THREE CYLINDER COMPRESSED AIR RADIAL ENGINE

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ABSTRACT

In this paper designing of three cylinder pneumatic engine is done on Solidworks and also static analysis is done on it. The design used for pneumatic cylinders is highly efficient and can be used for vehicle propulsion and lifting light weights. The main advantage of air radial engine is that no pollution is produced and as no combustion takes place, so no hydrocarbon is produced. We have done the assembly and made the parts of the engine in solidworks software. Also the stress, strain and other analysis is done. The material used for parts is suggested such that our design is more efficient and cheap. The selection of different material helps us to get an engine with high strength.

Key words: *Pneumatic Engine, Intended For, Main Advantage, Solidworks, Stress-Strain Analysis, Assembly, Material Selection, Cheap and Efficient.*

1. INTRODUCTION

Nowadays, the use of fossil fuel to produce energy or used as an engine in automobiles is becoming a concern due to the limited availability of fossil fuels. Moreover, this lead to cost addition to the production. As we know due to increase in the greenhouse gases and global warming, environmentalists and people are more concerned and enthusiast to "go green" and use green technology that is non-polluting eco-friendly technologies. But the point is that the eco-friendly technology replacing the old technologies should be equally or effective than the old technologies. Also the cost value of the product is also an important aspect in this innovation aiming era. There are many innovations which can be potentially useful but are not feasible because of its production cost or effectiveness.

At the present time, a new direction in designing automobile using the compressed air technologies and pneumatic power plants is being developed. Compressed air engine having the high efficiency as compared to gasoline engine and correspondingly low consumption of compressed air are necessary for development of non-polluting pneumatic automobile that run on compressed air. Moreover, the availability of compressed air is abundant and it is eco-friendly as no hydrocarbon is burnt in the process and no waste is produced. Also it is a non –polluting source of energy. The piston expansion machine based on pneumatic cylinder most closely corresponds to this criterion. As we know this is may be an important fuel for future generation many research is also being done in this field. Recent

developments in pneumatic servo system and innovative pneumatic components show important advances, which are expected in vehicle applications also.

In this project, we are going to design a three cylinder compressed air radial engine. We are going to design its parts and do the assembly as well as we go for the stress, strain and displacement analysis which will help us in deciding the feasibility and practicality of our design. We also going to learn about the problems faced during assembly and material selection for the three cylinder engine. Also the reason for selection of various points during our design process. In three cylinder radial engine the reciprocating motion of piston is converted to the rotating motion of flywheel which is done by connecting a shaft to flywheel at one end and piston holder at other. The cylinder radial engine not only have application as an automobile engine but it can also used in industries for carrying loads or may be used as a belt mover in the conveyor. This may also be used in production of electricity for small scale use like mobile charging etc. we have chosen this design because it has variety of application and abundant positive points for society and as well as environment.

2. LITERATURE SURVEY

"Thermal Engineering" by R.K.Rajput was referred for selecting the type of engine. There are various types of engine available like inline, v type, etc. but we choose radial engine because the main cause is power production by it is very high which is very necessary for us. Moreover, in radial engine all the pistons are in the same plane, they all get even cooling and normally can be air-cooled. That saves the weight of water-cooling. Instead of the long shaft that's used in a multi-cylinder car engine, there is a single hub -- all of the piston's connecting rods connect to this hub [1].

W.D. Callister, Jr.,(2010), "Materials Science and Engineering": An Introduction, 8th edition,Wiley & Sons this book was referred for the selection of material for the different parts of three cylinder compressed air radial engine. The parts were chosen on the basis of its strength, cost, its durability and lightness of the model which effect its efficiency [2].

Reciprocating Compressor Performance and Sizing Fundamentals, A Practical Guide to Compressor Technology, Second Edition, By Heinz P. Bloch Copyright 2006 John Wiley & Sons, Inc. and Compressor hand book, Paul C. Hanlon Editor, McGraw-Hill were referred for the compressor. Its very important to know how to use air compressor efficiently and effectively. Moreover, to know about the mathematical calculations to check the feasibility of our design this book was referred [3].

