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Diesel Engine Fuel Pump Pressure, Time Setting and Calibration

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***Abstract:** For a diesel engine, fuel pressure time setting and calibration are very important parameters, which influence and increase the engine efficiency, performance, emissions, and combustion. Other injection parameters affecting engine performance are rate of injection, injection pattern, number of injections etc. A single cylinder research engine was used to experimentally determine the effects of fuel injection strategies and injection timings on engine combustion, performance and emission characteristics. The experiments were conducted at constant speed (2500 rpm) with two FIPs (500 and 1000 bars respectively) and different start of injection (SOI) timings. Cylinder pressure and rate of heat release (ROHR) were found to be higher for lower FIPs however advanced injection timings gave higher ROHR in early combustion stages. Brake thermal efficiency (BTE) increased with increased injection pressures while exhaust gas temperature and brake mean effective pressure (BMEP) increased up to 500 bars. These parameters reduced slightly with increase in fuel pressure time pump.*

Diesel engine combustion quality is based on the formation of fuel-air mixture. Enormous efforts have made to reduce the harmful diesel engine emissions. High engine noise, Particulate matter (PM) and NOx production are the results of improper combustion process and considered as the major constraints. The performance and emission characteristics of diesel engines depend on many parameters. Precise control over the fuel injection process is one of the most important factors and plays a very important role in combustion to increase the engine performance with minimal exhaust emission. The injection system must satisfy high pressure capability, injection pressure control, flexible timing control, and injection rate control. The purpose of this study is to find the performance and exhaust emission of diesel engines by implementing the combination of various high injection pressures and variable injection timings. Present paper is concentrated towords optimization of the best combination of high pressure injection with suitable injection timing in a diesel engine fueled with pure diesel, to reduce the emission and fuel consumption with increased engine power. Keywords: Diesel Engine fuel pump pressure, time,setting and calibration.

I. INTRODUCTION

In the last few decades of global scenario, internal combustion engines utilisation number in automoblie transportation,marine application and stationary sector, increased tremendously.In diesel engine there are four main system are fuel system,lubrication system,cooling system and air system,fuel system is very important system. The fuel pump commonly used in the Cummins PT Fuel System is the PTG-AFC pump (PT pump with a governor and an air-fuel control attachment). The “P” in the name refers to the actual fuel pressure that is produced by the gear pump and maintained at the inlet to the injectors. The “T” refers to the fact that the actual “time” available for the fuel to flow into the injector assembly (cup) is determined by the engine speed as a function of the engine camshaft and injection train components.

In this fuel pressure time system calibration of pump and its parameter i.e fuel pressure,fuel time,fuel flow and engine revolution per minutes[RPM] its depend on standard specific parameters and their values this data given on fuel pump body left side which is shown in figure,as per this available data we have to set and calibrate fuel pump pressure, time,flow and RPM.

Type: Fuel Injection Pump

1) Size: Standard
2) Car Make: Cummins NT855 engine
3) ESN NO.: 3655644
4) Place of Origin: Cummins India
5) Brand Name: Cummins, CCE
6) Model Number: Cummins NT855
7) 3655644 for: cummins fuel injection pump NT855

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Figure- 1: Fuel pressure time pump

A. Fuel Pressure Time Pump

The Cummins PT fuel system is exclusive to Cummins diesel engines; PT stands for “Pressure – Time”. It uses injectors that meter and injects the fuel with this metering based on a pressure-time principle. A gear-driven positive displacement low-pressure fuel pump naturally supplies fuel pressure. The time for metering is determined by the interval that the metering orifice in the injector remains open. This interval is established and controlled by the engine speed, which determines the rate of camshaft rotation and consequently the injector plunger movement.

Serial number and Models 4BT3.9, 6BT5.9, 4ISBE4.5, 6ISBE6.7, QSB4.5, QSB6.7, ISB26CT8.3, L8.9, L9.3, L9.5, ISLe8.9, QSL3MTA11, QSM, ISME4ISF2.8, ISF3.8, QSF2.8, QSF3.85ISZ13, QSZ13, ISG6NT8557KT19, KT38, KT50, QSK19, QSK38, etc8Deutz BFM1013, BFM1015, FL912, FL913, FL914, FL413, FL5139MWM TBD234, TD226B10Perkins 1003, 1004, 1006, 403, 404, 1103, 1104, 110611Isuzu 4JB1, 4HK1, 6HK1, 4BD1, 6BD1, 4KH1, 6UZ112All Weichai engines.All Advance gearbox, marine and industrial Generator sets, marine and land-use.

