, giving parts a striking appearance. High- performance silicon nitride materials were developed for automotive engine wear parts, such as valves and cam followers, and proven effective. The cost of the ceramic parts never dropped enough to make the ceramics feasible in engines and turbochargers. The very high- quality bodies developed for these demanding high-reliability applications are available today and can be used in many severe mechanical, thermal, and wear applications.

Ti-4.SAl-3V-2Fe2Mo Material

Grade Ti l0V 2Fe 3Al alloy is a near-beta alloy that was mainly developed to suit airframe forging applications. This alloy has a unique combination of excellent hot-die forge ability and excellent high strength toughness and deep hardenability. Grade Ti 1 0V 2Fe 3Al alloy is hard to machine but can be successfully done using slow speeds, high coolant flow, and high feed rates. Tooling should be performed using tungsten carbide designations Cl-C4 or cobalt- type high-speed tools. Materials Properties

MATERIALS	Density g/cm^3	Poisson's Ratio(µ)	Young's modulus (Mpa)	Tensile strength(Mpa)	Thermal conductivity w/mk
NIMONIC 80A	8190	0.30	210000	1250	12.3
ATST4340	7850	0.28	200000	745	44.5
SILICON NITRIOE	3310	0.27	310000	450	20
TI-4.5AL-3V-2F - 2MO	4540	0.32	110000	1023	11

4. RESULTS

The constructed exhaust valve in CATIA is analyzed using ANSYS Vl6.2 and the results are depicted below. Combustion of gases in the combustion chamber exerts pressure on the head of the exhaust valve. Fixed support has been given at the surface of the exhaust valve top part because the exhaust valve will move from up and down.

