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Effect Of Thermal Load On Valve By Using Conventional Diesel And Blended Fuels

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Abstract : The valves used in the IC engines are of three types: Poppet or mushroom valve or Sleeve valve or Rotary valve. Of these three types, Poppet valve is most commonly used. Since both the inlet and exhaust valves are subjected to high temperatures of 500°C to 1200°C during the power stroke, therefore, it is necessary that the materials of the valves should withstand these temperatures. The temperature at the inlet valve is less compared to exhaust valve. Thus the inlet valve is generally made of nickel chromium alloy steel and exhaust valve is made of si-chrome steel.Automobile engines are usually petrol, diesel or gasoline engines. Petrol engines are Spark Ignition engines and diesel engines are Compression Ignition engines. Blended fuels are mixtures of traditional and alternative fuels in varying percentages. Here the effect of diesel blended fuels on valve is studied by mathematical correlations applying thermal loads produced during combustion. Blended fuels are usually bio fuels blended in different percentages. Percentages vary from 0%, 5%, 10% and 20%.Internal combustion engines produce exhaust gases at extremely high temperatures and pressures. As these hot gases pass through the exhaust valve, temperatures of the valve, valve seat, and stem increase. To avoid any damage to the exhaust valve assembly, heat is transferred from the exhaust valve through different parts, especially the valve seat insert during the opening and closing cycle as they come into contact with each other. In this thesis, a finite-element method is used for modeling the thermal analysis of an exhaust valve. The temperature distribution and resultant thermal fluxes are evaluated. Detailed analyses are performed to estimate the boundary conditions of an internal combustion engine. In this thesis, Catia is employed for modeling and Ansys is used for analysis of the exhaust valve.

1.INTRODUCTION

A poppet valve or a mushroom valve is used to control the timing and quantity of gas or vapour flow into an engine. It consists of a hole, usually round or oval, and a tapered plug, usually a disk shape on the end of a shaft also called a valve stem. The portion of the hole where the plug meets with it is referred as the 'seat' or 'valve seat'. The shaft guides the plug portion by sliding through a valve guide. A pressure differential helps to seal the valve in exhaust applications and in intake valves a pressure differential helps open it. From 1770sJames Watt used them on his steam engines for the first time.

1.1 Types of sleeve valves

The first successful sleeve valve was patented by Charles Yale Knight, and used twin alternating sliding sleeves. It was used in some luxury automobiles, notably Willys, Daimler, Mercedes-Benz, Minerva, Panhard, Peugeot and AvionsVoisin. The higher oil consumption was heavily outweighed by the quietness of running and the very high mileages without servicing. Early poppet-valve systems required decarbonization at very low mileages.

The Burt-McCollum sleeve valve was named for the two inventors that applied for similar patents within a few weeks of each other, the Burt system was an open sleeve type, driven from the crankshaft side, while the McCollum design had a sleeve in the head and upper part of the cylinder, and a more complex port arrangement (Source: 'Torque Meter' Magazine, AEHS). The design that entered production was more 'Burt' than 'McCollum,' and was used by the Scottish company Argyll for its cars, and later was adopted by Bristol for its radial aircraft engines, used a single sleeve which rotated around a timing axle set at 90 degrees to the cylinder axis. Mechanically simpler and more rugged, the Burt-McCollum valve had the additional advantage of reducing oil consumption (compared to other sleeve valve designs), while retaining the combustion chambers and big, uncluttered, porting area possible in the Knight system.