B. Operating Principle of Cummins fuel PT system

CUMMINS PT FUEL SYSTEM SECTION I Operating Principles Cummins PT Fuel System is a completely new application of basic hydraulic principles to the diesel engine fuel system. It is a Cummins design for Cummins Diesels. The identifying letters, ‘PT,’ are an abbreviation for 'pressure-time.’ The principle of the PT Fuel System is based on the. Industrial Cummins Engine Fuel Injection PT Pumps. We are offering wide range of Cummins Engine Fuel Injection Pump, Cummins Fuel Injection Pump, Cummins Fuel Pumps and Cummins Rotary Pumps. Offered pump is precisely-designed using quality assured components and innovative technology at our state of the art manufacturing unit. Access to Documents and Materials for Your Cummins Products Cummins produces a wide variety of documents to help customers get the most from their engines, generators and components. Much of this library is available online. Check out the digital resources listed below. Fuel supply line restriction between the fuel pump and the injectors. PT fuel pump AFC operation is malfunctioning or pump is not operating correctly. Fuel pump code (calibration) does not match engine (CPL) build. Injector calibration is not correct. Access to Documents and Materials for Your Cummins Products Cummins produces a wide variety of documents to help customers get the most from their engines, generators and components. Much of this library is available online. Check out the digital resources listed below or contact us for help with your specific needs.

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Since Cummins engines are all four-cycle, the camshaft is driven from the crankshaft gear at one-half of engine speed. The fuel pump turns at engine speed. Because of this relationship, additional governing of fuel flow is necessary in the fuel pump.
A flyball type mechanical governor controls fuel pressure and engine torque throughout the entire operating range. It also controls the idling speed of the engine and prevents engine overspeeding in the high-speed range. The throttle shaft is simply a shaft with a hole; therefore, the alignment of this hole with the fuel passages determines pressure at the injectors.
A single low-pressure fuel line from the fuel pump serves all injectors; therefore, the pressure and the amount of metered fuel to each cylinder are equal.

C. Pt Pump Fuel Pressure

1) The fuel-metering process in the Cummins PT fuel system has three main advantages
2) The injector accomplishes all metering and injection functions.
3) The injector injects a finely atomized fuel spray into the combustion chamber at spray-in-pressures exceeding 20,000 psi.

A low-pressure common-rail system is used, with the pressure being developed in a gear-type pump. This eliminates the need for high-pressure fuel lines running from the fuel pump to each injector.

D. Major Function of PT Pump Assembly

The air-fuel control (AFC) is an acceleration exhaust smoke control device built internally into the pump body. The AFC unit is designed to restrict fuel flow in direct proportion to the air intake manifold pressure of the engine during acceleration, under load, and during lug-down conditions.
Within the pump assembly a fuel pump bypass button of varying sizes can be installed to control the maximum fuel delivery pressure of the gear-type pump before it opens and bypasses fuel back to the inlet side of the pump. In this way the horsepower setting of the engine can be altered fairly easily. The major functions of the PTG-AFC fuel pump assembly are as follows:
To pull and transfer fuel from the tank and filter
To develop sufficient fuel pressure to the fuel rail (common fuel passage) to all of the injectors
To provide engine idle speed control (governing)

1) To limit the maximum no-load and full-load speed of the engine (governing)
2) To allow the operator to control the throttle position and therefore the power output of the engine
3) To control exhaust smoke emissions to EPA specifications under all operating conditions
4) To allow shutdown of the engine when desired A major feature of the PT pump system is that there is no need to time the pump to the engine. The pump is designed simply to generate and supply a given flow rate at a specified pressure setting to the rail to all injectors. The injectors themselves are timed to ensure that the start of injection will occur at the right time for each cylinder.
5) The basic flow of fuel into and through the PT pump assembly will vary slightly depending on the actual model. A simplified fuel flow is as follows:
6) As the operator cranks the engine, fuel is drawn from the fuel tank by the gear pump through the fuel supply line to the primary filter. This filter is normally a filter/water separator.
7) The filter fuel then flows through a small filter screen that is located within the PT pump assembly, and then flows down into the internal governor sleeve.
8) The position of the governor plunger determines the fuel flow through various governor plunger ports.
9) The position of the mechanically operated throttle determines the amount of fuel that can flow through the throttle shaft.
10) Fuel from the throttle shaft is then directed to the AFC needle valve.
11) The position of the AFC control plunger within the AFC barrel determines how much throttle fuel can flow into and through the AFC unit and on to the engine fuel rail, which feeds the fuel rail.