AISI 4340 Material

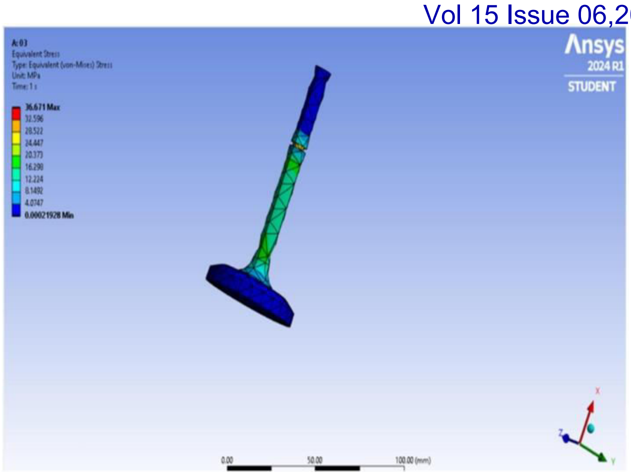

Figure 7.1 Vonmisses Stress of AISI 4340 Material

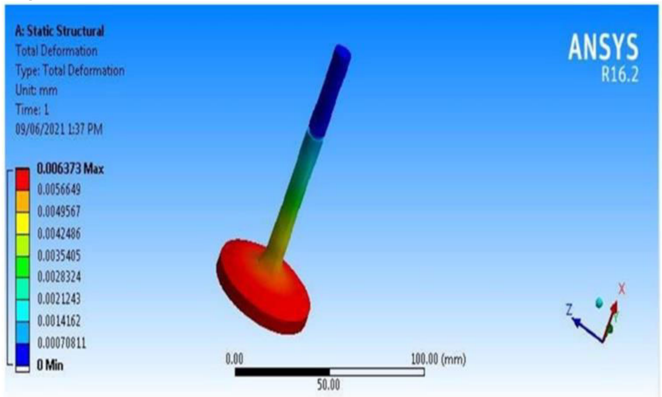

Figure 7.2 Total Deformation of AISI 4340 Material

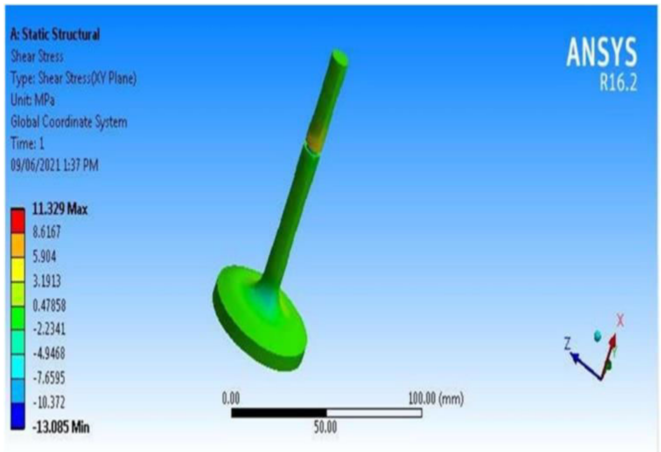

Figure 7.3 Shear Stress of AISI 4340 Material

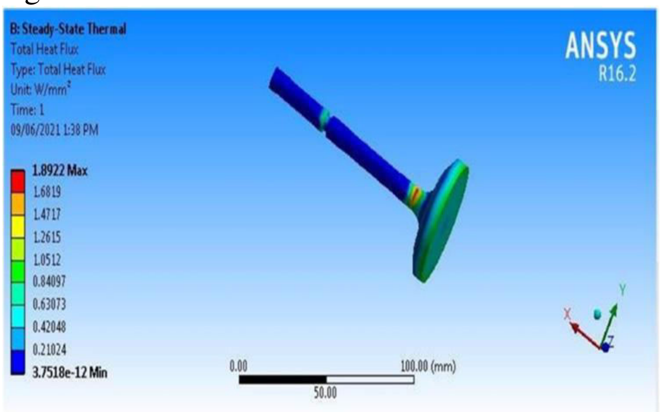

Figure 7.4 Total Heat Flux of AISI 4340 Material

NIMONIC 80A Material

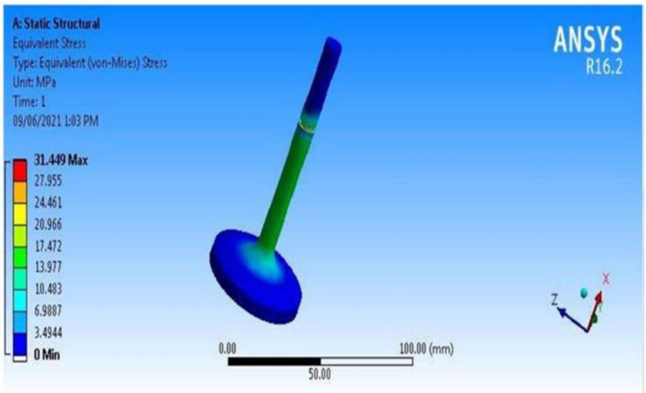

Figure 7.5 Vonmisses Stress of NIMONIC 80A Material

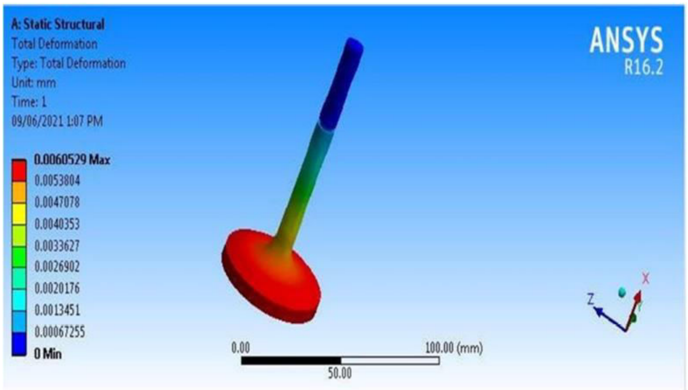

Figure 7.6 Total Deformation of NIMONIC 80A Material

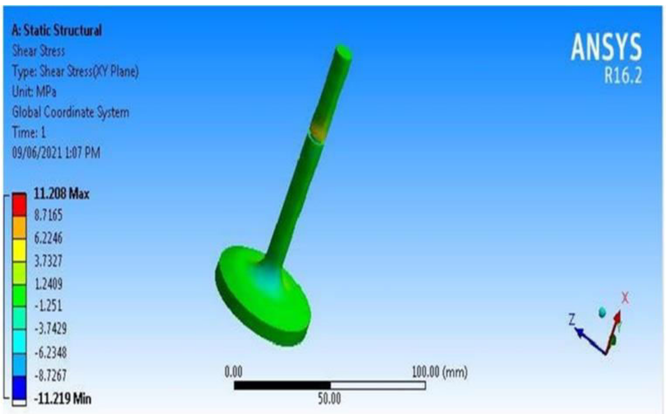

Figure 7.7 Shear Stress of NIMONIC 80A Material

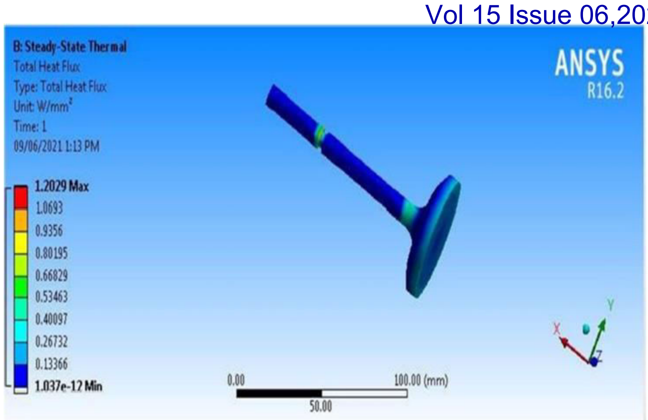