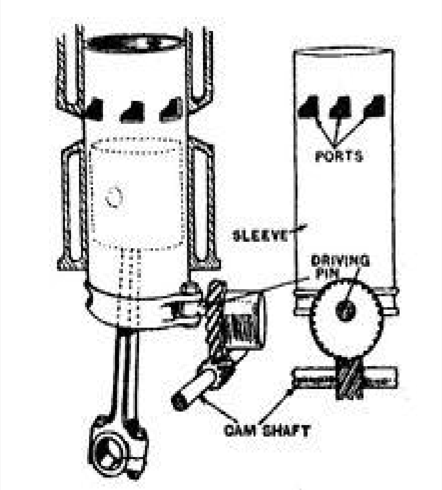


fig1: Argyll single sleeve valve

A small number of designs used a "cuff" sleeve in the cylinder head instead of the cylinder proper,[3] providing a more "classic" layout compared to traditional poppet valve engines. This design also had the advantage of not having the piston within the sleeve, although in practice this appears to have had little practical value. On the downside, this arrangement limited the size of the ports to that of the cylinder head, whereas in-cylinder sleeves could have much larger ports.

1.2 Fuel Blends

Biodiesel is a form of diesel fuel manufactured from vegetable oils, animal fats, or recycled restaurant greases bytransesterification. It is safe, biodegradable, and produces less air pollutants than petroleum-based diesel.

Blending amounts of alternative fuel with conventional fuel is an important option for reducing petroleum consumption. Examples of low-level fuel blends include B5 (5% biodiesel/95% diesel), and B2 (2% biodiesel/98% diesel). Blends can also consist of two types of alternative fuels, such as hydrogen and compressed natural gas (HCNG), which can be a combination of 20% hydrogen/80% CNG. B20 (20% biodiesel/80% diesel) .

2. INTRODUCTION TO CATIA

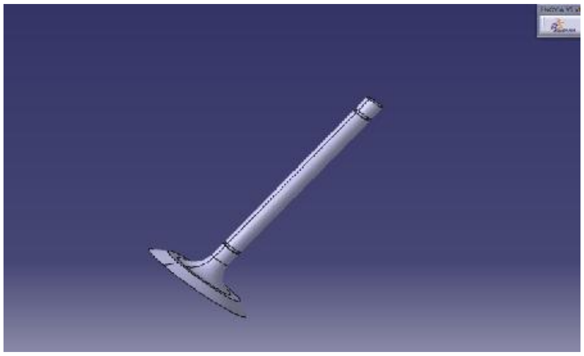
CATIA also known as Computer Aided Three-dimensional Interactive Application and it is software suit that developed by the French company call Dassult Systems.

CATIA is a process-centric computer-aided design/computer-assisted manufacturing/computer-aided engineering (CAD/CAM/CAE) system that fully uses next generation object technologies and leading edge industry standards. CATIA is integrated with Dassult Systems Product Lifecycle Management (PLM) solutions. It allows the users to simulate their industrial design processes from initial concept to product design, analysis, assembly and also maintenance. In this software, it includes mechanical, and shape design, styling, product synthesis, equipment and systems engineering, NC manufacturing, analysis and simulation, and industrial plant design. It is very user friendly software because CATIA Knowledge ware allows broad communities of user to easily capture and share know-how, rules, and other intellectual property assets.

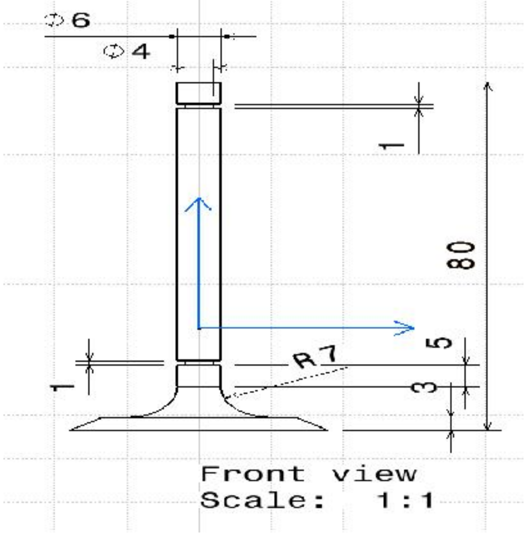
2.1 Investigation of Exhaust Valve Failure in Heavy - duty Diesel Engine