The AFC plunger position is determined by the amount of turbocharger boost pressure in the intake manifold, which is piped through the air passage from the intake manifold to the AFC unit. At engine start-up, the boost pressure is very low; therefore, flow is limited. uel under pressure flows through the electric solenoid valve, which is energized by power from the ignition switch. This fuel then flows through the fuel rail pressure line and into the injectors.A percentage of the fuel from both the PT
pump and the injectors is routed back to the fuel tank in order to carry away some of the heat that was picked up cooling and lubricating the internal components of the pump and the injectors.

E. Effect of Injection Pressure On Diesel Engine Performance

The engine performance, power output, fuel economy and emissions are greatly depends on combustion processes. At the end of compression stroke, fuel is injected in to the combustion chamber and atomize into very fine droplets. These droplets vaporize due to heat transfer from the compressed air and also from an air-fuel mixture. Continued heat transfer from hot air to the fuel yields the temperature to reach a value higher than its self- ignition temperature and makes the fuel to ignite spontaneously. By atomizing the fuel into very fine droplets, it increases the surface area of the fuel droplets resulting in better mixing and subsequent combustion. Atomization is done by forcing the fuel through a small orifice under high pressure. For low fuel injection pressure, fuel particle diameters and ignition delay period during the combustion will increase, results in increased pressure and the decrease in engine performance. Increase in the injection pressure leads to reduce the fuel particle diameter, the mixing of fuel and air becomes better during ignition period. The fuel injection pressure in a standard diesel engine is in the range of 200 to 1700 atm depending on the engine size and type of combustion system employed [10]. The fuel penetration distance become longer and the mixture formation of the fuel and air was improved when the combustion duration became shorter as the injection pressure became higher. The effects of high injection pressure benefits are;

Improved fuel atomization producing finer fuel droplets.

The smaller fuel droplets evaporate at a faster rate resulting in rapid fuel-air mixing.

F. Shorter Injection Duration.

With shorter injection duration injection timing may be retarded.

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Fuel may be injected closer to TDC in hotter air giving shorter ignition delay, resulting in emission control.

Higher spray penetration and better air utilization.

The high injection pressure effect on PM-NOx trade off . The width of band on the relates to the contribution of the particulate emissions. As the injection pressure increases the PM-NOx trade-off curve moves closer to origin indicating reduction both in the PM and NOx. Effect of high injection pressure on PM-NOx trad-off for a DI diesel engine.

G. Diesel Timing Importance

According to literature review rightist timing results in lowering emissions of nitrogen oxides(NOx) [2,3]. Lower timing is best for NOx levels, increase in carbon monoxide; hydrocarbon levels and brake specific fuel consumption. In addition to this lowered timing decreases cylinder pressure and reduces peak flame temperature (since the fuel is injected once the piston has past TDC and is already on its way back down the cylinder in the power stroke).

Literatures also suggest that advancing the timing results in increased cylinder pressures and to higher peak flame temperatures which leads to a more complete burn of the fuel injected and the to fuel effect on emissions is significant . In the mean while, the NOx level increases drastically past just a few degrees of advance, while hydrocarbons increase and carbon monoxide decreases.Brake specific fuel consumption drops off quickly as well.

