International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395-0056
Volume: 04 Issue: 11 | Nov -2017 www.irjet.net p-ISSN: 2395-0072

REDUCTION OF IDLE-HUNTING IN DIESEL FUEL INJECTION PUMP

Mr. Veeresha G[1] ,Vijay Kumar S[2] , Chandan Kumar S[3] ,Chetan Kumar Patil[4] ,Shashank Reddy J[5]

[1]*Assistant Professor, Department of Mechanical Engineering New Horizon College of Engineering Bengaluru560103, India*
[2,3,4,5]*Students , Department. of Mechanical Engineering New Horizon College of Engineering Bengaluru560103, India*

***

Abstract- In-line fuel-injection pumps have one pump element for each engine cylinder. These are arranged in a row. The camshaft of the in-line fuel-injection pump is driven by the gear wheels or chains of the combustion engine. The in-line fuel-injection pump runs at half the speed of the engine and always synchronously to the piston movements of the diesel engine. The fuel reaches the nozzle-holder assemblies with the injection nozzles via high-pressure lines. The in-line fuel-injection pump is the "classic" among injection systems. Nowadays it is only to be found in commercial vehicles, buses, building-site and agricultural machines or in stationary diesel engines. It permits injection pressures of up to 1,300 bar.

All injection pumps incorporate a governor to cut fuel supply if the crank speed endangers the engine. The heavy moving parts of diesel engines do not tolerate over speeding well, and catastrophic damage can occur if they are over-revved. Without a governor, the engine would either slow down to a standstill or over revolve uncontrollably when not under load.

Sometimes during idling periods of the engine, speed of the engine fluctuates above and below the idle speed setting. It is mainly due to the governor which controls the engine speed. This is called as idle hunting. The main aim of the project is to pinpoint, analyze various factors resulting in idle-hunting of PE pumps were found. Cause and effect diagram were used to analyze the effects of various factors that lead to idle hunting. Stratification was done to concentrate on a few vital factors or causes that lead to idle-hunting. The root causes were found and the necessary suggestions are suggested to reduce the problem of Idle-hunting.

INTRODUCTION

Fuel Injection System

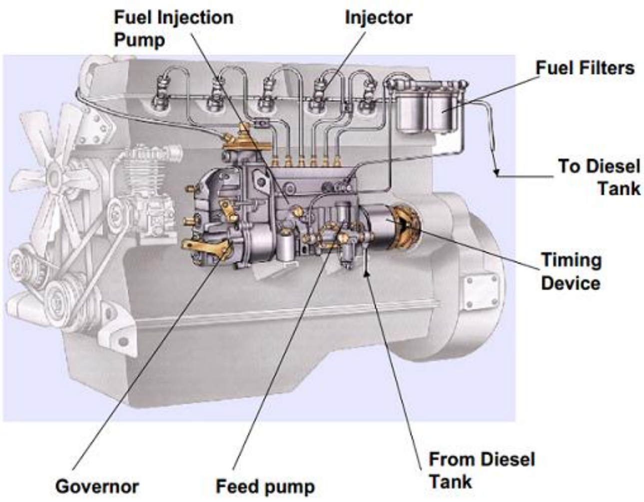


Fig. 2.2 Fuel Injection System

I. The Fuel Injection System is responsible for supplying diesel engine with fuel. To do so the injection pump generates the pressure required for fuel injection. The fuel under pressure is forced through the high-pressure fuel injection tubing to the injection nozzle, which then injects it in to the combustion chamber.

II. The Fuel Injection System has the following components and assemblies. The fuel tank, the fuel filter, the feed pump, the injection nozzles, the high-pressure injection tubing, the governor and the timing device (if necessary).

The combustion process in the diesel engine depends tom a large degree upon the quality of fuel, which is injected, and upon the method of introducing this fuel into the combustion chamber. The most important criteria in this respect are the fuel injection timing and the duration of injection.

IDLING

Generally speaking, idling is the lowest stable operational speed / least fuel consumption state of an engine. Idle state will need to take into account any parasitic loads on the engine as well ambient conditions. For example, if you start your car in a parking lot and your car is in neutral or park, it experiences a different load than if it were in drive (assuming an automatic transmission.) However, if the gas pedal is not pressed and the car is not in motion, both situations would be considered idling - despite the engine requiring more fuel to stay alive when encountering the additional load from the automatic transmission when in drive.

