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Design and Manufacturing of Tool to Remove Actuator from Fuel Pump

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Abstract - Fuel pump is the heart of the engine. It is the most vital parts of the engine. PT pump means a pressure time fuel pump. When working, PT fuel pump is responsible for oil regulator, PT injector completes the tasks that generate high pressure and timing injection. The most important role is played by the actuator in the functioning of the fuel pump. It is an electronic device which converts the timing of fuel in the system. To remove this actuator, a fixture is needed to be designed and manufacture. This fixture should be designed in such a way that it should be easy to remove the actuator or fuel pump. Safety considerations and also need to taken into consideration. The material used should be softer than that of the material of actuator so that the actuator does not get any scratches.

Key Words: Fuel pump, Actuator, O-ring, Fixture.

1. INTRODUCTION

Fuel pump is the heart of the engine. It is the most vital parts of the engine. A fuel pump is a component is used in a car or other internal combustion engine device.
PT pump means a pressure time fuel pump. PT fuel system is widely used in the upward 10L Cummins diesel engine. Similarly actuator is the heart of the fuel pump. The actuator is used of timing the fuel supply from the pump. This is also a delicate and expensive part which has to be handled carefully.

In any industry, while designing any machine or tool human safety is the first priority. Human safety is most critical element of an industry. Therefore while designing a fixture safety consideration is necessary.

Fixture is a device used to hold the work piece or support the work piece. Fixtures are also used for locating a device and it also ensure that the production quality while working in the fixture remains the same. Also it reduces the requirement of skilled labor in the industry. Fixture helps in reducing the cost of manufacturing of any component or work piece.

Fig-1: PT Fuel Pump

1.1 PROBLEM STATEMENT

When there is any problem in the fuel pump while testing, the actuator is needed to be removed. Removing this actuator is a difficult task. It is difficult to remove the actuator because of the O-ring. The O-ring is acts as a seal and it gets compressed between two components thus making it difficult to remove the actuator. The previous method of removing the actuator was by using a mallet/screw driver/other tools. This method created a risk of hand injury. Also it was noticed that the actuator was damaged while removing it. Thus to avoid this problem there was a need to design a fixture or a tool to remove the actuator safely and without any damage and hand injury.

Fig-2: Traditional Method of Removing Actuator

1.2 DAMAGED ACTUATOR

When the fuel pump is assembled on the assembly line, it is further sent for testing in a test cell. If any defects observed it is further sent for reworking. During reworking of Fuel Pump the actuator needs to be removed. Actuator needs to be removed if rework of fuel pump is required Actuator mounting bolts were loosened and actuator is pulled by hand to remove it from fuel pump housing. The current Actuator removing process is by hammering and use of screw driver. Due to hammering or using screw driver to remove the actuator as well as fuel pump gets damaged. Dents and scratches appear on the actuator after removing it.

Fig-3: Damaged Actuator

1.3 TRADITIONAL METHOD PROBLEMS

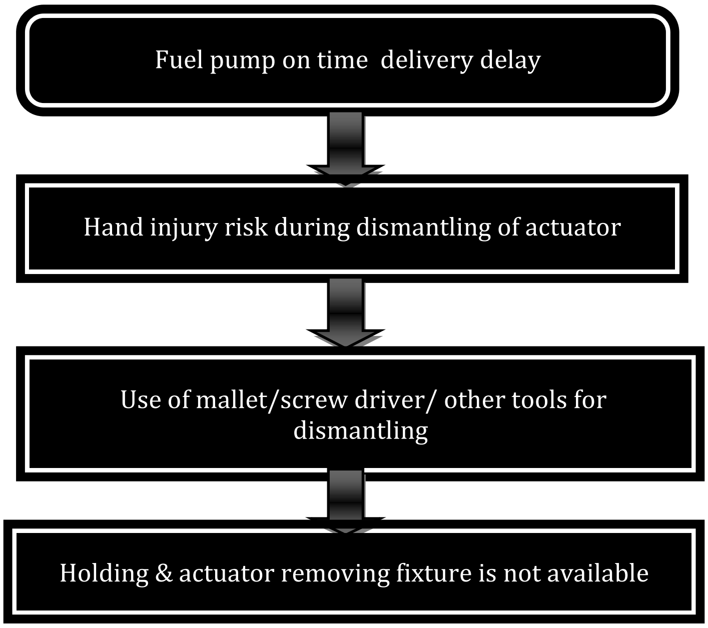


Fig-4: Flow Diagram of Traditional Method

1.4 O-RING

An O-ring is a circular shaped ring made from elastomer or rubber; O-rings are also made from Polytetrafluoroethylene and thermoplastic materials. The O-ring is manufactured by pressure molding process. O-rings are used for sealing. An O-ring is a seal which is used to avoid any leakage of a gas or liquid. In an application with relative motion between the components, to avoid any leakage these O-rings are used.