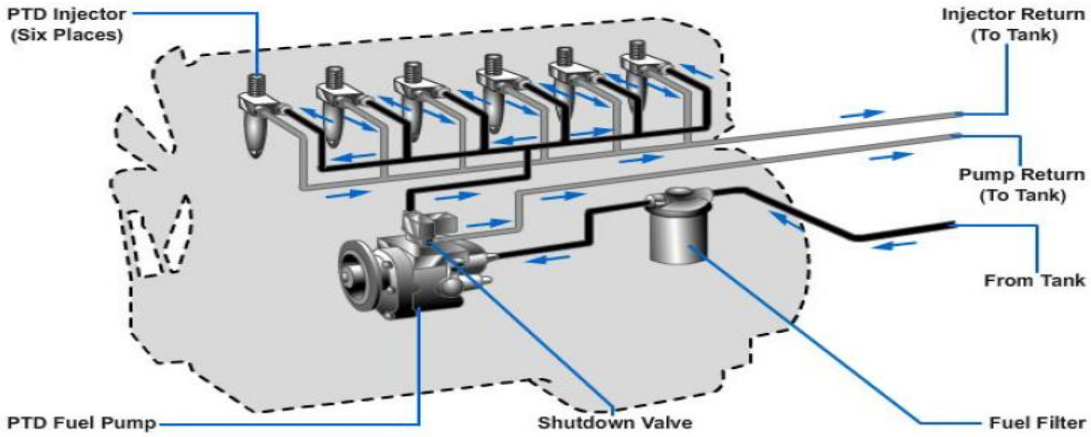


Figure- 2: Fuel pump pressure time fuel system

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H. Functions of Fuel system

Basic of any fuel system are as follows below

1) To control the quantity of fuel to each cylinder
2) To ensure that the fuel is delivered at correct time
3) To deliver the fuel in correct condition

II. LITERATURE REVIEW

[1] G.R. Kannan et al, varied the injection pressure and timing, and found that the combined effect of higher injection pressure of 280 bar and an advanced injection timing of 25.5°BTDC had substantial improvement in the brake thermal efficiency, cylinder gas pressure and heat release rate with decrease in nitric oxide and smoke emission.

[2] Kiplimo et al, found that reduced NO emissions and UBHC, smoke and CO emissions were obtained when the injection timing was advanced, meanwhile smoke, UBHC and CO were low with Higher injection pressure.

[3] Murari Mohon Roy, found that shortest ignition delay and minimal emissions were lower at high Injection pressures (60–80 MPa).

[4] K. M. Mrityunjayaswamy et al, found that, with the proper injector opening pressure and injection timing (200 bar and 30°BTDC) a substantial improvement in the performance and emissions can be obtained.

[5] N.Venkateswara Rao et al, concluded that, injection timing advance and increase in injector opening pressure will reduce exhaust emissions from an engine with biodiesel operation.

[6] Venkatraman et al, stated that, the combined increase of compression ratio, injection timing and injection pressure increases the BTE and reduces BSFC.

[7] Meyyappan Venkatesan, found through experiments that, CNG - JOME can be used as fuel with better performance for higher pressure and advanced injection timing.

[8,9] Srinath Pai et al, suggested that; an increase in injection pressure will improve the combustion, which in turn improves the performance parameters and emission reduction they also observed that, smoke opacity gets reduced with increase in injection pressure for all loads.

[10] Han, D. Zhai, J. Q. Duan, Y. Z. Wang, C. H. and Huang,Z. (2018). Nozzle effects on the injection characteristics of diesel and gasoline blends on a common rail system and pressure, time ,flow and RPM.

[11] M. U. Waqas, A. Hoth, C. P. Kolodziej, T. Rockstroh, J. P. Gonzalez, and B. Johansson,Characterization of Low Temperature Reactions in the Standard Cooperative Fuel Research.

[12-20] Details study of marine application and its maintenance and operating system.

[21-31] Cummins engine application wise rpm requirement and the horse power study for different applications of engines.

III. REPORT ON PRESENT INVESTIGATION

Fuel pump pressure time calibration and analysis there is four important parameter if you set and control high idle and low idle by below methodology no need to replace new fuel pump because in marine application customers require immediate solution for their pump and that time, time is very important .

Calibrate the pump by using method mentioned below, as per below method you can set and calibrate pump on site by usig add and subtract 0.001'' shims set low idle and high idle as per customer engine application and pump number plate details we will calibrate the PT pump as per required cutoff, Both cummins N and NH series diesel engines adopt PT fuel system, which has two types: pt-g Pump, system governor - controller, and pt-r pump, pressure - regulator.

