JOURNAL OF CRITICAL REVIEWS

ISSN- 2394-5125 VOL 10, ISSUE 03, 2023

DESIGN ASSEMBLY AND OPTIMIZATION OF RADIAL ENGINE

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Abstract

The radial engine is a reciprocating type internal combustion engine configuration in which the cylinders point outward from a central crankshaft like the spokes on a wheel. This configuration was very commonly used in large aircraft engines before most large aircraft started using turbine engines. In a radial engine, the pistons are connected to the crankshaft with a masterand-articulating-rod assembly. One piston, the uppermost one in the animation, has a master rod (Red on the animation) with a direct attachment to the crankshaft. The remaining pistons pin their connecting rods (Yellow on the animation) attachments to rings around the edge of the master rod. Four-stroke radials always have an odd number of cylinders per row, so that a consistent every-other-piston firing order can be maintained, providing smooth operation. This is achieved by the engine taking two revolutions of the crankshaft to complete the four strokes, (intake, compression, power, exhaust), which means the firing order is 1,3,5,7,9,2,4,6,8 and back to cylinder 1 again. This means that there is always a two-piston gap between the piston on its power stroke and the next piston to fire (i.e., the piston on compression) In this project, you will create the Radial Engine assembly shown. The Radial Engine assembly will be created in two parts, one will be the subassembly and the other will be the main assembly. The dimensions of the components of the Radial Engine assembly are shown.

KEY WORDS: Aluminum Alloy, ANSYS R 14.5, CATIA V5 R20, Master Rod, Structural Steel.

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INTRODUCTION

The radial engine is an internal combustion engine configuration in which the cylinders point outward from a central crankshaft like the spokes on a wheel. This configuration was very commonly used in aircraft engines before being superseded by turbo shaft and turbojet engines. It is a reciprocating engine.The cylinders are connected to the crankshaft with a master-and-articulating-rod assembly. One cylinder has a master rod with a direct attachment to the crankshaft. The remaining cylinders pin their connecting rods attachments to rings around the edge of the master rod (see animation). Four-stroke radials almost always have an odd number of cylinders, so that a consistent every-other-piston firing order can be maintained, providing smooth running. The debate about the merits of the radial vs. the inline continued throughout the 1930s, with both types seeing some use. The radial was more popular largely due to its simplicity, and most navy air arms had dedicated themselves to the radial because of its improved reliability for over-water flights and better power/weight ratio for aircraft carrier takeoffs. Although inline engines offer smaller frontal area than radials, inline engines require the added weight and complexity of cooling systems and are generally more vulnerable to battle damage. The vast majority of radial-engined aircraft designed since the 1930s were also were fitted with NACA cowlings to reduce drag & to also enhance forward thrust by virtue of its airfoil effect.In general, a piston is a sliding plug that fits closely inside the bore of a cylinder.Its purpose is either to change the volume enclosed by the cylinder, or to exert a force on a fluid inside the cylinder. There are two ways that a piston engine can make power. These are the two-stroke cycle and the four-stroke cycle. A single cylinder two-stroke engine produces power every crankshaft revolution, while a single cylinder four-stroke engine produces power every other crankshaft revolution. Older designs of small two-stroke engines produced more pollution than four stroke engines however modern two-stroke designs, like the Vespa ET2 Injection utilise fuel-injection and are as clean as four-strokes. Large diesel two-stroke engines, as used in ships and locomotives, have always used fuel injection amobile engines in existence. In theory, a four stroke engine has to be larger than a two stroke engine to produce an equivalent amount of power. Two stroke engines are becoming less common in developed countries these days, mainly due to manufacturer reluctance to invest in reducing two-stroke emissions. Traditionally, two stroke engines needed more maintenance, even though they have fewer moving parts and tended to wear out faster than four stroke engines, however fuel-injected two-strokes achieve better engine lubrication and cooling should improve considerably.

PROBLEM STATEMENT

Normal internal combustion engines are rectangular shaped and have many irregular patterns

in it. The weight of the components also increases the gross weight of the vehicle. Most of the space is occupied by the engine compartment like cylinder block, cylinder head, crank case, flywheel, turbo charger and cooling system such as radiator and other accessories. These are the components which are occupying more and more space in engine compartment so it reduces the space in driver and passenger compart-ment. And also it will reduce themileage speed of the vehicle so these are the major problem which is not solved in now a day modern vehicles.