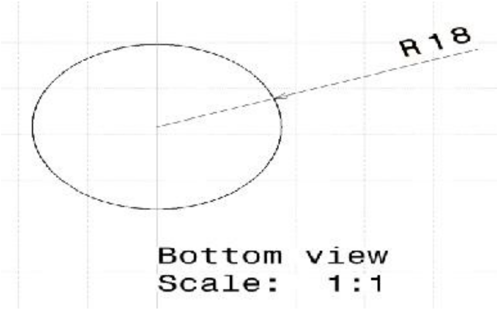
The different failure modes affecting the valve failure are discussed. The combination of impact and sliding during the valve closing can lead to valve seat wear. The deposits formed on an exhaust valve are due to the reaction of fuel-borne contaminants and lubricating oil during combustion as well as the reaction of combustion products with valve materials. The build-up of deposits on the valve face and seat can have an insulating effect that slows cooling and makes the valve run hot and therefore valves can lead to hot corrosion. Another failure mode of valves is fatigue, which may cause the valve to break. Valves usually fail as a result of different failure modes like fatigue, corrosion, wearing and impact which are explained above. The reason for a valve failure may be one of the above explained failure modes or some sort of combination of them. In order to see that combination a failed exhaust valve is examined. It is possible to bring forward following conclusions from the theories well-known and failure modes discussed above. The fractures on the failed valve were observed around the impact area at the table of the failed exhaust valve. Impact area of the valve is exposed to maximum mechanical forces and stresses. These mechanical stresses cause valves to become weaker. The material of the failed exhaust valve is X45CrSi93. There was a dramatic decrease in the carbon content of the material of the failed valve. It was found between 0.28 and 0.34% although the normal value of carbon content is 0.40-0.45%. The causes of considerable decrease of the carbon content in valve material likely owing to decarburisation which was occurred in whole structure. Angular titanium phases were found in microstructure of the material of the failed valve. The angular phases had caused crack initiation in the material structure. Vanadium was found on the surfaces of the failed valve. The fuel-born vanadium has caused the corrosion on the valve. Chromium carbide was detected on the surface, which is due to high ambient temperature.

DESIGN OF VALVE



DRAFT OF VALVE





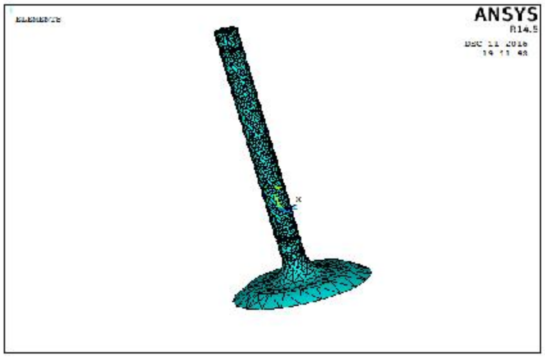
3.INTRODUCTION TO ANSYS

ANSYS is general-purpose finite element analysis (FEA) software package. Finite Element Analysis is a numerical method of deconstructing a complex system into very small pieces (of user-designated size) called elements. The software implements equations that govern the behaviour of these elements and solves them all; creating a comprehensive explanation of how the system acts as a whole. These results then can be presented in tabulated, or graphical forms. This type of analysis is typically used for the design and optimization of a system far too complex to analyze by hand. Systems that may fit into this category are too complex due to their geometry, scale, or governing equations.

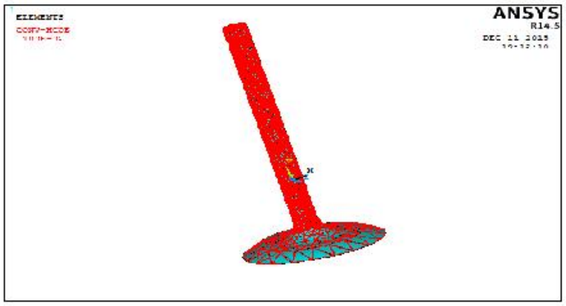
ANSYS is the standard FEA teaching tool within the Mechanical Engineering Department at many colleges. ANSYS is also used in Civil and Electrical Engineering, as well as the Physics and Chemistry departments.