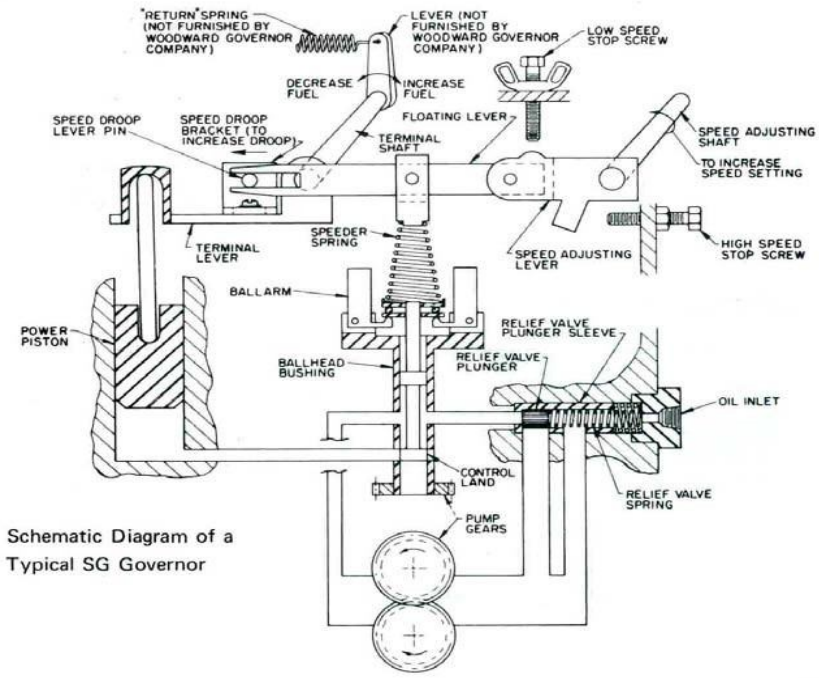
The main features of the PT pump fuel system are: in the PT fuel system of Bosch, the fuel oil production pressure, timing distribution and oil volume adjustment are carried out in the fuel pump;In the fuel pump and fuel injector fuel system, fuel to produce high voltage, time distribution and fuel control in fuel pump and fuel injector, its enter only about 20% of the injector fuel injector is sprayed into the combustion chamber, the rest of the fuel injector for cooling and lubrication return tank.

Because only a PT fuel pump in the fuel system output low pressure oil without high pressure tubing, does not exist the problem of pressure wave under high speed, and fuel injector piston downward speed, nozzle size, and the maximum injection pressure is 100 mpa, which is beneficial to fuel atomization, combustion efficiency fully, sewage, and good;When the diesel engine stops, it uses the cut-off valve to close the oil circuit to cut off the flow of oil.

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IV. OBJECTIVES

1) To improve diesel engine efficiency
2) To consume time period of Marine customers
3) To solve problem within time limit
4) To save travelling time and marine customers urgency
5) To set on site pressure,time ,RPM and flow
6) To improve engine efficiency fuel PT system is very important
7) To supply fuel as per required pressure and time
8) To supply fuel as per required flow
9) To consume calibration and travelling time
10) To pull and transfer fuel from the tank and filter
11) To develop sufficient fuel pressure to the fuel rail (common fuel passage) to all of the injectors
12) To provide engine idle speed control (governing)
13) To limit the maximum no-load and full-load speed of the engine (governing)
14) To allow the operator to control the throttle position and therefore the power output of the engine
15) To control exhaust smoke emissions to EPA specifications under all operating conditions



