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THERMAL ANALYSIS OF ENGINE FAILURE CONDITIONS IN ENGINE OVERHEATING CASES

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ABSTRACT:

Most engines are designed to operate within a "normal" temperature range of about 195 to 220 degrees F. A relatively constant operating temperature is essential for proper emissions control, good fuel economy and performance. But problems can arise that cause the engine to run hotter than normal, resulting in engine overheating. Let's take a look at some of the most common causes. This is the primary cause of engine overheating. Possible leak points include hoses, the radiator, water pump, thermostat housing, heater core, head gasket, freeze plugs, automatic transmission oil cooler, cylinder heads and block. Perform a pressure test. An estimated 50 percent of all engine failures are associated with problems in the cooling system. This paper presents the study conducted to find out the causes of engine overheating temperature because of failure through thermal analysis, cause and effect design is prepared in the computer aided software catia to classify the causes into sub causes and the thermal analysis of the cylinder liner is done using Ansys two different materials gray cast iron and Nikasil. Nikasil is a trademarked electrodeposited lipophilic nickel matrix silicon carbide coating. With help of the ansys software find which material is better chose for engine cylinder linears.

Keywords: cylinder liner, Engine overheating cases, Thermal analysis, cast iron, Nikasil, catia, ansys.

1. INTRODUCTION

Engine failures are most commonly occurred in every engine. Besides taking away your wheels, it forces you to make a painful financial decision. If the cost to repair, overhaul or replace the engine is more than the resale value of your car or truck, the investment may not be worth it. But if your vehicle is in good condition otherwise, repairing or replacing the engine may be less expense than trading for another used vehicle (always a gamble), or taking on payments for a new car or truck. Assuming you have gotten past the initial trauma and has decided in favor of fixing the engine, you have to figure out why the engine failed so the repaired engine (or replacement engine) won't suffer the same fate. A good place to start your postmortem is to review the circumstances that preceded the failure. Sometimes failures occur unexpectedly. One minute the engine is running fine and your keeping up with traffic, and the next you're sitting alongside the road with the hood up wondering what happened. In most instances, though, there is ample warning that something is amiss long before the engine actually fails.

1.2 Causes of engine failure:

The major causes of engine failures can be lumped into four basic categories:

- Overheating (excessive heat)
- Lubrication (or the lack thereof)
- Detonation (Spark Knock)
- Misassembled.

1.3 Engine overheating:

Overheating can be caused by any number of things. It is often the result of coolant loss or a low coolant level, which is turn may be due to leaks in hoses, the radiator or the engine itself. A weak radiator cap that leaks pressure can allow coolant to escape from the system. Not getting the cooling system completely filled after changing the antifreeze can allow steam pockets to form that make the engine overheat or run hot. An electric cooling fan that fails to come on due to a faulty thermostat, relay, wiring or motor may be an overlooked cause of overheating. So too can a slipping fan clutch. Even a missing fan shroud that reduces the fan's effectiveness may be a contributing factor.

1.4 Possible consequences of engine overheating:

If your engine is overheating, it may start to detonate. The engine may rattle and ping and lose power. If detonation continues, it may damage the rings, pistons or rod bearings. Overheating can also cause piston scuffing. As the engine gets hotter and hotter, the pistons may swell to the point where there is no more room for expansion and they scrape against the cylinders, damaging the pistons and cylinders. Exhaust valves may also stick or scuff in their guides. This can damage the valves, guides and lead to a loss of compression.

CHAPTER – 2

LITERATURE REVIEW:

- Abdul (1996) specified the characteristics of good and efficient coolant as high specific and good thermal conductivity, fluidity within the temperature range of use, low freezing point, high boiling point, non- corrosive to metal , minimum degradation to non-metals, chemical stability over the temperature range of use, low flammability, high flash point , and low toxicity.
- Bayrakceken et al. (2007) has presented his work on the single cylinder diesel engine used in the agricultural vehicles. The study shows that two different cases of engine failure has been investigated and in both cases slight design differences were mentioned. As the failure mechanism for both the engines is due to overheating only.
- Clancey (1984) recommended test repair as a straightforward selection tool to a successful diagnostic application in expert system and that the overview of TEST in the repair strategies included overview of TEST, verification, alternative diagnostic and sequencing. Diagnosing causes of overheating in bulldozer engine and proffering solution to the overheating problem is the focus of this study. The causes of overheating were diagnosed using the computer program and solutions were proffered to the overheating problems.
- Cornelius (2002) defined expert system as a computer program that simply simulates the thought and imagination of a human expert to restively solve complex decision problems in a particular field. For several years expert system has been a reliable, dependable and convenient tool for technical diagnosing model for solving problems in different fields of engineering and technology (Lugar & Stubblefield, 2004).