ANSYS provides a cost-effective way to explore the performance of products or processes in a virtual environment. This type of product development is termed virtual prototyping

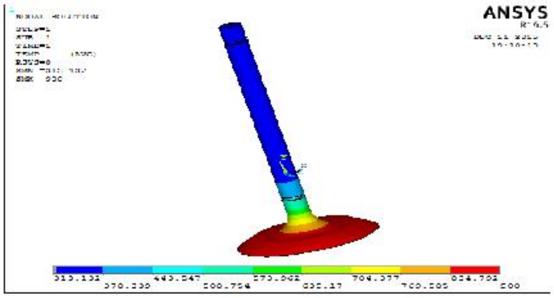
3.1 thermal Analysis Valveusing The Material Silichromesteel With Pure Diesel



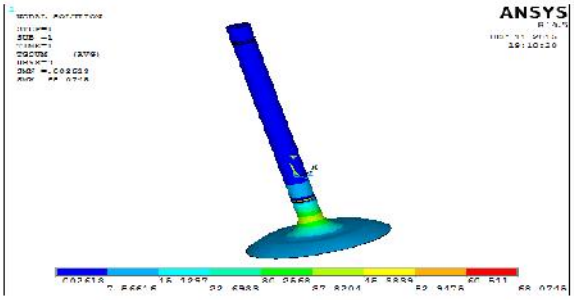
3.1 Meshed model



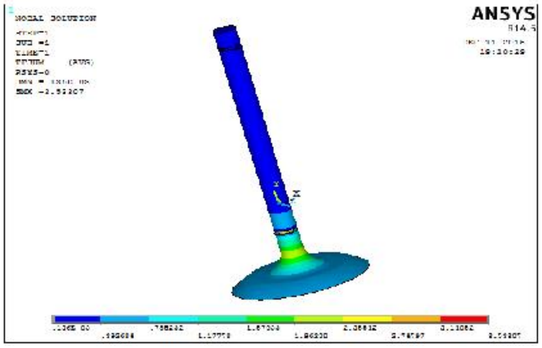
3.2Loads applied model



3.3 Nodal Temperature



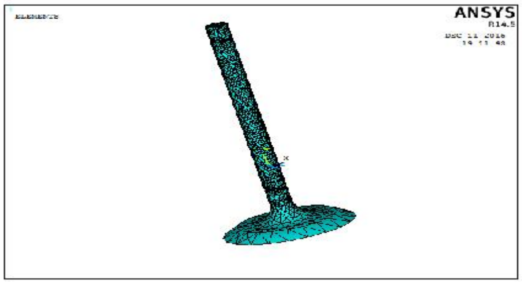
3.4 Thermal Gradient



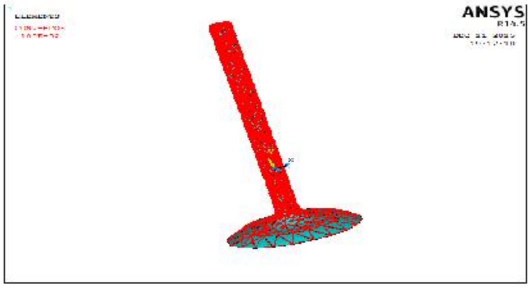
3.5 Thermal Flux

3.2 Thermal Analysis Valveusing The Material Nimonic 942 With Pure Diesel

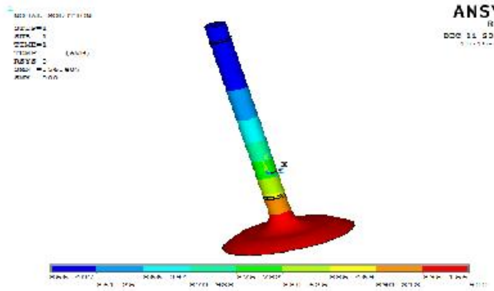
3.6 Imported model



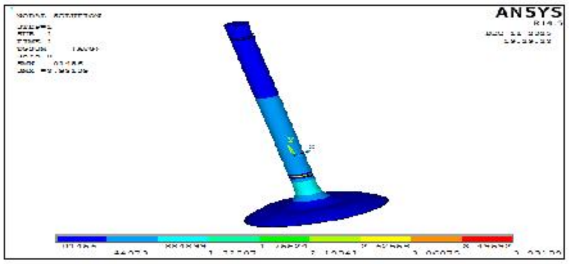
3.7 Meshed model



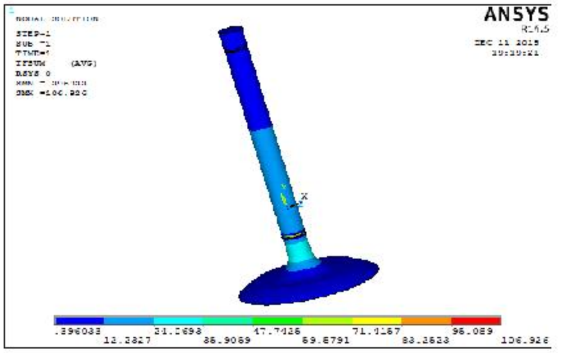
3.8 Loads Applied Model



3.9 Nodal Temperature



3.10 Thermal Gradient



