Experimentation to fretting wear and counter measure in dv seat grinding of PF 45 pump.

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Abstract —Companies are experiencing intense competitive pressure due to globalization. Hence the main objective of this company is to satisfy the customer needs and demands. This project mainly focuses on reducing the oil leakage associated with the PF-45 pump assembly line at industrial companies. PF is the German abbreviation for 'PUMP WITH FOREIGN DRIVE '. It is a fuel injection pump used for diesel engine, locomotives, marine engines, agricultural farm equipment's and such other engineering applications.

The key outcome of the project was the reduction of leakage, to increase the efficiency of the pump and to decrease cycle time.

Keywords— PF 45 pump, Barrel, Plunger, Delivery valve, DV seat area.

1. INTRODUCTION

Fretting wear is surface damage that occurs between two contacting surfaces experiencing cyclic motion i.e. Reciprocating motion.

The project aim is to reduce the fretting wear in dv seat grinding of PF 45 pump which causes leakage of fuel and also to reduce cycle time to optimize process flow and to reduce manufacturing cost.

2. OBJECTIVES

- To reduce fretting wear
- To reduce leakage
- To decrease cycle time
- To decrease manufacturing cost
- To increase overall efficiency of pump.

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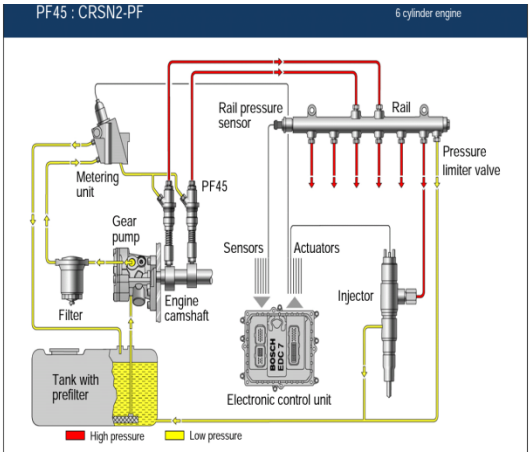
3. LITERATURE SURVEY

Macian et al (2006) analysed the metallic wear debris and Contaminants found in the fuel used by the diesel engine. The particle is subsequently characterized by means of the optical microscope and electron Microscope, where it is possible to establish the type and severity of the Fretting wear, As well as establishing how the machine part is actually affected by wear.

Petkova (1993) carried out the tribological study of the precise plunger friction pairs of fuel injection pump in a diesel engine. The investigation identified the causes of failure of precise plunger pairs and the causes of high wear and surface contact. The study also developed the design, technology, and operating methods for controlling the process of wear.

4. STRUCTURE OF DIESEL ENGINE



In diesel engines air is drawn into the cylinder during the suction stroke and compressed to a very high pressure thus bringing the air up to the temperature required to ignite the fuel oil sent into the cylinder. Consequently the fuel oil has to be injected into the combustion chamber within a precisely defined period of cycle. To achieve smooth and economical operation, the fuel injection system has to supply the engine with fuel.

It mainly consists of:

1 .ECU: It is control unit of diesel engine it controls the flow of diesel at high pressure using different sensors and actuators which senses different parameters.

2. PF 45: It converts low pressure fuel into very high pressure.

i. PF-45 16: operates at 1600 bar

ii. PF-45 20: operates at 2000 bar

3. Injector:At compression stroke injector is actuated and fuel is sprinkled for combustion.

4. Common rail: In Common Rail System (CRS) pumps, Fuel flow is controlled and pumped into the engine as per the engine requirement by Electronic Circuit Unit (ECU). In CRS, the fuel is directly injected into the rail.