Figure 7.8 Total Heat Flux of NIMONIC 80A Material

Silicon Nitride Material

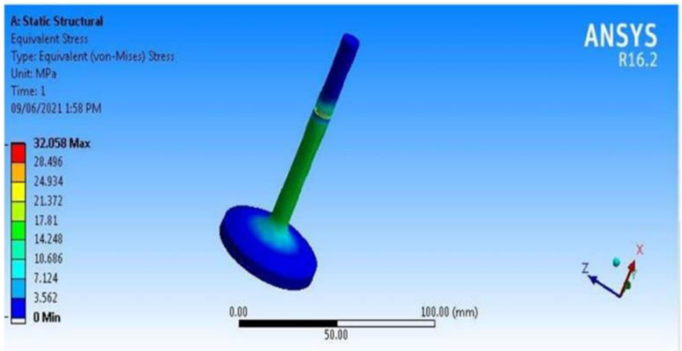

Figure 7.9 Vonmisses Stress of Silicon Nitride Material

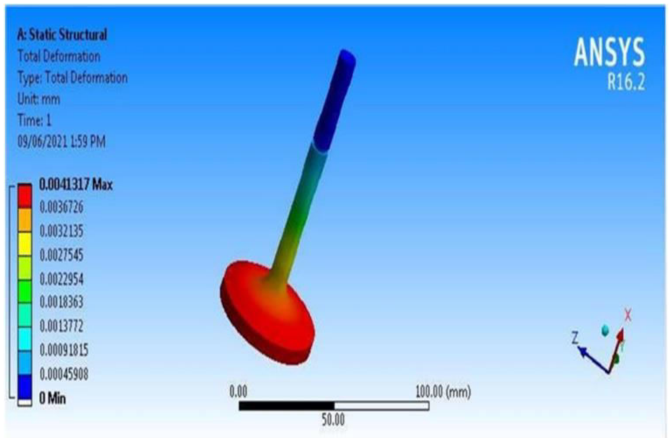

Figure 7.10 Total Deformation of Silicon Nitride Material

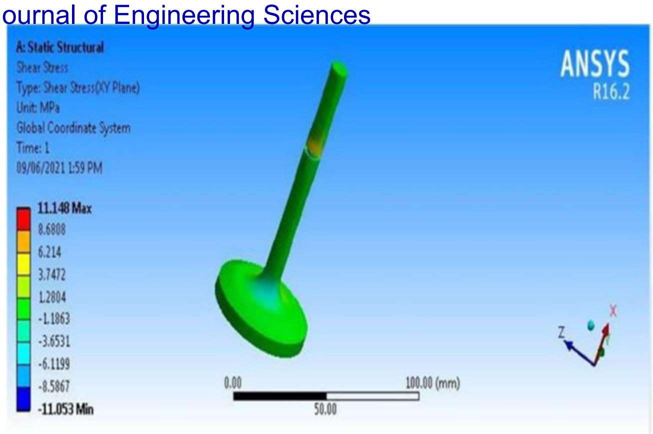

Figure 7.11 Shear Stress of Silicon Nitride Material

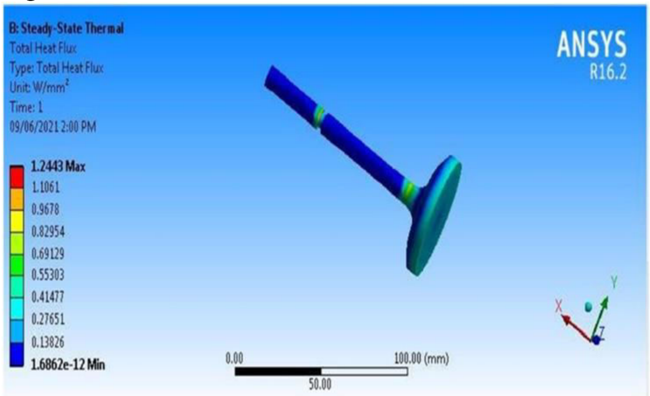

Figure 7.12 Total Heat Flux of Silicon Nitride Material

TI-4.5AL-3V-2FE-2MO Material

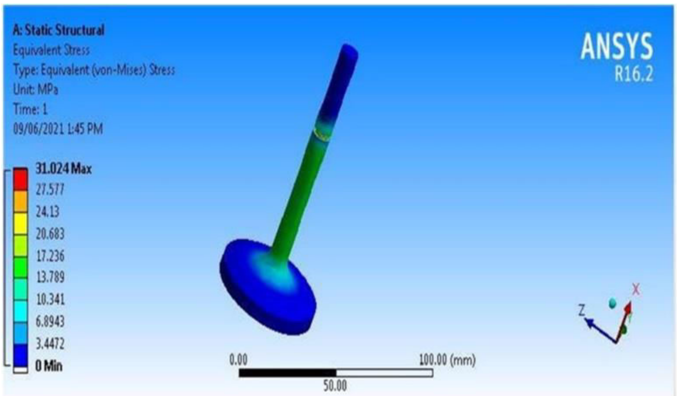

Figure 7.13 Vonmisses Stress of TI-4.5AL-3V-2FE-2MO Material

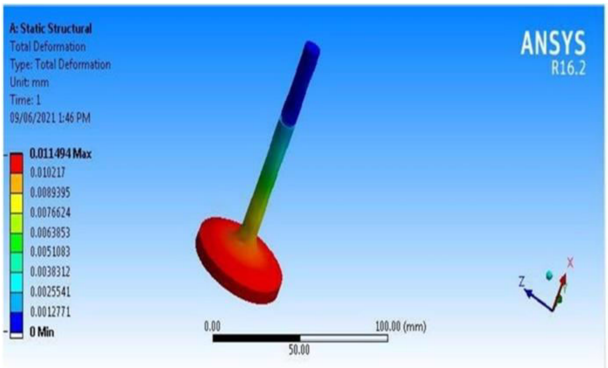

Figure 7.14 Total Deformation of TI-4.5AL-3V-2FE-2MO Material