3.11 Thermal Flux

4. RESULTS

RESULTS TABLE -POPPET VALVE

4.1Results Comparison tables with pure diesel

	TEMPERATURE		THERMAL GRADIENT		THERMAL FLUX	
	MIN	MAX	MIN	MAX	MIN	MAX
SILICHROME	313.132	900	0.002613	68.0745	1.36E-04	3.53307
NIMONIC 942	856.407	900	0.01456	3.93109	0.396033	106.926

4.2 Results Comparison tables with 5% Blended Fuel

	TEMPERATURE		THERMAL GRADIENT		THERMAL FLUX	
	MIN	MAX	MIN	MAX	MIN	MAX
SILICHROME	313.144	954	0.002853	74.337	1.48E-04	3.85809
NIMONIC 942	906.396	954	0.015833	4.29272	0.432466	116.762

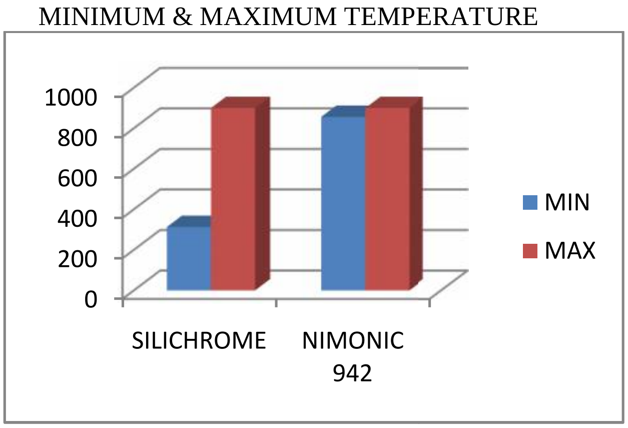
4.3 Results Comparison tables with 10% Blended Fuel

	TEMPERATURE		THERMAL GRADIENT		THERMAL FLUX	
	MIN	MAX	MIN	MAX	MIN	MAX
SILICHROME	313.164	1047	0.003267	85.1222	1.70E-04	4.41784
NIMONIC 942	992.49	1047	0.018206	4.91553	0.49521	133.703

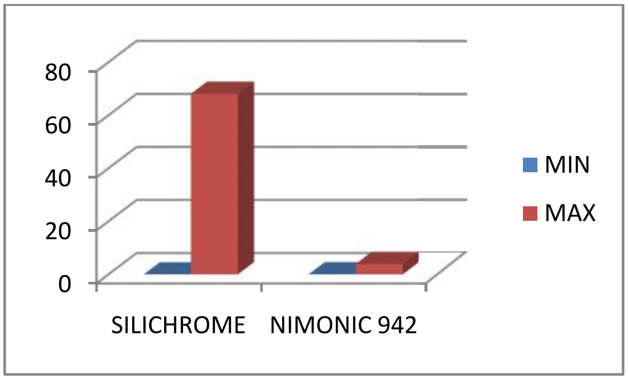
4.4 Results Comparison tables with20% Blended Fuel

