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DESIGN AND LOAD ANALYSIS OF PNEUMATIC PRESS MACHINE FOR AUTOMOBILE WHEEL HUB ASSEMBLY – A CASE STUDY

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ABSTRACT

The oil seal is an important component used in the hub of the axle assembly to restrict the grease flow from the hub and to hold the bearing in position, while the vehicle is in the running condition. The process carried out in fixing of oil seal is done using various methods like hammering and fixing it using fixtures, but these methods leads to more damage to the oil seal while fixing it, so it leads to excess scrap, which increases total cost of the component. So to overcome this problem we designed a pneumatic press machine for fixing the oil seal in the hub of axle assembly as an automation or Non-automation process using the concept of low automation process. We have designed this system and analyzed the press machine using Solid works Simulation 2013 Software to check whether the system suits for the process or not and we have designed this set up in such a way that it is suitable for all types of hubs both front and rear axle assemblies. We hope that, this idea will satisfy the industrial needs.

Keywords: Pneumatic Press Machine, Oil Seal, Hub of Axle assembly, Low Cost Automation.

INTRODUCTION

Front and Rear axle system plays an important role to transmit the power to the wheels. The rear axle transfers to the rear wheels through the differential. The tires are connected to the hub of front and rear axle. We have noticed a problem in the assembly of hub in front and rear axle. The problem that we noticed was fixing of oil seal in the hub. This is done manually by hammering on die over the oil seals. This is leading to damage of oil seals and leading to excess scrap or in future may lead to oil leakage in the hub. Thus we have given a proper solution as the Alternate way of fixing oil seal in hub of axle assembly using pneumatic system. We have designed this setup in such a way that it is suitable for all types of hubs both front and rear. We hope that, this idea will satisfy the industrial needs at shop IV.

Ravi.D, The author investigated the finite element modeling of 'C' frame power press of 10 ton capacity and to analyze the power press under static condition. Santosh kumar.S, et al Describes that using the optimum resources possible in designing the hydraulic presses frame can effect reduction in the cost of the hydraulic presses. Arun.S, et al, They proposed work describes the design and fabrication of prototype of automatic punching machine controlled by PLC and shedding light on the working principle and the hardware structure of the system. Chauhan.H.N, et al , Metal forming is one of the manufacturing processes which are almost chip less. These operations are mainly carried out by the help of presses and press tools. Gaurav Pradip, et al, This paper includes the concept development, design, analysis and manufacturing of press machine. Various parts of the press are modeled by using Pro-E modeling software. Structural analysis has been applied on the parts of press machine by using analyzing software ANSYS.

Case Study: The case study was taken from one of the automobile industry; they are manufacturing axle assemblies of heavy duty vehicles (both front and rear axle assemblies) in automobile field. In the construction of axle assembly there was an important part called as hub which holds many part into it and there was a problem identified in the fixing of oil seal in the hub of axle assemblies due to the improper method carried out in fixing it. To overcome the problem a suitable solution was suggested.

Problem Definition: The hub assembly of front and rear axle has various stages. In every stage always some problem arises. Among these problems, the miscellaneous problem that we have noticed is Fixing of oil seals to the hub. During the assembly of the hub , first the lubricated bearing is fitted to hub then the oil seal is fitted.

Fig.1 : Oil Seal Damage

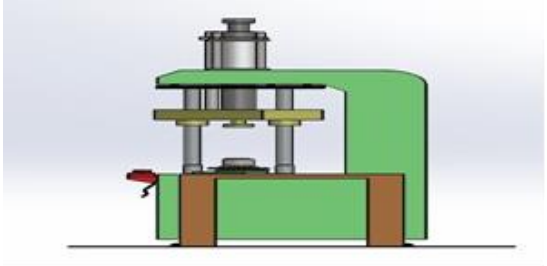

Fig.2: Design Model of pneumatic press

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The purpose of oil seal is to avoid leakage of grease from the bearing. The process involved in fitting of oil seal is continuous Hammering of oil seal using fixture of required shape in the hub manually. Fig.1 shows the image of oil seal damage during fixing of oil seals to the hub.