J.m.tressler, T.clement, H.kazerooni, M.lim, Dynamic behavior of pneumatic system for lower extremity extenders, university of California at Berkeley,(2002 IEEE) this paper was referred for leaning the use of pneumatic system [4].

Engineering analysis with solidworks" by Pail M.Kurowski was used to know how to create different parts of the assembly and then assemble them into one single body in solidworks software. This book also helped in stress, strain and displacement analysis of the assembly and used to remove any errors came during analysis [5].

"Design for assembly" by Boothray it was referred for the assembly of our design. This book was used to know how to create different components of our assembly [6].

Sasa Trajkovic, The Pneumatic Hybrid Vehicle, A New Concept for Fuel Consumption Reduction, Doctoral ,thesis, Division of Combustion Engines, Department of Energy Sciences, Faculty of Engineering, Lund university done paper on this topic which helped in designing and understanding pneumatic system [7].

Mohammad Masood, Compressed Air Engine: A New IC engine that can work on compressed air Designed & Developed, Associate Professor, Mechanical Engg.Dept., M.J. College of Engg. & Technology, Banjara Hills, Hyderabad, A.P. India the written paper was used to know application of our design in automobile field [8].

3. ASSEMBLY

PARTS (with color coding) As shown in fig.1:-

- Piston (black):- It is made of brass as it has lower friction and moreover it can resist high pressure.

(Other parts are made from mild steel because it is cheap.)

- Flywheel (black checks)
- Cylinder (red)
- Cylinder holder (blue)
- Hexagonal bolts (big –green, small-yellow)
- Shaft (dark red)
- Base (green)
- Piston holder(purple)

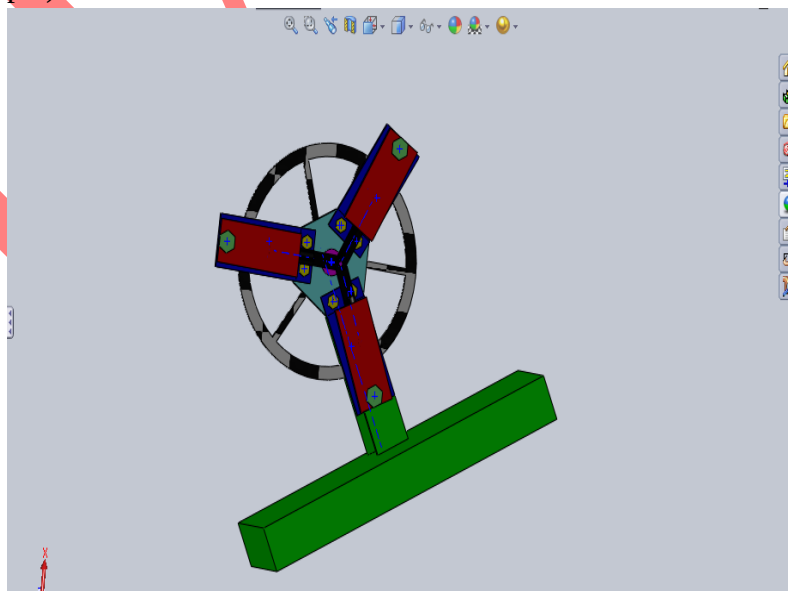

Fig.1:- Solidworks design of three cylinder air radial engine

4. RESULT & DISCUSSION

Table.1:- Units used

Unit system:	SI
Length/Displacement	mm
Temperature	Kelvin
Angular velocity	rad/s
Stress/Pressure	N/m^2

Table.2:- Material Properties

No.	Body Name	Material	Mass	Volume
1	Cylinder	Plain Carbon Steel	2.20333 kg	0.000282478 m^3
2	Cylinder	Plain Carbon Steel	2.20333 kg	0.000282478 m^3
3	Cylinder	Plain Carbon Steel	2.20333 kg	0.000282478 m^3
4	Small bolts	Plain Carbon Steel	0.0223316 kg	2.86302e-006 m^3
5	Small bolts	Plain Carbon Steel	0.0223316 kg	2.86302e-006 m^3
6	Small bolts	Plain Carbon Steel	0.0223316 kg	2.86302e-006 m^3
7	Small bolts	Plain Carbon Steel	0.0223316 kg	2.86302e-006 m^3