The engine is said to be idling when it is running at the lowest no-load speed without fluctuating. Idling is the phase where the engine runs on when it is uncoupled to the drive train and the throttle pedal is not depressed.

At idling condition, the engine generates enough power to run reasonably smoothly and operate the necessary components of the vehicle, without the actual movement of the vehicle. The engine is not generating any output torque. It is overcoming only the internal friction. Some sources refer to the entire no-load range as idling. The upper no-load speed (breakaway speed) is then called the upper idle speed.

IDLING HUNTING

Idle hunting is the phenomenon during which the speed of the engine (in RPM) fluctuates from its mean position (i.e. the idling speed).

If, during Idle Hunting the speed of engine exceeds the mean speed, more fuel consumption occurs. If, during Idle Hunting the speed of engine decreases below the mean speed, the engine will cut off.

4.1. Causes for idle-hunting

Idle - Hunting can be caused by various factors. In general, they are classified as:

4.1.1. MAN

These are based on human error.

Improper assembly.

Setup verification not done

Wrong interpretation of printed instructions.

Over tightening of screws.

Improper handling leading to damage of man and material.

4.1.2. METHOD

Improper clearance between links.

Casting defects

improper lubrication

Casting defects.

Increased predetermined

Deviation in tolerance level.

4.1.3. MATERIAL

Variant stress concentration.

Improper composition.

4.1.4. MACHINE

Due to continuous use of machines.

Flyweight machining error.

Bending of levers.

No gauge repeatability.

4.1.5. ENVIRONMENT:

Temperature of the surroundings.

Dust particles or metal chips sticking to the elements.

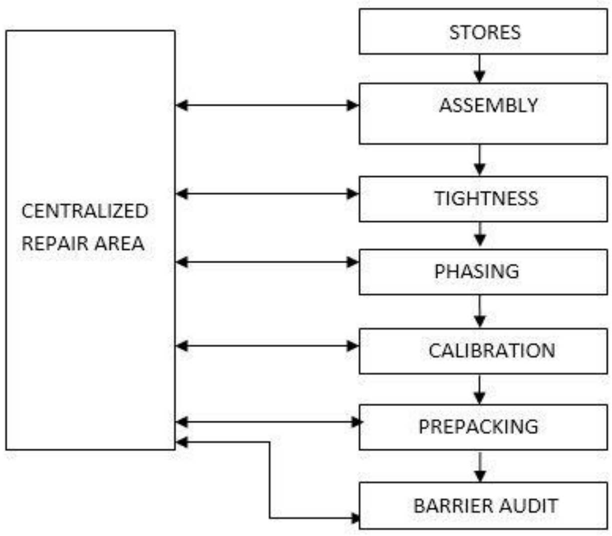
DATA COLLECTION

Data collection is any process of preparing and collecting data, for example, as part of a process improvement or similar project. The purpose of data collection is to obtain information to keep on record, to make decisions about important issues, or to pass information on to others. Data are primarily collected to provide information regarding a specific topic.

Data collection usually takes place early on in an improvement project, and is often formalised through a data collection plan which often contains the following activity:

1. Pre collection activity: agree on goals, target data, definitions, methods
2. Collection: data collection

5.1. Assembly Lines Flow Diagram



The main cause for the idle hunting is CRT. This is encountered in the assembly line, by the manual checking we can easily identify CRT. The pump control rod is spring loaded that it should come back after pushing it into pump, If the rod comes out of the pump the CRT is ok. The same way if it doesn't come back CRT is not ok then CRT exists this is caused due to problem in either pump side or cover side.

Double Lever

In a double-lever type governor for fuel injection pump providing a governor lever and a tension lever, and securing a start fuel increment stroke in the governor lever by the help of a start spring.

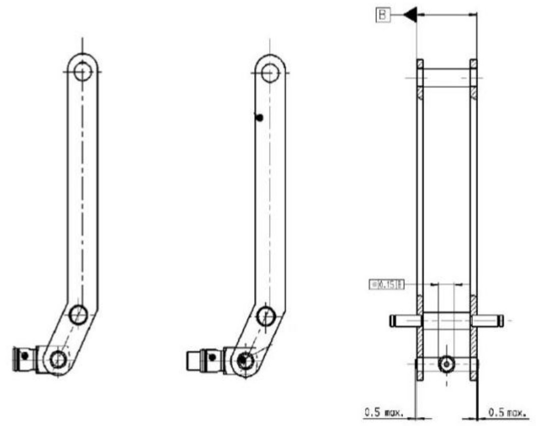


Fig 6.1Schematic diagram of Double Lever

6.3. Shackle Lever.

It is sheet metal member, which connects the control rod and the floating lever. And also maintain a positive contact between the floating lever and control rod.