Chapter3

3.1 DESIGN:

CATIA offers a solution to shape design, styling, surfacing workflow and visualization to create, modify, and validate complex innovative shapes from industrial design to Class-A surfacing with the ICEM surfacing technologies. CATIA supports multiple stages of product design whether started from scratch or from 2D sketches. CATIA is able to read and produce STEP format files for reverse engineering and surface reuse

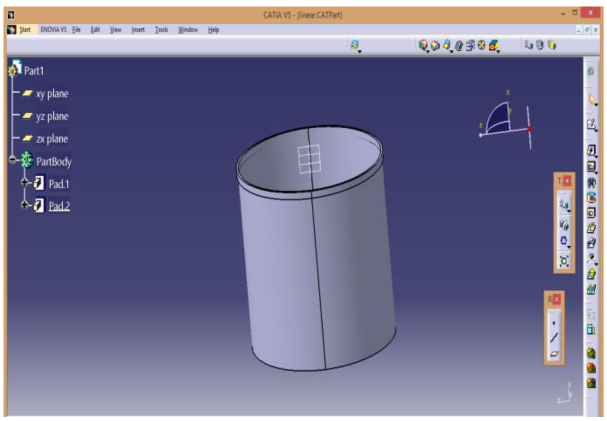


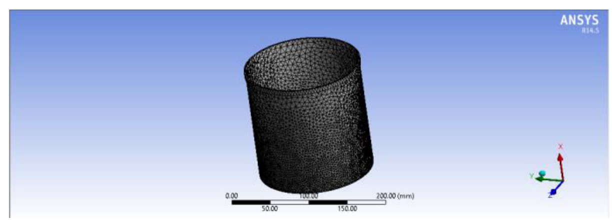
Fig.7: Sketching Cylinder model in Catia

4 Ansys:

ANSYS is general-purpose finite element analysis software, which enables engineers to perform the following tasks:

1. Build computer models or transfer CAD model of structures, products, components or systems
2. Apply operating loads or other design performance conditions.
3. Study the physical responses such as stress levels, temperatures distributions or the impact of electromagnetic fields.
4. Optimize a design early in the development process to reduce production costs.
5. A typical ANSYS analysis has three distinct steps.
6. Pre Processor (Build the Model).

Mash:



Transient Thermal:

The ANSYS/Mechanical, ANSYS/FLOTRAN, and ANSYS/Thermal products support steady-state thermal analysis. A steady-state thermal analysis calculates the effects of steady thermal loads on a system or component. Engineer/analysts often perform a steady-state analysis before doing a transient thermal analysis, to help establish initial conditions. A transient analysis also can be the last step of a transient thermal analysis, performed after all transient effects have diminished. You can use steady-state thermal analysis to determine temperatures, thermal gradients, heat flow

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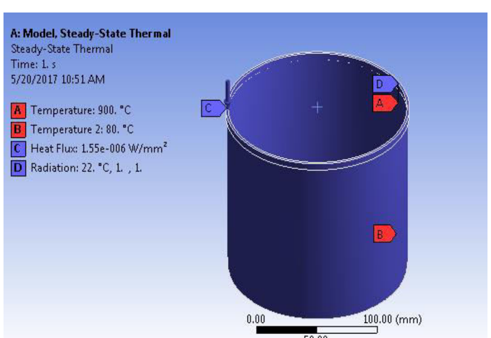
rates, and heat fluxes in an object that are caused by thermal loads that do not vary over time. Such loads include the following:

- Convections
- Radiation
- Heat flow rates
- Heat fluxes (heat flow per unit area)
- Heat generation rates (heat flow per unit volume)
- Constant temperature boundaries.

A steady-state thermal analysis may be either linear, with constant material properties; or nonlinear, with material properties that depend on temperature. The thermal properties of most material do vary with temperature, so the analysis usually is nonlinear. Including radiation effects also makes the analysis nonlinear.

Loads:



Object Name	Temperature	Temperature 2	Heat Flux	Radiation
Geometry	1 Face		1 Body	1 Face
Magnitude	900. °C (ramped)	80. °C (ramped)	1.55e-006 W/m m² (ramped)	
Correlation				Surface to Surface
Emissivity				1. (step applied)
Ambient Temperature				22. °C (ramped)
Enclosure				1.