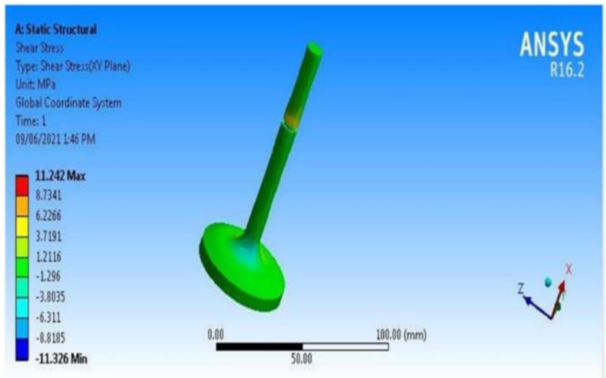

Figure 7.15 Shear Stress of TI-4.5AL-3V-2FE-2MO Material

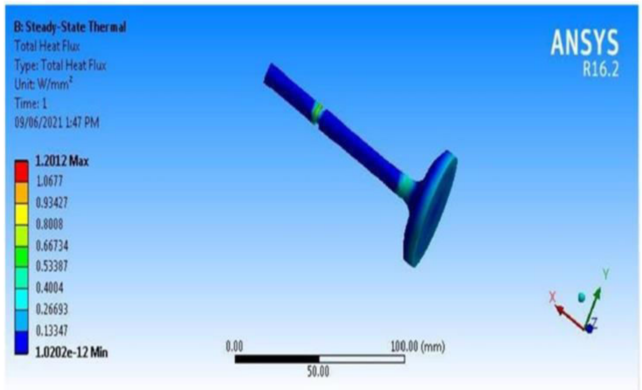

Figure 7.16 Total Heat Flux of TI-4.5AL-3V-2FE-2MO Material

Graphs

The static structural analysis of Ti-4.5Al-3V-2Fe2Mo, SILICON NITRIDE, AISI 4340, IMO IC 80Aare done, and results are obtained for Equivalent (Von-Mises) stress, shear stress, total deformation, heat flux, These results are plotted graphically and a comparison is made between these results.

Vonmisses Stress Graph

we can observe that in the case of equivalent von-misses stress, Exhaust valve various materials made of Ti-4.5Al-3V-2Fe2Mo, SILICON NITRIDE, AISI 4340, NIMONIC 80A