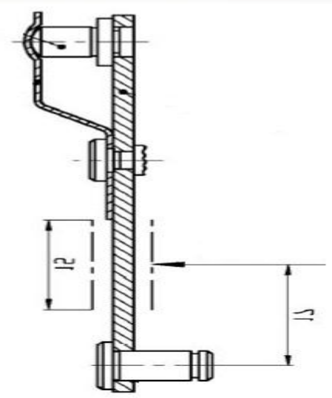


Fig 6.2 Schematic diagram of Shackle Lever

6.4. Floating Lever.

A control lever and a flyweight assembly move a floating lever which determines the position of a control rod which controls the fuel injection volume.

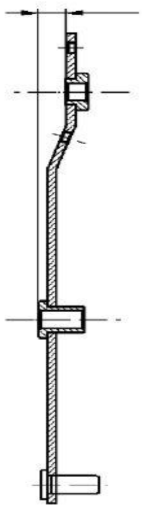
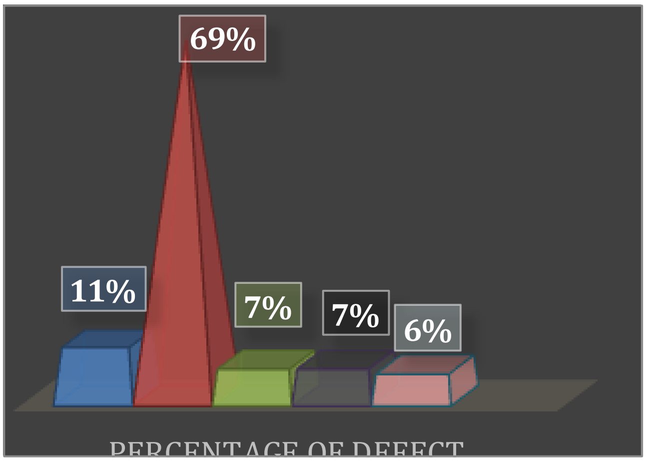


Fig 6.3 Schematic diagram of Floating Lever

Defect Graph



From the above defect graph we can conclude that we have much problem with the floating lever. So we started with making trial batch of floating lever with different dimensions.

6.6. Floating Lever Gauge

An instrument that measures and gives a visual display of the amount, level, or contents of something. It is measuring device, used to check straightness of the floating lever. And also to check the dimension of the floating lever from point A to C and A and B as shown in figure. It is also used for changing the dimension by bending lever in standard fixture in the particular position where the annealing is done.

Fig 6.4 The gauge used for checking straightness of floating lever.

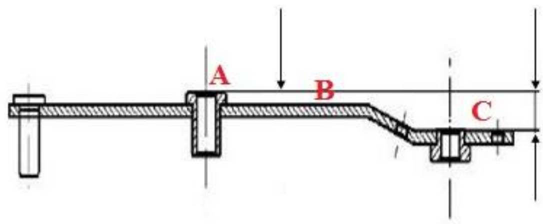


Fig 6.5 Illustration of Floating Lever

To check the gauge repeatability, we took 48 pieces of 2 batch which came out of the straightness station which is having dimension of 5.9$^{+}/_{-}$ 0.3 mm. And we rechecked the dimension with help of digital height gauge. The dimensions where not up to mark.

TRAIL BATCH 2		
FLOATING LEVER DIMENSION		RESULT
5.73		NOT OK
6.34		NOT OK
6.14		OK
6.31		NOT OK
5.82		OK
6.2		OK
5.9		NOT OK
6.24		NOT OK
5.81		NOT OK
6.04		OK
6.1		OK
5.9		OK
6.07		OK
6.1		OK
5.9		OK
6.07		OK
6.1		OK
5.85		OK
6.74		NOT OK
6.1		OK
6.01		NOT OK
5.81		OK
5.6		OK
6.29		NOT OK