Cast Iron:

Thermal Conductivity	8.3e-002 W mm^-1 C^-1
Density	7.2e-006 kg mm^-3

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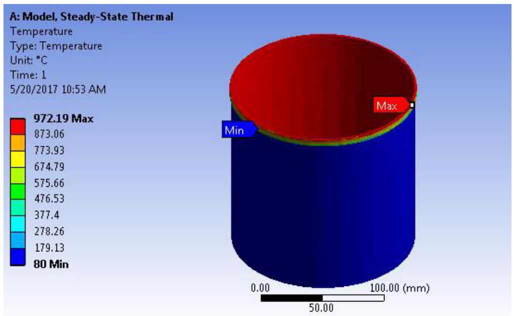
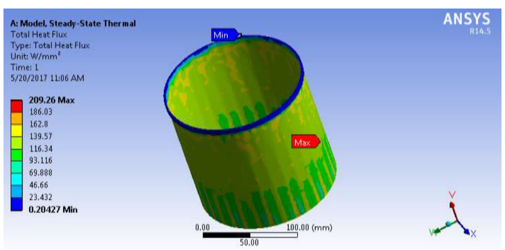
Specific Heat	1.65e+005 mJ kg^-1 C^-1

Temperature



Total Heat Flux

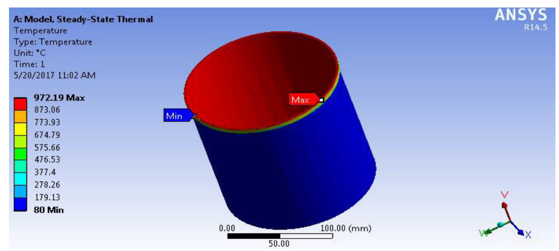


Type	Temperature	Total Heat Flux	Directional Heat Flux	Thermal Error
Minimum	-1.1642e+005 °C	9.2572e-005 W/mm²	-141.81 W/mm²	2.0345e+009
Maximum	2.0802e+005 °C	188.86 W/mm²	120.65 W/mm²	6.3001e+015

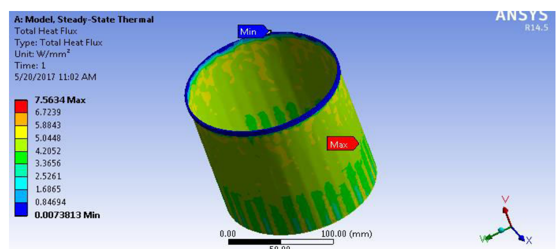
zirconium

Density	5.7e-006 kg mm^-3
Thermal Conductivity	3.e-003 W mm^-1 C^-1
Specific Heat	9.e+005 mJ kg^-1 C^-1

Temperature



Total Heat Flux



Type	Temperature	Total Heat Flux	Directional Heat Flux	Thermal Error
Minimum	80. °C	7.3803e-003 W/mm²	-5.5826 W/mm²	9.7011e-003

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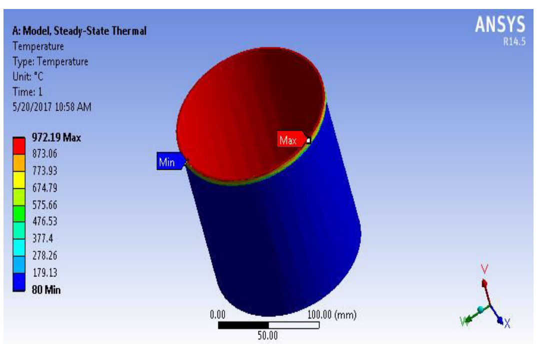
Maximum	972.22 °C	7.5634 W/m²	3.3116 W/mm²	6.6091e+006

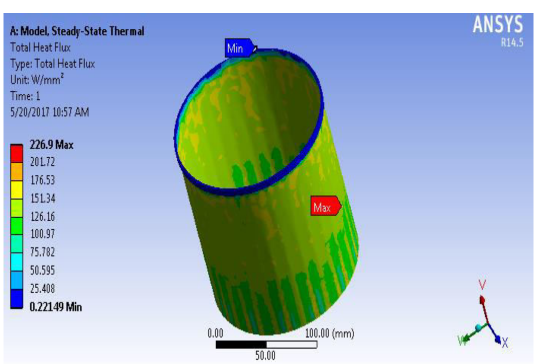
Nikasil:

Thermal Conductivity	90 W m^-1 C^-1
Density	8900 kg m^-3
Specific Heat	444 J kg^-1 C^-1

Temperature



Total Heat Flux



Type	Temperature	Total Heat Flux	Directional Heat Flux	Thermal Error
Minimum	80. °C	2.2149e+005 W/m²	-1.6748e+008 W/m²	2.9101e-004
Maximum	972.19 °C	2.269e+008 W/m²	9.9348e+007 W/m²	1.9827e+005

Conclusions:

From the above study of I.C. Engine over heating failures, it is quite evident that a common cause of engine fracture is fatigue. Engine block fails due to cyclic loading at high temperatures. High temperature is also responsible for decrease in hardness and yield strength of engine block linear material, and also causes corrosion of exhaust valves. The surface oxidation on the engine linear stem occurs due to overheating and fatigue strength is decreased due to overheating. Wear failure occurs generally at the seat face of linear and at the overheating due to cooling failures and environmental conditions guide. Thermal stress failure is the main cause of engine failures.

Comparing results zirconium is high in temperature value and total heat flux value, thermal error with other existing material

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