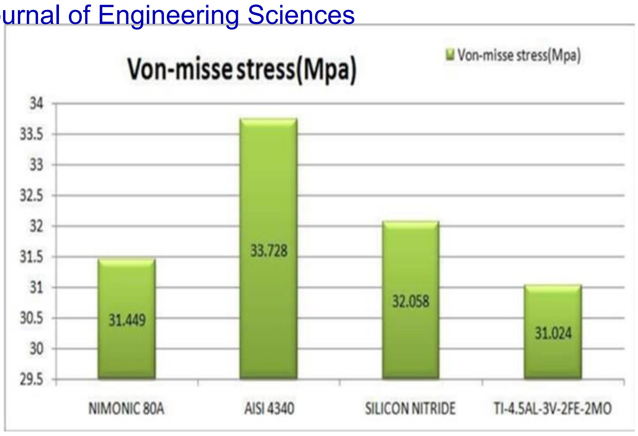

Figure 7.17 Vonmisses Stress Graph

Total Deformation Graph

after analysis we found to have the least stress of 31.024Mpa Ti-4.5Al-3V-2Fc2Mo in comparison with remaining materials. The highest Von-misses stress of AISI 4340 is 33.728 Mpa observed as shown below the graph. We can observe that in the case of Total deformation, the Exhaust valve of various materials made of Ti-4.5Al-3V-2Fe2Mo, SILICON NITRIDE, AISI 4340, NIMONIC 80A after

analysis we found to have the least Total deformation silicon nitride 0.00413mm and Nimonic 80A 0.00605 in comparison with remaining materials. The highest Total deformation Ti-4.5Al-3V-2Fe2Mo is 0.011 observed as shown below the graph.