Schematic Diagram of a Typical SG Governor

Figure-3: schematic Diagram Of Typical SG Governor



Figure-4 :Pressure Time Pump Assembly

V. COMPONENTS IN PT FUEL SYSTEM

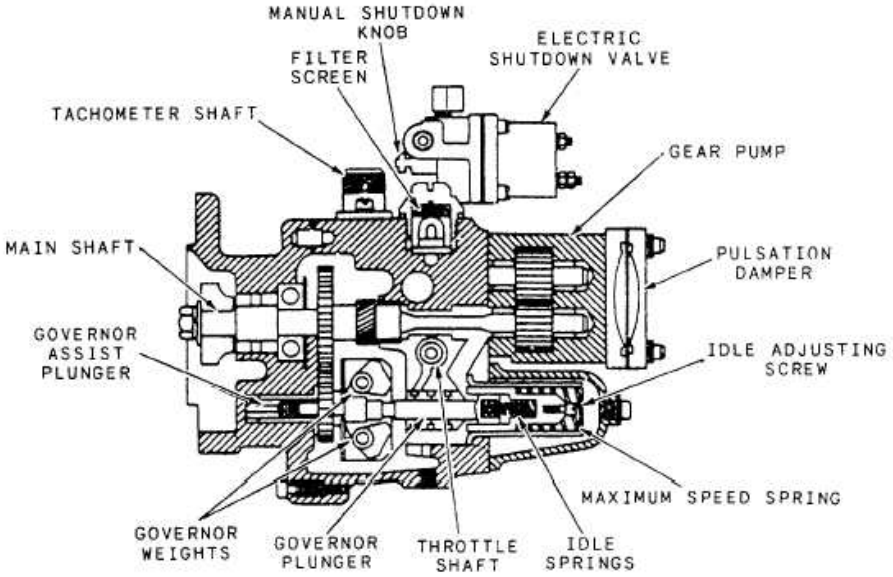


Figure-5: PT Pump components

Fuel pump Components in P.T.fuel system

1) Fuel tank
2) Float tank
3) Suction line
4) Fuel filter, Water separator
5) P.T.pump • E.F.C / Hydraulic governor
6) Fuel manifold
7) Injectors Fuel flow in P.T.system Fuel tank (float tank) Fuel water separator Fuel filter P.T. pump S.D.valve Fuel manifold Injectors Combustion chamber 80 % fuel returns back into tank Fuel Flow – PTG AFC Pump STC Valve Sensing PTG AFC Fuel Pump

VI. CALIBRATION PROCESS

A. Control of Low Idle

1) Gear pump rotates slowly when engine cranked - low fuel pressure
2) Fuel entering governor - leaves via low idle passage to S.D.valve & injector
3) Injectors operate - engine starts up - speed increases
4) Excess speed gives more inertia to gov.Weights & moves gov. plunger forward against low idle spring
5) Strength of low idle spring controls the low idle speed control of low idle
6) Weights push gov plunger forward till idle port is closed by tapered edge on plunger
7) Engine speed reduces when fuel outlet is reduced
8) Point of obstruction dependent on spring strength - strong spring - higher engine speed more inertia to weights to cut off -weak spring - lower engine speed
9) Strength of idle spring controlled by low idle adj.screw
10) For low idle - screw turned clockwise
11) For high idle - screw turned anticlockwise
12) Sealed screw driver ST-984 to adjust on running engine