8	Small bolts	Plain Carbon Steel	0.0223316 kg	2.86302e-006 m^3
9	Small bolts	Plain Carbon Steel	0.0223316 kg	2.86302e-006 m^3
10	Hexagon holder	Plain Carbon Steel	3.89342 kg	0.000499157 m^3
11	Supporter	Plain Carbon Steel	3.21903 kg	0.000412696 m^3
12	Supporter	Plain Carbon Steel	3.21903 kg	0.000412696 m^3
13	Supporter	Plain Carbon Steel	3.21903 kg	0.000412696 m^3
14	Main frame	Plain Carbon Steel	269.101 kg	0.0345001 m^3
15	Piston	Brass	0.315099 kg	3.70705e-005 m^3
16	Piston holder	Plain Carbon Steel	0.104462 kg	1.33926e-005 m^3
17	piston	Brass	0.258839 kg	3.04517e-005 m^3
18	piston	Brass	0.269918 kg	3.17551e-005 m^3
19	Big bolts	Plain Carbon Steel	0.10097 kg	1.29449e-005 m^3
20	Big bolts	Plain Carbon Steel	0.10097 kg	1.29449e-005 m^3
21	Big bolts	Plain Carbon Steel	0.10097 kg	1.29449e-005 m^3

22	Extra portion	Plain Carbon Steel	1.0647 kg	0.0001365 m^3
23	Fly wheel	Plain Carbon Steel	5.40189 kg	0.00069255 m^3
24	shaft	Plain Carbon Steel	0.159279 kg	2.04204e-005 m^3

Table.3:-Mesh Information

Mesh Type:	**Solid Mesh**
Mesher Used:	Standard mesh
Automatic Transition:	Off
Smooth Surface:	On
Jacobian Check:	4 Points
Element Size:	33.654 mm
Tolerance:	1.6827 mm
Quality:	High
Number of elements:	23610
Number of nodes:	37562
Time to complete mesh(hh;mm;ss):	00:00:11

Table.4:- Results

Name	Type	Min	Location	Max	Location

Stress1	VON: von Mises Stress	56832.9 N/m^2 Node: 4212	(-19.9162 mm, -104.092 mm, 320.142 mm)	2.30865e+009 N/m^2 Node: 37346	(-67.7122 mm, -111.915 mm, 371.176 mm)
Displacement1	URES: Resultant Displacement	0 mm Node: 2605	(-259.826 mm, 29.0004 mm, 311.866 mm)	10.2983 mm Node: 36928	(88.1003 mm, -187.882 mm, 476.398 mm)
Strain1	ESTRN: Equivalent Strain	4.83491e-007 Element: 2702	(-41.9675 mm, -60.0817 mm, 321.403 mm)	0.00965053 Element: 23608	(-68.1514 mm, -111.21 mm, 369.389 mm)

- We have done stress and strain analysis of three cylinder air radial engine through solid works software.
- The following three slides contains the images of our analysis.
- By applying forces and pressure at different part of our assembly.