	TEMPERATURE		THERMAL GRADIENT		THERMAL FLUX	
	MIN	MAX	MIN	MAX	MIN	MAX
SILICHROME	313.145	960	0.00288	75.0328	1.49E-04	3.8942
NIMONIC 942	911.951	960	0.016048	4.3329	0.436514	117.855

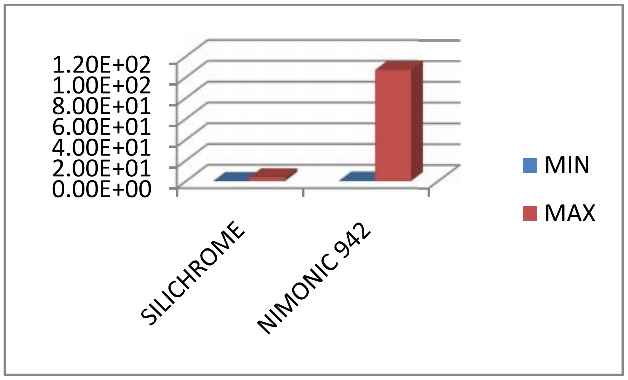
4.5.1 Comparison Graphs for SiliChrome Steel and Nimonic 942 with pure diesel for minimum and maximum temperature



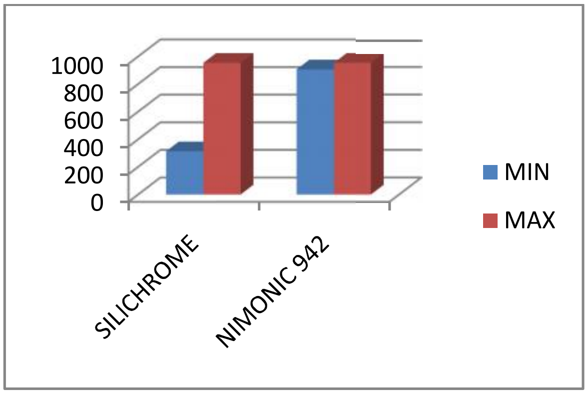
4.5 .2 Comparison Graphs for SiliChrome Steel and Nimonic 942 with pure diesel for minimum and maximum Thermal gradient



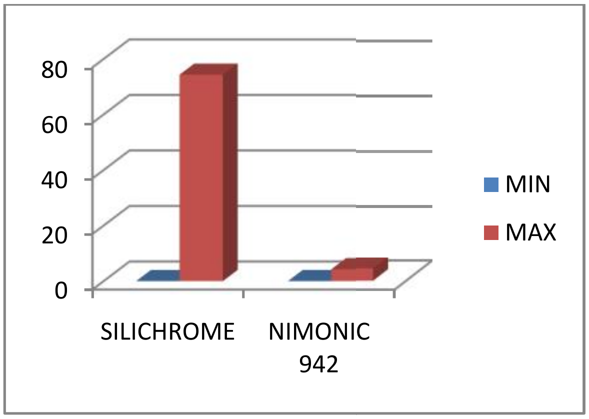
4.5 .3 Comparison Graphs for SiliChrome Steel and Nimonic 942 with pure diesel for minimum and maximum Thermal flux