5. Tank:It stores fuel and supplies fuel whenever necessary.

5. PF 45

It works under 1600 to 2000 bar pressure the main components of PF 45 are:

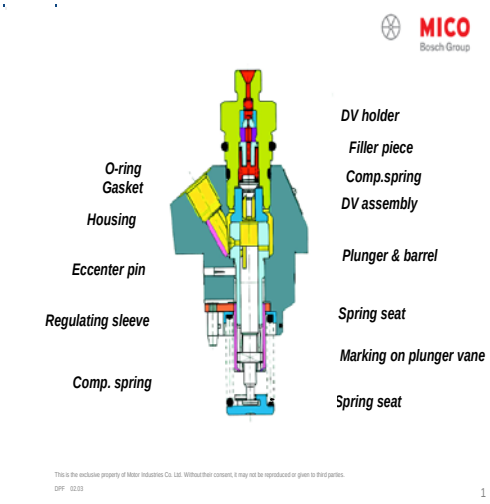
Parts of fuel injection Pump

1. Delivery Valve

2. Plunger and Barrel

3. Roller Tappet

4. Cam Shaft



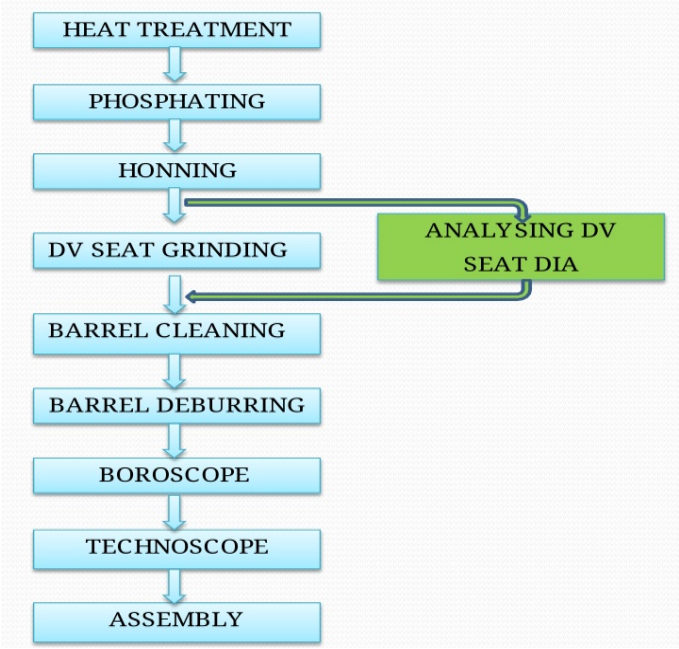
1. **Delivery Valve**: The function of delivery valve is to relive the high pressure delivery line. The delivery valve is of the non-return type. It is seated on a DV holder and is held against the seat by means of a spring. The delivery valve contains a delivery pin that has slot to allow fuel through it when the delivery valve opens.

2. **Plunger and Barrel**: The function of the plunger is to send the fuel to the delivery valve under pressure. The fuel flows into the barrel from the inner port and is delivered to delivery valve from plunger pressurising it through reciprocation. The barrel is honed. The plunger is then match grinded to required tolerance so that no additional sealing is necessary.

3. **Roller Tappet**:The function of the roller tappet is to reciprocate inside the pump and to actuate the plunger. It is in between pump and camshaft it converts rotary motion of cam into reciprocatory motion to plunger.

4. **Cam Shaft**: The function of the cam shaft is to ensure that injection sequence corresponds to the firing order of the engine by means of the cam shaft. The roller tappet converts the rotary motion of the cam shaft to reciprocating movement of the plunger. The cam provides movement up to the top dead centre where the plunger return spring provides movement up to the bottom dead centre.

6. PROCESS FLOW OF BARREL



7. DV SEAT GRINDING

It is removing of material using grinding tool which gives precision and accurate surface finish for delivery valve seating purpose. Grinding operation actually multipoint cutting action on job (rubbing action done on job). Finishing obtained by grinding in microns levels.