OBJECTIVE

The main aim of the project is to design and assembly of a radial engine and also the analysis of Master rod. The radial engine is an internal combustion engine, configuration in which the cylinders point outward from a central crankshaft like the spokes on a wheel.The Extra "rows" of radial cylinders can be added in order to increase the capacity of the engine without adding to its diameter. Four-stroke radials have an odd number of cylinders per row, so that a consistent every-other-piston firing order can be maintained, providing smooth operation.They're lighter than liquid-cooled inline engines and since they don't rely on coolant, they' re more damage-resistant. Radial engines are simpler - the crankshafts are shorter and they need fewer crankshaft bearings. They're more reliable and run smoother. Radial engines can range from 3 cylinders on a single bank to 42 cylinders displaced over multiple banks. The biggest benefits of such engines are the relatively simple construction, the smooth operation, and the fact they can take a pounding.

HISTORY

The very first design of internal combustion aero engine made was that of Charles Manly, who built a five-cylinder radial engine in 1901 for use with Langley`s ‘aerodrome‘ , as the latter 15 inventor decided to call what has since become known as the aero-plane. Manly made a number of experiments, and finally decided on radial design, in which the cylinders are so rayed round a central crank-pin that the pistons act successively upon it. By this arrangement a very short and compact engine is obtained, with a minimum of weight, and a regular crankshaft rotation and perfect balance of inertia forces. When Manly designed his radial engine, high speed internal combustion engines were in their infancy, and the difficulties in construction can be partly realized when the lack of manufacturing methods for this high-class engine work, and the lack of experimental data on the various materials, are taken into account. During its tests, Manly`s engine developed 52.4 brak horsepower at a speed of 950 revolutions per minute, with the remarkably low weight of only 1.09 kg per horsepower, his latter was increased to 1.64.

METHODOLOGY

This sequence of methodology is listed below:Problem formulation and identification through literature survey from various ASME journal, Wikipedia and websites collected towards the present research topic. Understanding the working principle of the master rod used in radial engine and reasons for its failure.Modelling of master rod of different geometry in CATIA V5 R20.Static structural analysis in ANSYS 14.5 workbench carried out to determine structural strength of the master rod.Fatigue analysis of master rod of radial engine in ANSYS 14.5 under different boundary conditions carried out to determine the failure life of master rod.Selection of materials for the master rod. Applying the material property for the master rod. Comparing the materials and showing that which material is best for the master rod. Comparisons and validations of the results and improve the fatigue life.

ISSN- 2394-5125 VOL 10, ISSUE 03, 2023

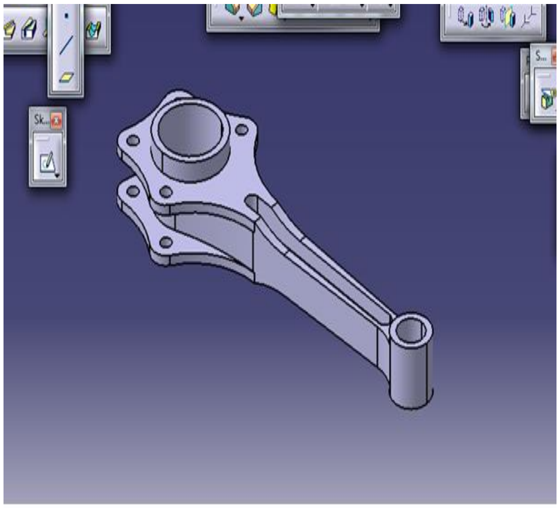


Fig 1 Making of Master Rod

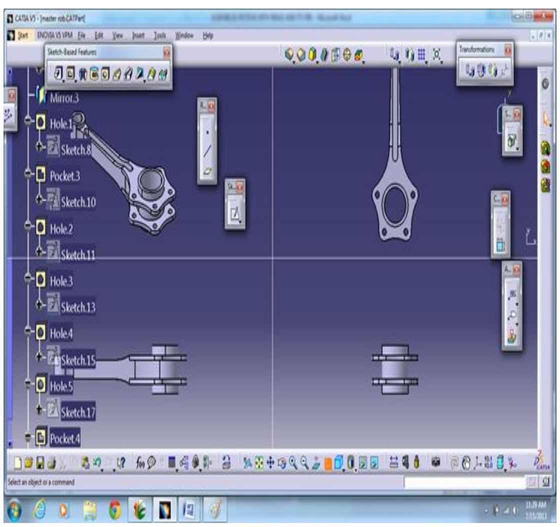


Fig 2 Views of Master Rod

Assembly and Optimization of Radial Engine

Parameters of the Master Rod	
Thickness of the master rod	5mm
Width of the section (B=4t)	20mm
Height of the section (H=5t)	25mm
Height of the big end	28mm
Height of the small end	23mm
Inner diameter of small end	24mm
Outer diameter of small end	35mm
Inner diameter of big end	52mm
Outer diameter of big end	69mm