Fig-5: O-Ring

1.5 METHODOLOGY

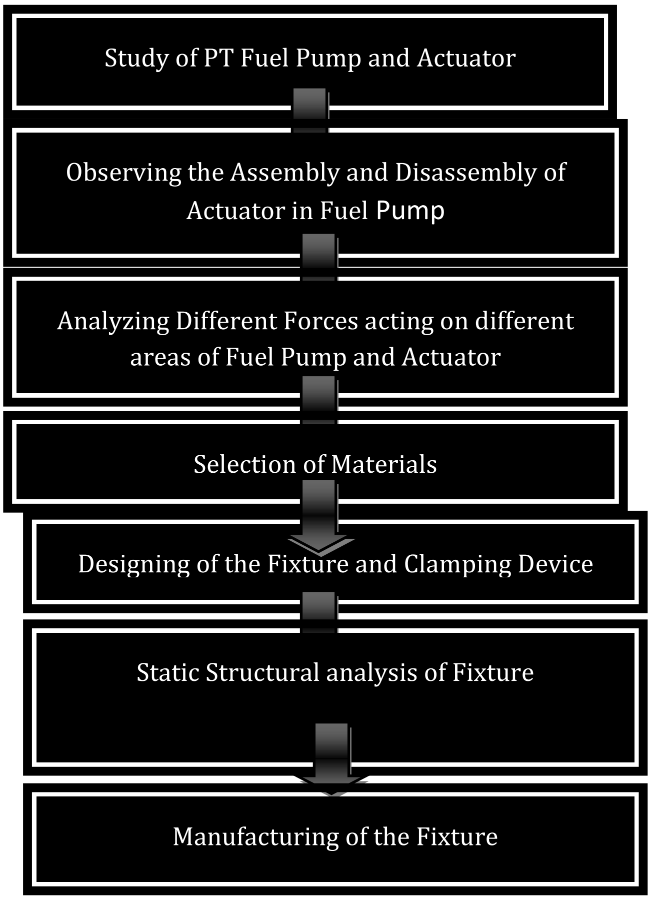


Fig-4: Flow Diagram of Methodology

2. SOLUTION IMPLEMENTATION

- **Material:-** The material used for manufacturing the fixture must be used from the scrap material which is obtained from the reworking or the rejection material. This is mainly to reduce the cost of manufacturing the fixture.
- **Machine:-** The machining operation should also be done in house. The machining operation should be done by available tools by experienced worker.
- **Performance:-** The main aim of this fixture is to avoid any damage of actuator and also for the safety of hands.
- **Manpower:-** The fixture is designed in such a way that it can be handled by any worker whether he is an ITI or Diploma holder.

3.1. DESIGN CALCULATIONS

FORCE REQUIRED TO REMOVE THE ACTUATOR

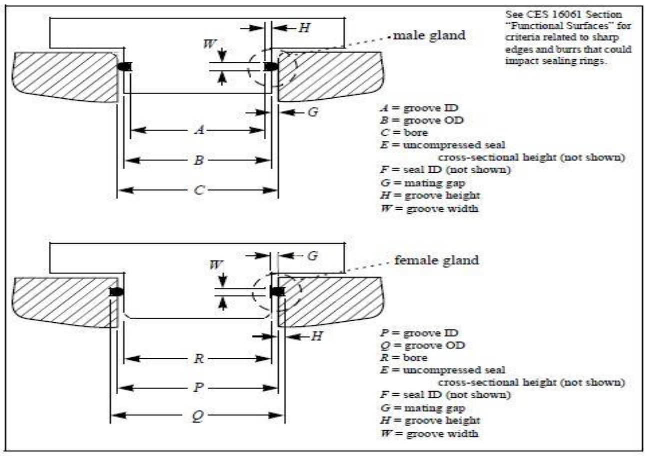


Fig-5: Assembly of Actuator stuck in fuel pump due to O-ring.

- **SEAL COMPRESSION**

Crush (radial) = (E-1/2(C-A)/E)

E=Uncompressed O-ring c/s

= (0.07-1/2(0.9325-0.832))/0.07

= (0.073-0.0515)/.073

= 0.2945=29.45%

FORCE (F) =Fc+Fh

F=Total sealing friction force

Fc=Friction due to seal compression

Fh=Total friction due to hydraulic pressure on seal

=0

Therefore F=Fc

Fc=fc*Lp

fc=Friction due to O-ring compression

LP=Length of the rubbing surface

fc=2

LP=2.95 inch

Therefore,

Fc=fc*LP

=2*2.95

=5.95 pounds

F = Fc+Fh

=5.95+0

=5.95 pounds

1 pound =.4536 kg

1 newton = 0.10197 kg

Force = 26 N

Considering more than 20% - 30%

Therefore **Pulling Force = 30 N**

3.2. DESIGN OF FIXTURE

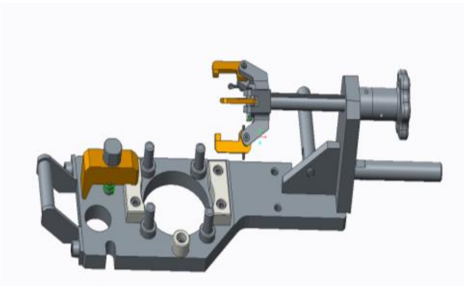


Fig-6: Design of Fixture.