Before After

7.1 Grinding Machine Parameter:

Grinding Wheel Speed RPM: 30000rpm

Work head Speed RPM: 250rpm

Clamping Pressure: 11-15 Bar

Hydraulic Pressure: 15-20 Bar

Coolant Pressure: 1.5-3 Bar

Lubricating Pressure: 10-15 Bar

Pneumatic Pressure: 4-8 Bar

Cycle time: 36 sec.

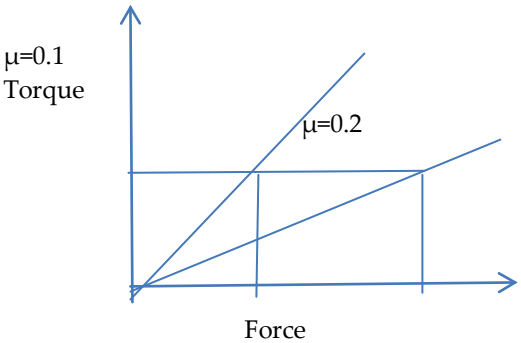
8 CONCLUSION

During torque tightening method preload is setup due to tightening of delivery valve holder to barrel so all the component inside the barrel are in compact position i.e. input/output valve inside the barrel make tight sealing. During operation plunger reciprocates and make I/O valve to compress and decompress due to this small amplitude of vibration is created due to this wear occurs, this wear particles acts as abrasive hence wear rate propagates this lead to decrease in preload.

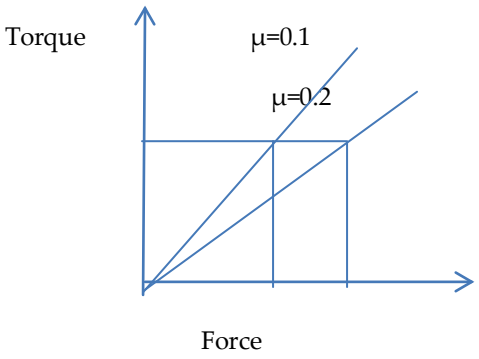
In order to increase preload angle tightening method is preferred instead of torque tightening and also by varying DV seat area.

8.1 Tightening methods

- Torque Tightening:-The amount of preload created when torque is largely dependent on friction.

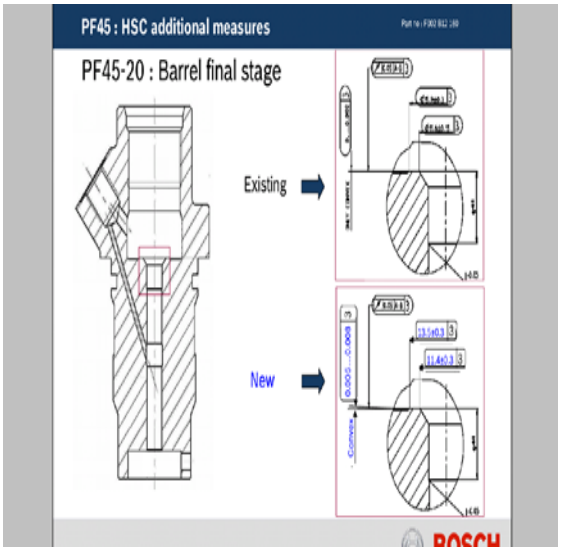


- Angle tightening:-This method also known as turn of the nut method. The bolt being tightened to a predetermined angle beyond the elastic range.



From the above graph angle tightening is preferred over torque tightening, band width obtained from graph is lesser for angle tightening and its about 60 –70 KN. Using this method preload can be improved.

Fretting wear can be decreased by varying Delivery valve seat diameter.



- This can be done by reducing area of dv seat.
- As we know force and pressure related to area as

  P=F/A

Where,

P=Pressure of the fluid(1600 bar) F=Preload which set during dv holder tightening.

A=Area of dv seat.

- As area decrease pressure of the fluid increases for given force.
- As convexity increases area decreases.

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