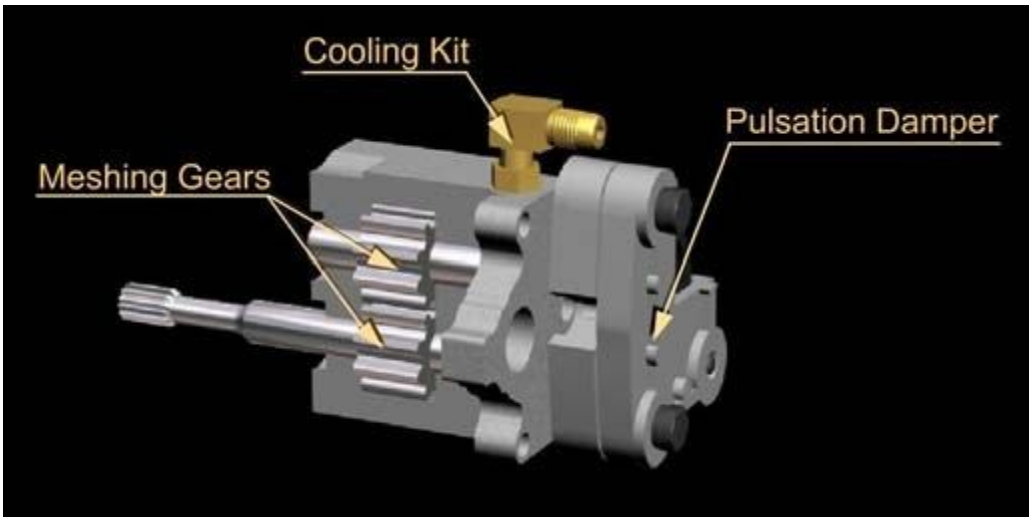


Figure- 6: PT Pump Gear

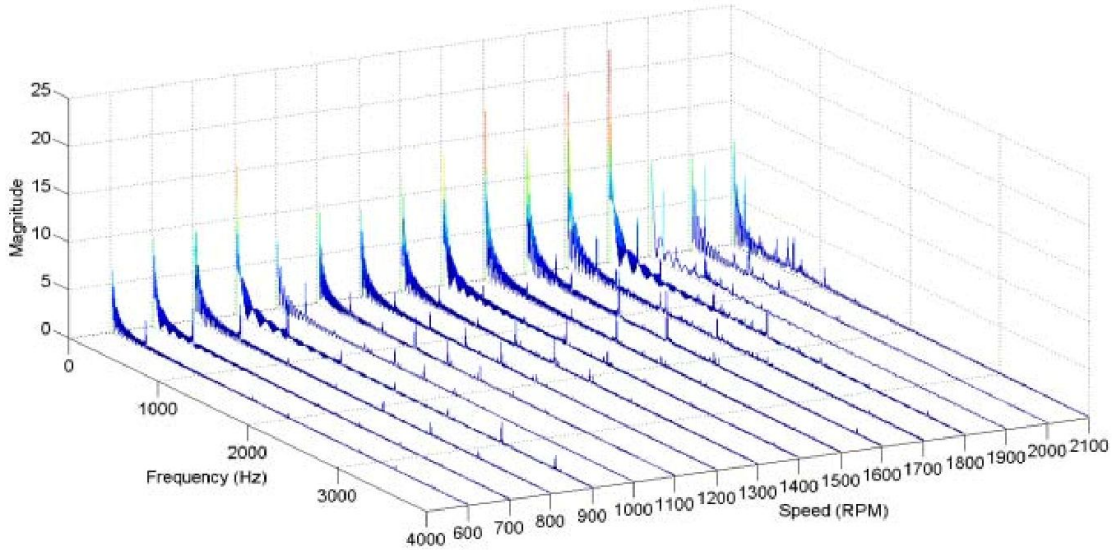


Figure-7: frequency, magnitude and speed parameter graph

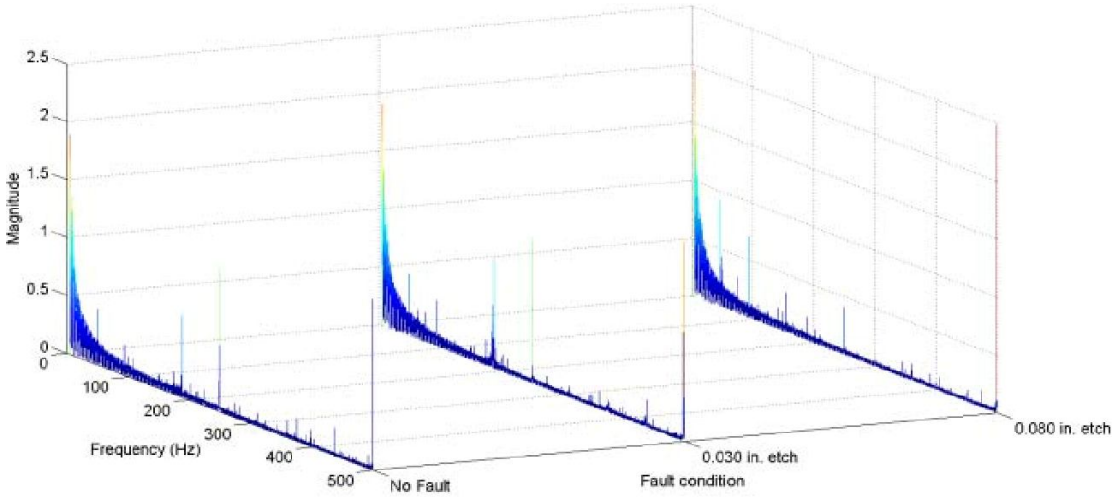


Figure-8: frequency and magnitudeparameter graph

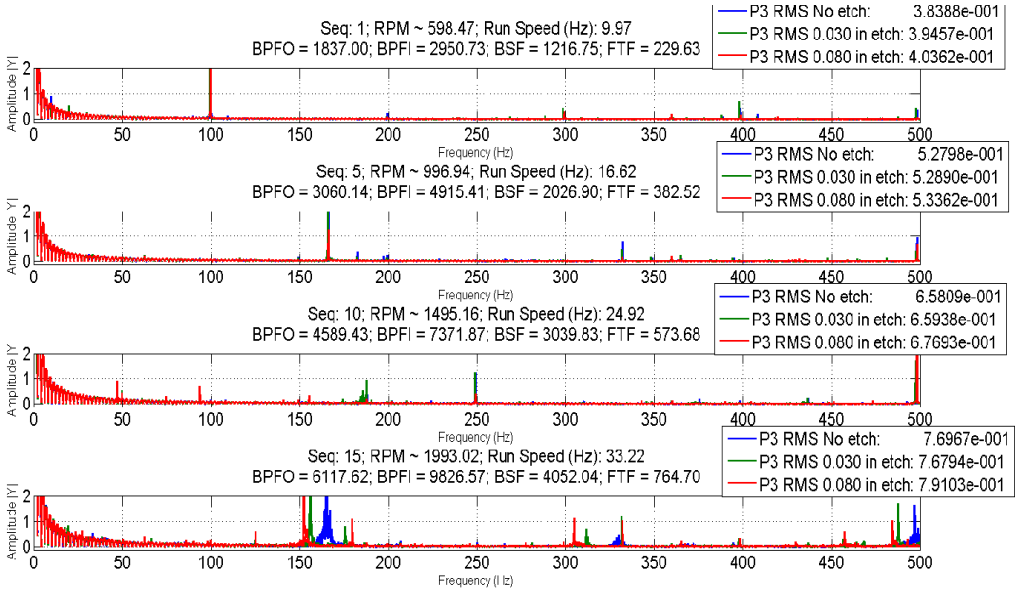