Causes for the Problem: Presently a Hydraulic Press machine is used for pressing the oil seal in the hub, which uses more than (5-6bar) pressure for operation which is more than the required pressure that leads to damage of oil seal, some damages are made after its final assembly, due to its running time. Though hydraulic presses reduces fixing time and gives even seating of oil seal but sometimes due to high pressure it damages the oil seal.

Proposed Methods: We are going to design a Pneumatic Presses with analysis various load condition to fixing a oil seal. A pneumatic is a press machine which operates by compressed air , normally at a pressure up to 5 bar and a maximum force of up to 50 kilo Newton can be used . A pneumatic press machine is designed using solid works software for oil seal pressing using suitable conditions. Fig.2 shows the modeled image of pneumatic press.

Material Selection: Material is selected for frame and machine bed based on properties such as high bending & tensile strength, ease of availability, ease of machining, welding, finishing, cutting etc. Mild steel/plain carbon steel (25C8/AISI 1025) is used. Material Properties of 25C8 are given in Table 1 Below:

Table 1: Material Property

Parameter	Details
Material	25C8
Tensile Strength	390N/mm²
BHN	170HB
Elastic module	210Gpa

Frame Design: The Structural design of the frame depends on the pressing force this determines the required rigidity, the dimension of dies influencing the size of the tool area, work area accessibility that determines on the shape of the press frame, the degree of guidance precision.

Specification of function: The main function of the frame is to withstand the force developed by the hydraulic cylinder. Frame is used mounting and housing the press accessories like pneumatic cylinder, Support arm etc.

Tensile Strength = 410×10^6 N/mm²
Density = 7850 Kg/m
Young's Modulus = 2.1×10^5 N/mm²
Poisson's Ratio = 0.3
Factor of Safety = 4.0
Max Allowable stress = 410/4
σ = 102 N/mm²

Design Calculations:

$$1.\ \text{Shear Force} = \frac{0.667 \times Su \times W \times t^2}{L}$$

Where, Su = Ultimate tensile stress
W = Width of component
t = Thickness of sheet metal
L = Radius = Rd + Rp + c = 1.5 + 0.5 + 0.2 = 2.2mm
Rd= Radius of the Die
Rp= Radius of the Punch
C = Clearance

$$\text{Shear Force} = \frac{0.667 \times 50 \times 50 \times 1.5^2}{2.2}$$

= 1705.39 N

2. Thickness of the Punch = 1.5 Td
= 1.5 x 12 x F.S (1.4)
= 24mm

$$3.\ \text{Cylinder Thrust}(F) = \frac{\{\pi \times (D - d) \times P\}}{4}$$

Where, F = Cylinder thrust in Kg.
D = Dia of piston rod in cm.
p = Operating air pressure in "bar".
f = spring force in Kg.

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fr = frictional resistance

$$F = \frac{\{3.14 \times (8 - 2.5) \times 5\}}{4}$$

= 226.7kg

4. Air Consumption to ption

$$\text{Forward Stroke } C = \frac{\{\pi \times D^2 \times (P + 1) \times L\}}{1000}$$

Where, D = Dia of piston in cm.
d = piston rod dia.
L = stroke in cm.
P = Air pressure in bar

$$C = \frac{\{3.14/4 \times 8^2 \times 4 \times 28\}}{1000}$$

C = 5.629 ltrs.

$$\text{Return Stroke } C = \frac{\{\pi \times (D^2 - d^2) \times (P + 1) \times L\}}{1000}$$

$$C = \frac{\{3.14/4 \times (8^2 - 2.5^2) \times 4 \times 28\}}{1000}$$

C = 4.079 ltrs.

Hence for one complete cycle of operation for this cylinder, the free air consumption will be (5.629+ 4.079 = 9.708) liters.

5. Distance between Frame and Bed
= Total Length - (Length of Hub + Length of Support arm)
= 80 – (15+25)
= 40mm

Load Analysis: The analysis for the Pneumatic press machine and components is done using Solid Works Simulation 2013 Software. The below analysis results is obtained when the following loads are being applied on the Oil seal.