3.2. ASSEMBLY OF FIXTURE AND FUEL PUMP

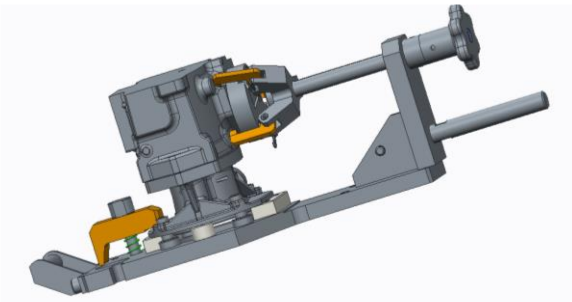
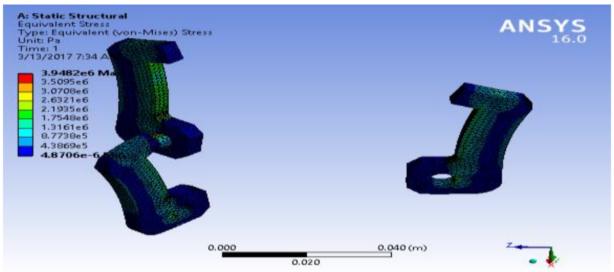


Fig-6: Assembly of Fixture and Fuel pump.

3.3. ANALYSIS OF JAWS

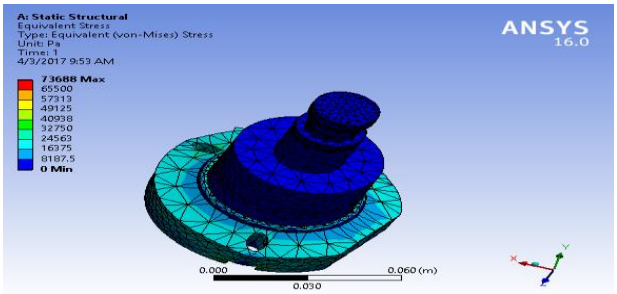


Material of Jaws is Brass.

- Total Force applied = 30N
- Force applied per element of jaw= 30/3
- Stress applied on jaw =80 Mpa
- SUT of jaw= 380Mpa…..(brass material)

Hence, **DESIGN OF JAW IS SAFE**.

3.4. ANALYSIS OF ACTUATOR



Material of Actuator is Steel.

- Total Force applied = 30N
- Force applied per node of actuator= 30/3
- Stress applied on actuator =80 Mpa
- SUT of actuator= 530Mpa…..(steel material)

Hence, **DESIGN OF JAW IS SAFE.**

4.1. TANGIBLE BENEFITS

Performance:-The fixture is manufactured in house. This is done for reducing cost of manufacturing .The fixture is made from the scrap material generated in the company itself. Thus the fixture is very cost effective.

Quality: - Eliminated any possibility of dent mark & damages due to mallet / screw driver usage for part removal. Thus the hands of operator are safe from damage also.

Cost: - The rejection cost of actuator is thus reduced. Zero investment required in completing the project. Approx. savings of 1.5 lakhs per month saved with the help of this fixture.

Risk Analysis: - The risk score is decreased due to elimination of hammer action and screw driver.

4.1. COST SAVING PER MONTH

- Fuel pumps produced per month:-360 to 400
- No of fuel pumps for reworking per month:- 10 to 12
- No. of damaged actuator per month :- 3 to 4
- Cost of one actuator :- Rs 40,000
- Cost saved per month :- 40000*4 = Rs 1,60,000

NOTE- The above cost saving calculation is based on last 2 years observations, and are the average values of the readings.

3. CONCLUSIONS

The efficiency and reliability of the system is enhanced by the fixture. Thus it is more reasonable and cost effective to work with the help of fixture. The designing of fixture in CREO and ANSYS makes the design more reliable. The design of fixture considering the dynamic forces and optimal fixture layout could minimize the deformation of the work piece . The fixture helps to remove the actuator easily without any damage to actuator. The safety of hands of operator has also enhanced. Thus the fixture saves the cost of rejection of actuator due to damage. The fixture manufactured thus saves cost of manufacturing (1.5 lakhs per month on an average).

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