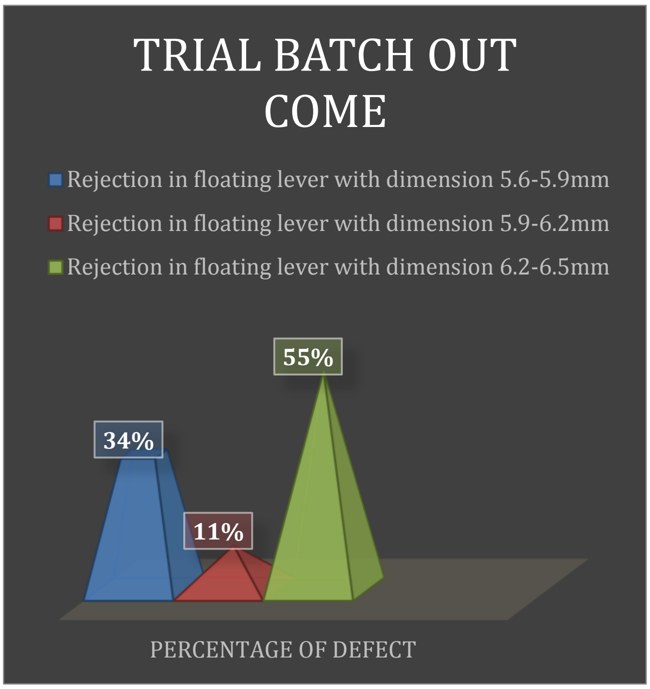
TRAIL BATCH 2		
FLOATING LEVER DIMENSION		RESULT
6.44		NOT OK
6.02		OK
5.95		OK
6.29		OK
6.44		NOT OK
6.25		OK
6.44		NOT OK
5.6		NOT OK
6.21		NOT OK
6.38		NOT OK
6.34		NOT OK
5.55		NOT OK
6.46		NOT OK
5.92		NOT OK
6.13		OK
6.16		OK
6.38		NOT OK
5.97		OK
6.26		NOT OK
5.92		OK
5.93		OK
6.07		OK
6.24		OK
6.31		NOT OK

From the above trial batch, we confirmed that gauge has no repeatability. So we decided to make another trial batch of 24 pieces 3 batches of dimension from A to C. and assemble it to the pump and check for CRT which cause IDLE hunting. Trial batch dimension results are as follows.

TRIAL NO 1		
FLOATING LEVER DIMENSION	5.6 to 5.9	RESULT
5.75		OK
5.85		OK
5.82		OK
5.59		NOK
5.52		NOK
5.78		OK
5.51		NOK
5.49		NOK
5.71		OK
5.95		OK
5.64		OK
5.88		OK
5.73		OK
5.8		OK
5.74		OK
5.72		OK
5.8		OK
5.55		NOK
5.67		OK
5.7		OK
5.73		NOK
5.85		OK
5.87		OK
5.9		OK
5.82		OK

TRIAL NO 2		
FLOATING LEVER DIMENSION	5.9 to 6.2	RESULT
5.92		OK
5.95		OK
5.97		OK
5.98		OK
6.2		OK
6.02		OK
6.05		OK
6.07		OK
5.97		OK
5.91		OK
5.99		OK
5.99		OK
6.02		OK
6.04		OK
6.08		OK
6.1		OK
6.14		OK
6.18		NOK
6.2		OK
6.17		NOK
6.15		OK
6.16		OK
6.13		OK
5.93		OK
5.92		OK

TRIAL NO 3		
FLOATING LEVER DIMENSION	6.2 to 6.5	RESULT
6.26		OK
6.34		OK
6.44		NOK
6.5		NOK
6.37		OK
6.48		OK
6.22		OK
6.23		OK
6.24		OK
6.34		OK
6.41		OK
6.45		NOK
6.41		OK
6.32		OK
6.22		OK
6.47		NOK
6.49		NOK
6.38		OK
6.28		OK
6.44		NOK
6.26		OK
6.52		NOK
6.54		NOK
6.49		NOK
6.48		NOK



From the above results obtained from trial and error method we can conclude that the rejection rate is very much less in the dimension range 5.9-6.2mm.

Hence by changing the dimension from 6.2mm to 5.9mm the rejection can be reduced.