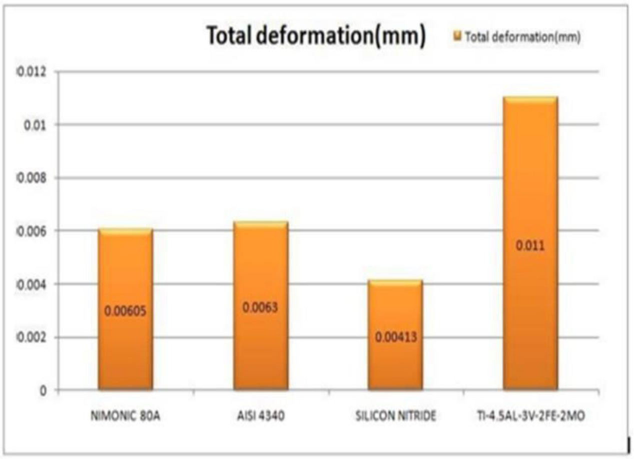

Figure 7.18 Total Deformation Graph

Shear Stress Graph

We can observe that in the case of equivalent Shear stress, Exhaust valve various materials made of Ti-4.5Al-3V-2Fe2Mo, SILICON NITRIDE, AISI 4340, NIMONIC 80A after

analysis we found to have least Shear stress of silicon nitride 1 1 .148Mpa and Nimonic 80A 11 .208Mpa in comparison with remaining materials. The highest Shear stress of AISI 4340 is 11.329 Mpa observed as shown below the graph.

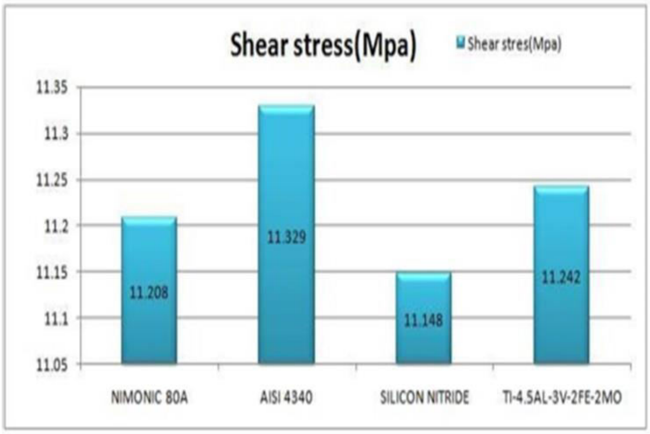

Figure 7.19 Shear Stress Graph

Total Heat Flux Graph

We can observe that in the case of Total heat flux w/mm2, Exhaust valve various materials made of Ti-4.5Al-3V-2Fe2Mo, SILICON NITRIDE, AI SI 4340, NIMON IC 80A after analysis. we found to have least Total heat flux w/mm2 of Ti-4.5Al-3V 2Fe2Mo 1.201w/1111111, silicon nitride 1.244 w /mm2, NIMONIC 80 A l.202W/mm2, Highest Total heat flux. AISI 4340 1 .89w/mm2 observed as shown below the graph.