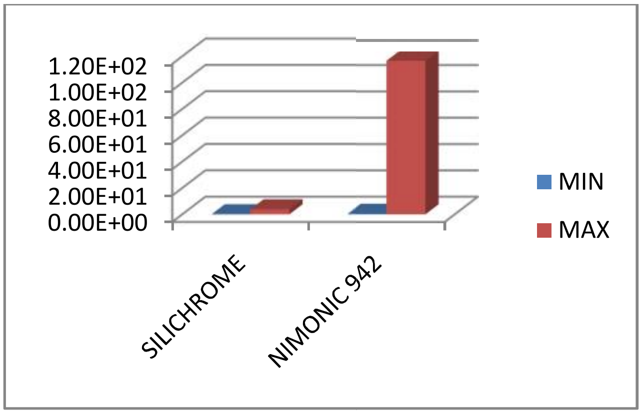
4.5 .4 Comparison Graphs for SiliChrome Steel and Nimonic 942 with 5% blended fuel for minimum and maximum temperature



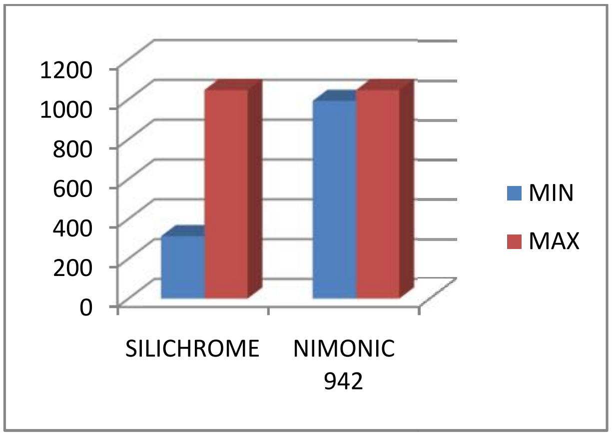
4.5 .5 Comparison Graphs for SiliChrome Steel and Nimonic 942 with 5% blended fuel for minimum and maximum Thermal gradient



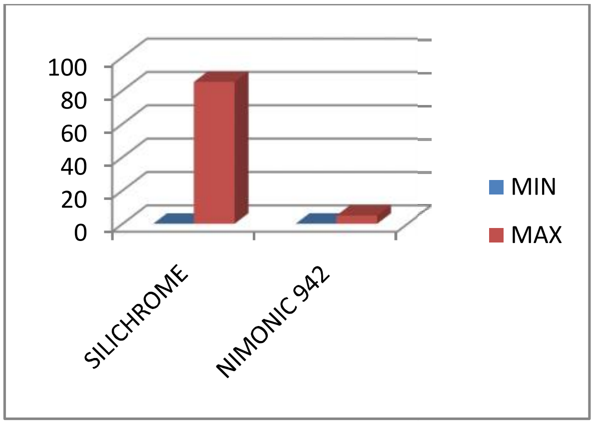
4.5 .6 Comparison Graphs for SiliChrome Steel and Nimonic 942 with 5% blended fuel for minimum and Thermal flux



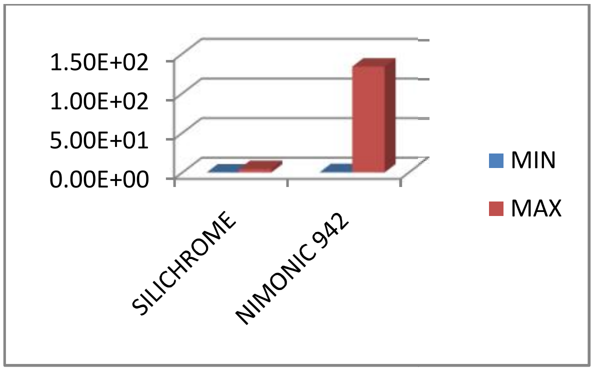
4.5 .7 Comparison Graphs for SiliChrome Steel and Nimonic 942 with 10 % blended fuel for minimum and maximum temperature