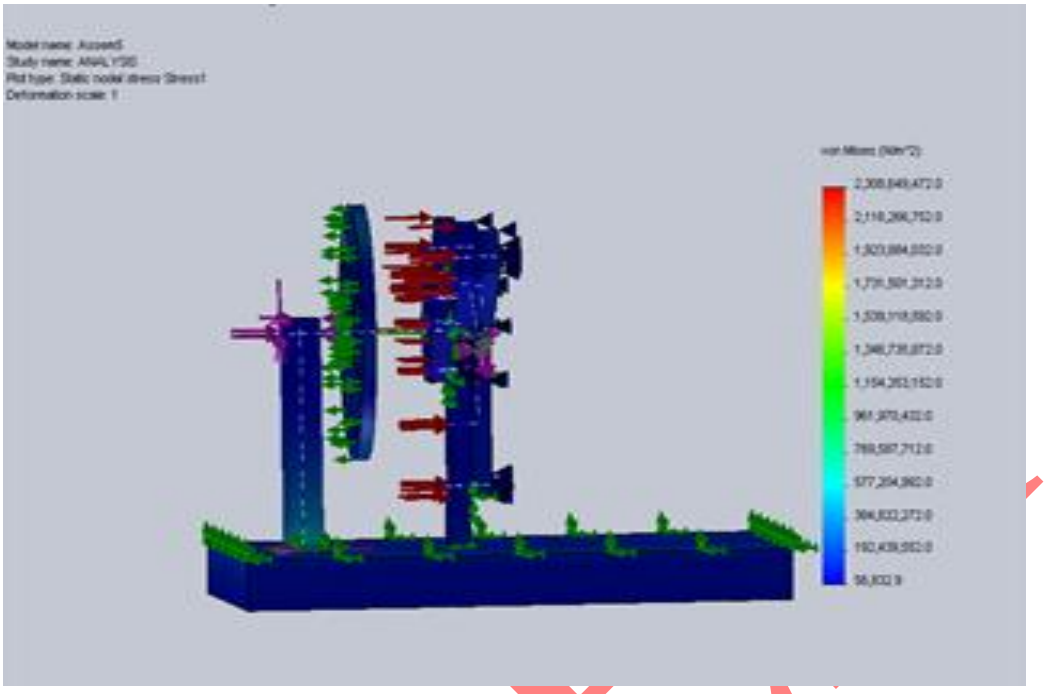

Fig.2:- Von Mises Analysis

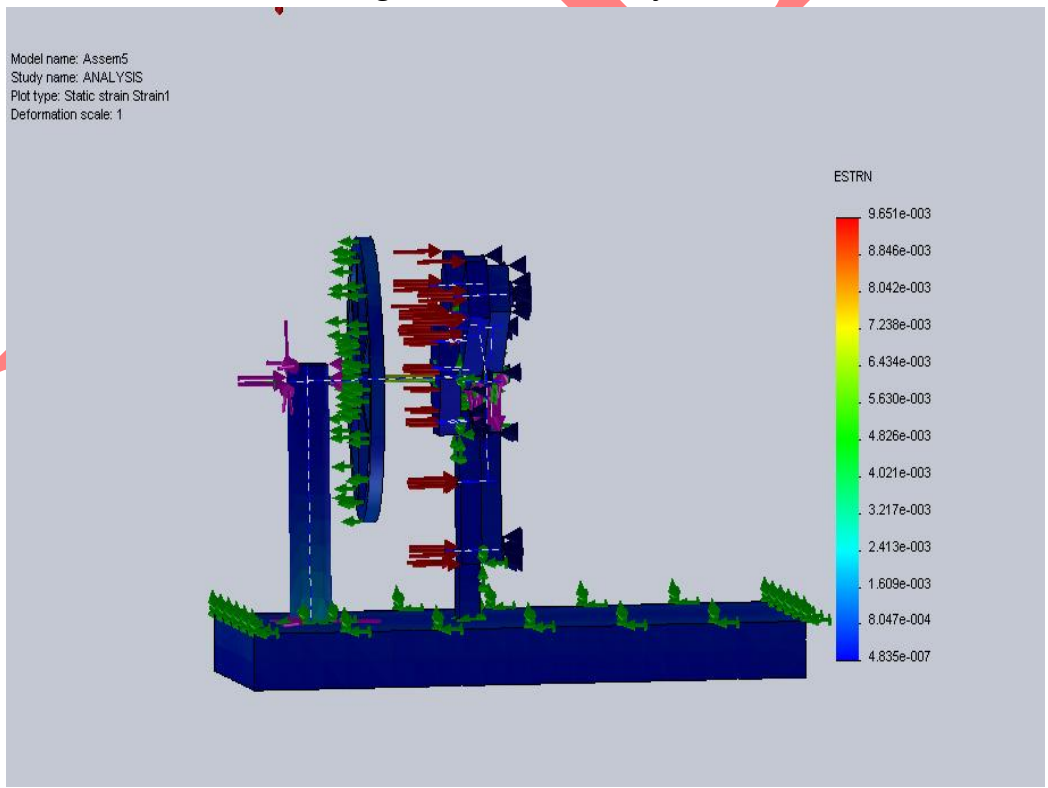

Fig.3:- Static strain analysis

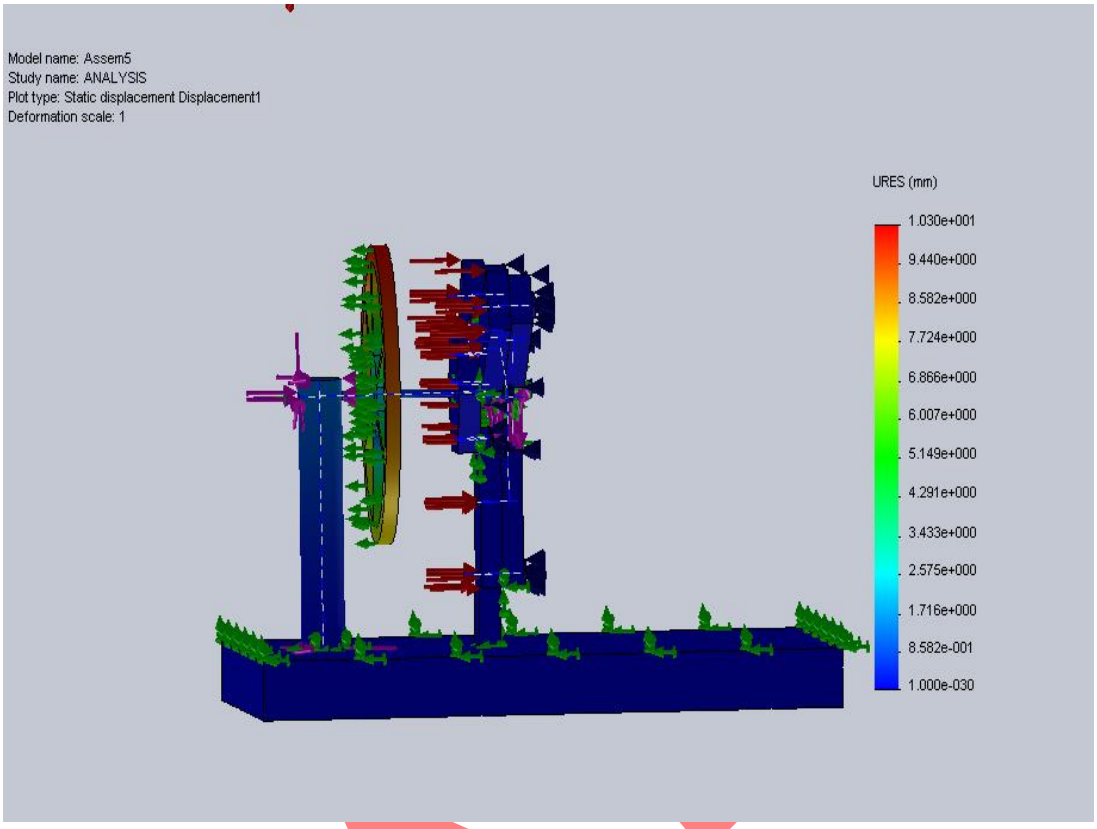

Fig.4:- Static displacement analysis

During analysis the main problem faced is the mesh error, which was coming mainly due to the imperfection in our design.

- Mesh error was removed by changing the assembly and using the parts of correct dimensions.
- Material was chosen so that engine have high strength and high efficiency.
- We successfully completed the assembly and stress strain analysis of our design through solid work software.

5. CONCLUSION

- We can conclude that the dimensions should be carefully taken as inlet and outlet valve are placed on the cylinder support accordingly.
- After analysis the final color key shows the stress and strain at different point and how much stress that the material can resist.
- Also it shows how much more force can be applied before failure of design.
- After completing our design assembly and analysis one can easily design and create a prototype or hardware model of three cylinder air radial engine.

6. REFERENCES

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