Table 1 : Parameters pf the Master rod

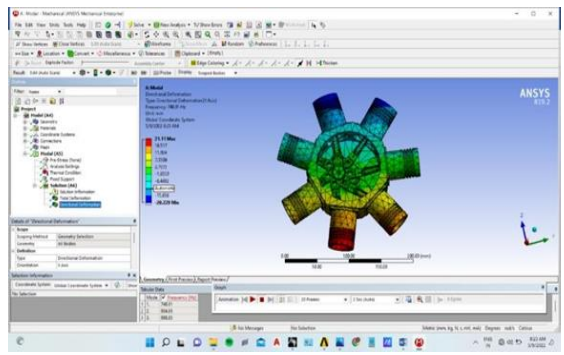


Fig 3 Directional Deformation

RESULTS AND DISCUSSION

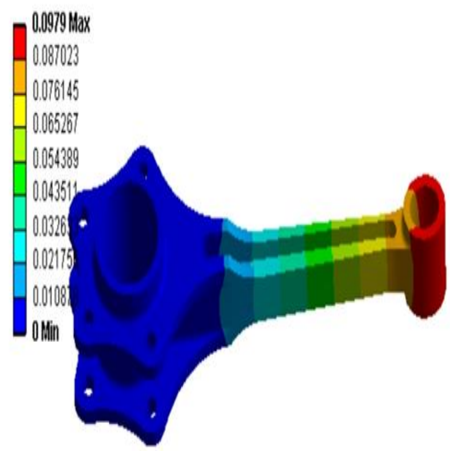
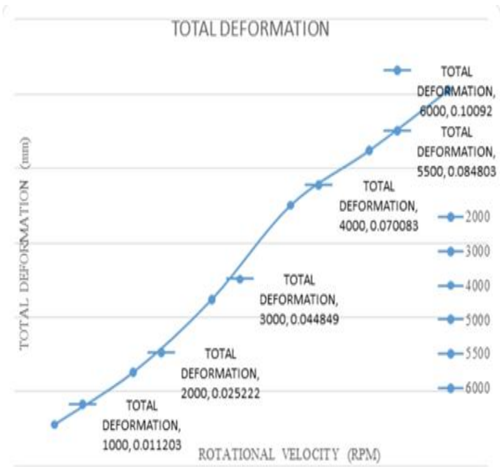


Fig4.1 : Deformation in the rod for steel

STRUCTURAL STEEL GRAPH



Graph 1: Deformation v/s Rotational velocity

CONCLUSION

The static analysis maximum equivalent stress distribution in radial engine connecting rod is 131.28Mpa. The maximum stress occurred at crank end and yield strength of steel material is 250Mpa, working stress is 131.28Mpa, which is much less than the yield strength of the material hence rotational velocity of 6000rpm to radial engine connecting rod is applied by considering the factor of safety within the range of 1.5 to 2, once increased in rotational velocity above 6000rpm for steel, connecting rod will leads to fail, hence maximum rotational velocity should be within 6000rpm for steel material. Radial Engine is a new revolution of the Flying vehicle department & it is a key research topics for engine researcher. It was play the main role in Air-force Department and help for the engineers to get a idea for making a new innovative and more efficiency full various typed Engine. Designing of an engine at all is a very complicated process which involves serious of other processes that are hard to be designed. It takes a very long time of thinking of the proper dimensions, proper material and even the proper shape of all different parts. The design of the radial engine is not less complicated process than any other engine. It has crank case that is a little bit different than the other engines but although that is hard to be figured out too. It also has pistons, cylinders, rods, it has a cam mechanism that in the ordinary engines is called cam shaft, and lets not forget about the gear mechanism that is some ways different than the gear mechanism in the ordinary engines but the way it works is the same in both engines. And the crank shaft- the same as in an ordinary engine but with less journals, easier to be manufactured. The crank shaft is a really amazing part of the engine, torque is transmitted into distance is exciting. After all difficulties about dimensions, shape, different mechanism and nevertheless calculations about the stress and the strength of the materials the radial engine came to an end.

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ISSN- 2394-5125 VOL 10, ISSUE 03, 2023

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