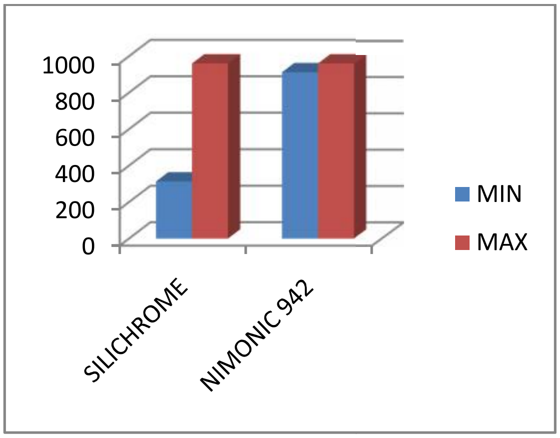
4.5 .8 Comparison Graphs for SiliChrome Steel and Nimonic 942 with 10% blended fuel for minimum and maximum Thermal gradient



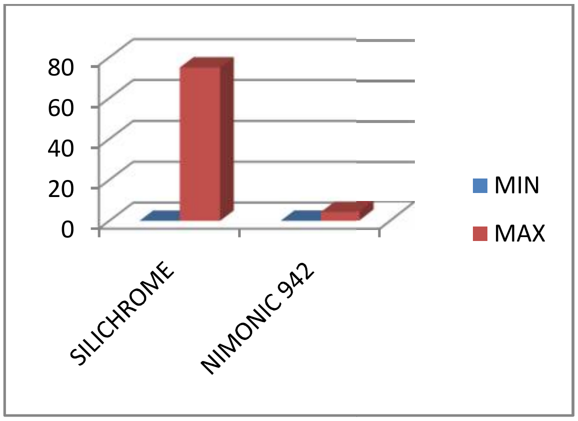
4.5 .9 Comparison Graphs for SiliChrome Steel and Nimonic 942 with 10% blended fuel for minimum and maximum Thermal flux



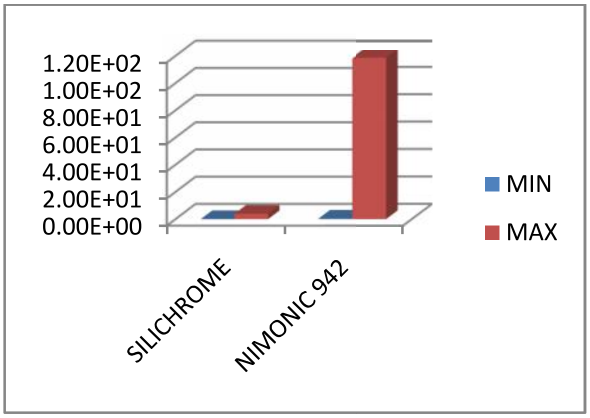
4.5 .10Comparison Graphs for SiliChrome Steel and Nimonic 942 with 20 % blended fuel for minimum and maximum temperature



4.5 .11 Comparison Graphs for SiliChrome Steel and Nimonic 942 with 20 % blended fuel for minimum and maximum Thermal gradient



4.5 .12 Comparison Graphs for SiliChrome Steel and Nimonic 942 with 20 % blended fuel for minimum and maximum Thermal flux



Conclusion

In this thesis, a finite-element method is used for modeling the thermal analysis of an exhaust valve. The temperature distribution and resultant thermal stresses are evaluated. Detailed analyses are performed to estimate the boundary conditions of an internal combustion engine. In this thesis, Catia v5 is employed for modeling and Ansys is used for analysis of the exhaust valve.

Here the effect of diesel blended fuels on valve is studied by mathematical correlations applying thermal loads produced during combustion. Blended fuels are usually bio fuels blended in different percentages. Percentages vary from 0%, 5%, 10% and 20%.

As per the obtained results, we have compared in the results in the graph we can observe that the silichrome steel with 0% blended fuels is having minimum thermal gradient (68.0745) and minimum thermal flux (3.53307) when compared with the silichrome steel and nimonica 942 with 5%, 10% and 20% mixture of blended fuels.And the variation in minimum temperature is very low in all the cases which suggests that biodiesel blends can be used with regular diesel engines without any effect on engine material, life time and heat dissipation.

So as per the results observed we can conclude that the valve with silichrome steel can be used with blended fuels up to 20% blend it is B20 as there is no much variations in the thermal fluxes

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