Stress Analysis: The Section shows the details of finite element analysis of this developed model .The Finite element method is easy technique to the theoritical method to find out the stress developed in various components of press. The analysis were made in 1,2 and 3bar pressure analysis is shown below:

Fig.3: Meshing

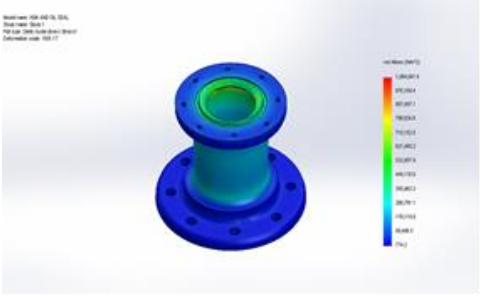
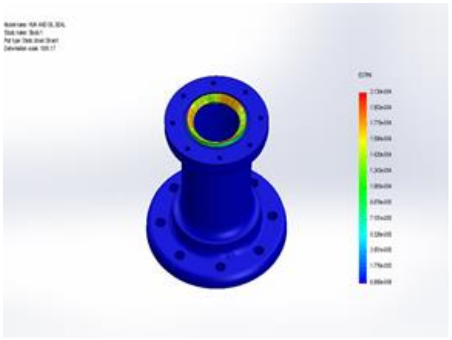


Fig.4: Stress Analysis for 1 bar pressure

RESULT AND DISCUSSION

- Finally a complete design and analysis of pneumatic press machine is obtained and the suitable pressure required for the operation is also found using various analyses.
- From that we come to an end that up to 3 bar pressure is enough for the fixing oil seal inside the hub of axle assembly.



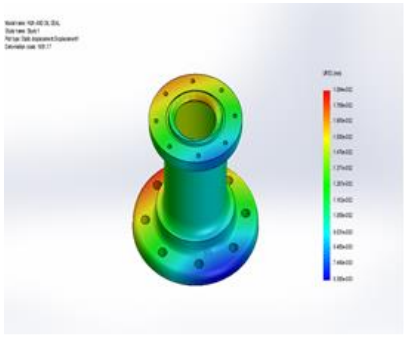


Fig.5: Stress Analysis for 2 bar pressure **Fig.6: Stress Analysis for 3 bar pressure**

Table 2: Comparison of Analysis result

Load	Stress (N/m²)		Strain		Displacement (mm)	
	Min	Max	Min	Max	Min	Max
1 Bar	12949.2	1.74824 e+006	6.29648 e-008	5.50239 e-006	0.00362821	0.0555546
2 Bar	516.122	709894	4.59302 e-009	0.000142013	0.0042633	0.0126247
3 Bar	774.182	1.06484 e+006	6.88952 e-009	0.000213019	0.00639502	0.018937

CONCLUSION

As the main aim of this paper is to improve productivity and reduce the damage of oil seal by using the pneumatic press machine by applying the concept of low cost automation is achieved. We designed a pneumatic press which costs less than that available in the market. We are very good at what we have done and had fun doing it. Our pneumatic press is useful to do simple pressing operations and other simple operations also, so this machine can also be altered to suit for some other operations it is a flexible system and a useful one in also industries. As our Project is based on Design and Analysis of Pneumatic Press, further modifications can be done in the design to suit for the required area.

REFERENCES

Arun.S, Sree Rajendra and Vijayavithal Bongale, Automatic Punching Machine :A Low Cost Approach, International Journal of Advanced Mechanical Engineering,Vol 4,(2014),PP 509-517.

Chauhan.H.N, M.P.Bambhania, Design & Analysis of Frame of 63 Ton Power Press Machine by using finite element method, Indian Journal of Applied Research, Vol 3. (2013),PP 285-288.

Gaurav Pradip sonawane and shailesh vijay,Design,Analysis and Manufacturing of Hydro-Pneumatic press machine, International Journal of computational Engineering Research, Vol 4,(2014),PP 18-26.

Ravi.D, Computer Aided Design and Analysis of Power Press, Middle east Journal of Scientific resarch,(2014),PP 1239-1246.

Santosh kumar.S,Malipatil, Prof. Yogita N. Potdar, Prof. A. C. Mattikalli, Analysis and structural optimization of 5 ton H-frame hydraulic press,International Journal of Innovative Science,Engineering and Technology,Vol 1,July (2014),PP 356-360.