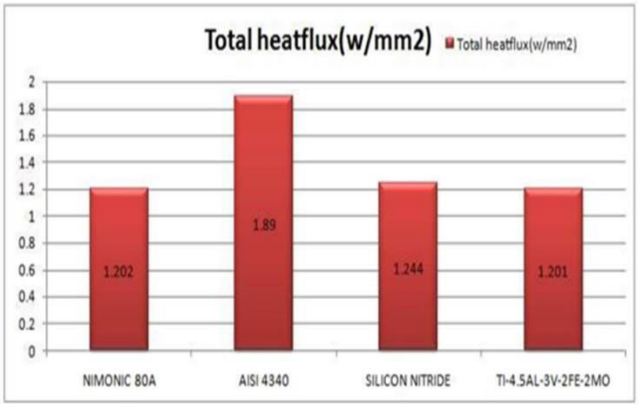

Figure 7.20 Total Heat Flux Graph

5. CONCLUSION

An exhaust valve is a valve that releases burned gases from a cylinder. The exhaust valve closes during the initial part of the induction stroke. The inlet valve usually opens a little before the top dead centre and the exhaust valve remains open a little after the top dead centre. In this project, the 3D model of the Exhaust poppet valve was designed by using CATIA software. The model is static and thermal analysis meshed by using ANSYS software. The static and thermal analysis was successfully done and carried out to determine the Von misses stress, deformation, Shear stress, and total heat flux on the Exhaust valve using various materials Ti-4.5Al-3V-2Fe2Mo, SILICON NITRIDE, AISI 4340, NIMONIC 80A. Finally concluded the Silicon Nitride and Nimonic 80 A is the suitable material because of less Von misses stress, deformation, Shear stress, and better heat transfer of total heat flux compared to the remaining materials. Hence it is suitable for manufacturing the exhaust valve.

REFERENCES

[1] Sanoj. T, S. Balamurugan, Thermo Mechanical Analysis of Engine Valve, International Journal of Science and Research (IJSR) ISSN (Online): 2319-7064, Volume 3 Issue 5, May 2014.

[2] Deepak.Bhargav, Anurag.Singh Rana, Chirag Narayana, Nikhil Sharma, Amit Sethi. Design and performance Evaluation of thermal barrier Coated Engine Valve Using FEA\ International Journal of Innovative Research in science engineering and technology (IJIRSET), Volume 5, Issue 5, May-2016.

[3] Sagar.S Deshpande, Vidyadhar. C. Kale, K.V. Chandratre "Analysis Of Stress Concentration Factor For Engine Valve Designs For Improved Fatigue Strength " International Journal of Modern Trends in Engineering and Research, Volume 2, Issue 7, [July- 2015] Special Issue of ICRTET'2015.

[4] Karan Soni, S. M. Bhatt, Ravi Dayatar, Kashyap Vyas "Optimizing IC Engine Exhaust Valve Design Using Finite Element Analysis" International Journal Of Modern Engineering Research (IJMER), IJMER, ISSN: 2249-664, Vol. 5 ,Issue 5 , May 2015 , 55.

[5] LucjanWitek, Failure and thermo-mechanical stress analysis of the exhaust valve of diesel engine, Engineering Failure Analysis 66 (2016) 154-165.

[6] Kum-Chul,Oh et.al. (2014) "A Study of Durability Analysis Methodology for Engine Valve Considering Head Thermal Deformation and Dynamic Behaviour" of R&D Center, IIyundai Motor Company, at 2014 SIMULIA Community Conference.

[7] Yuvraj K Lavhale, Prof. .leevan Salunke, An Overview of Failure Trend of Inlet & Exhaust Valve, Volume 5, Issue 3, March (2014), pp.104-113, ISS0976- 6340 (Print).

[8] B. E. Gajbhiye, et.al. (20 I 4)"Vibration Testing and Performance Analysis of IC Exhaust Valve Using Finite Element Technique" at International Journal of Research in dvent Technology, E-ISSN: 232 l-9637Vol.2,

[9] Naresh Kr. Raghuwanshi et.al. (2012) "Failure Analysis of Internal Combustion Engine Valves: A Review" by International Journal of Innovative Research in Science, Engineering and Technology ISSN: 2319- 8753 Vol. 1, lssue 2.

[10] A. S. More and S P. Deshmukh, "Analysis of Valve Mechanism," IOSR Journal of Mechanical and Civil Engineering (IOSR-JMCE), 2014.

[11] M. H. Shojaefard, A. R. Noorpoor, M. Ghaffarpour, F. Mohammadi, "Analysis Heat Flow between Seat and Valve of ICE," American Journal of Applied Sciences 4 (9): 700-708, 20071SS 1546-9239© Science Publications 2007 [I 2] S.K. Rajesh Kanna, R. Ragu, P.S. Rajeswaran and Muthuvignesh, Performance evaluation using FEA on Al-Si coated engine valve, IJCRAR ISS: 2347-3215 Volume 3 Number 8, pp. 67- 72.