BEFORE

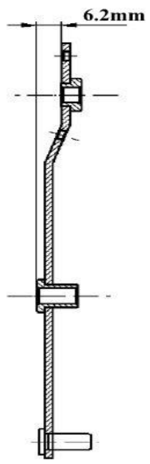


Fig 6.6 Dimension before implementing

AFTER

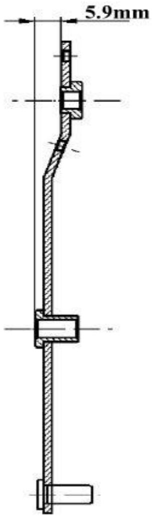


Fig 6.7 Dimension after implementing

6.7 Double Lever Improvements

6.7.1 Four Point Caulking:

This operation is performed on double lever. Caulking is both the processes and material to seal joints or seams in various structures and some types of piping

6.7.2 EFFECTS:

Improves the strength of the joint 4-point calking prevents part move relative to each other

BEFORE CAULKING AFTER CAULKING

Fig 6.7 Schematic diagram of Double Lever caulking.

6.8 Fixture Improvements

Presently used fixture to straighten floating lever.

The fixture shown has many disadvantages such as

1. No repeatability
2. Dial gauge has to be calibrated regularly
3. Process time is more
4. Complex operation

Fig 6.8 Old Fixture

Since the presently used fixture has many disadvantages, so we have proposed new fixture design and proposal has been accepted.

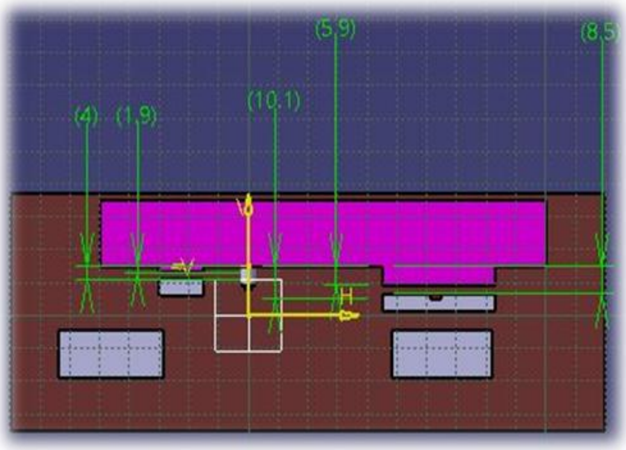


Fig 6.9 New Proposed Fi

ROOT CAUSES

As listed in the cause and effect diagram. Idle-hunting is caused due to many problems in engine, pump calibration, pump assembly and component assembly. But we have we have focused on the most significant root causes that lead to idle-hunting due to CRT (control rod tightness)

7.1 Root causes for idle hunting.

1. Improper dimension of floating lever
2. Bending of shackle, fulcrum and double levers.
3. No repeatability of gauges.
4. Weak double lever caulking strength.

RESULTS AND DISCUSSIONS

Percentage of acceptance

Present method	Proposed method
out of 296 pumps, 25 pumps were being rejected,271 pumps were accepted	out of 296 pumps,5 pumps are being rejected,291 pumps are accepted
271/296*100 = 91.55%	291/296*100 = 98.31%

- Increase in percentage of acceptance to **6.76**%

Economic benefits

Present method

Cost of rework of one pump = Rs 180

No of pumps per shift = 296

Number of rejections per shift = 25

Rework cost=25*180 = 4500

For 3 shift = 4500*3=13500

For 1 week =13500*7=94500

Per month = 94500*4 week = 3,78,000

Proposed method

Cost of rework of one pump = RS 180

No of pumps per shift =296

Number of rejections per shift=5

Rework cost=5*180 = 900

For 3 shifts = 900*3=2700

For 1 week =2700*7=18900

Per month = 18900*4 week = 75600

Repair cost can be reduced from Rs 3,78,000 to Rs 75600

- **Rs 3,02,400** can be saved on rework cost per month.

CONCLUSION

We conclude that by changing dimension of floating lever from 6.2 $^+/_-$ 0.3mm to the 5.9 $^+/_-$0.3mm and by improving double lever caulking process, there will be reduction in the rejection rate of pumps and an increase in the percentage of acceptance by 6.76% and Rs 3,02,400 can be saved on the assembly and rework cost per month.

During manufacturing rejection due to Control Rod Tightness can be reduced by the following methods:

Ensuring parallelism of the governor cover axis and the cover axis can reduce CRT

Bend of floating lever can be verified and corrected by changing the dial gauge position so that straightness of the floating lever is ensured.

Certain changes in dimensions of floating lever reduce friction between floating lever and shackle lever.

While assembling the governor cover to pump housing by screwing in the right sequence CRT can be reduced.

By improving the repeatability of the floating lever fixture.

REFERENCE

Books Referred.

Diesel in-line fuel injection pumps – BOCSH (Automotive technology).

BOSCH automotive handbook.