Figure-9 frequency and amplitude control

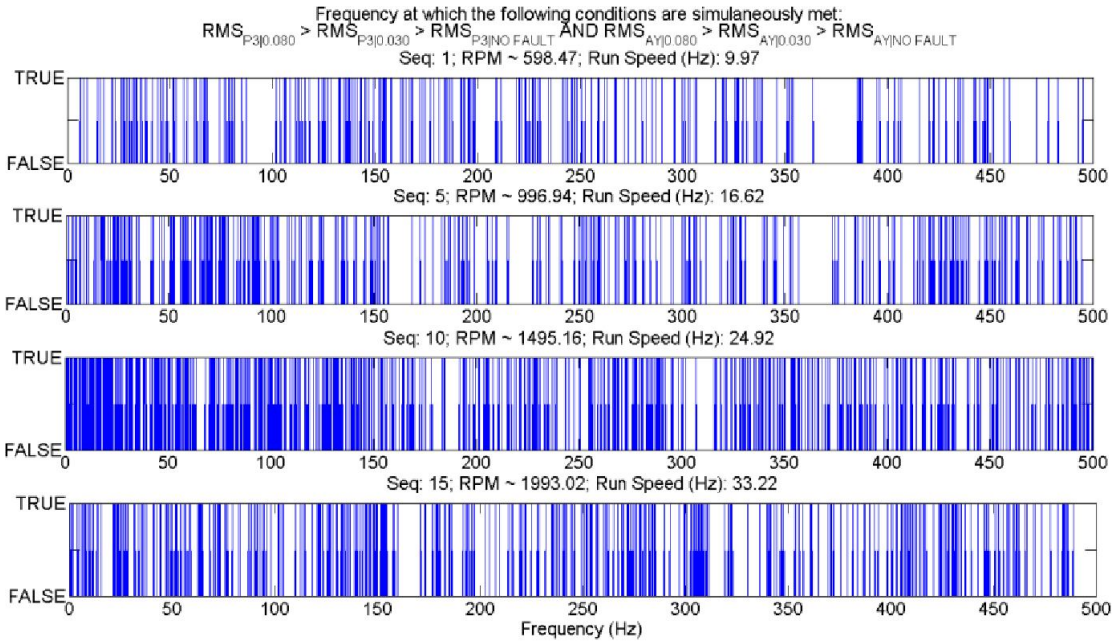


Figure-10 : speed and frequency

B. Governor Speed Control

1) Throttle opened - more fuel - speed increases
2) Increase in speed causes idle port to close by pushing gov. plunger
3) All fuel passes through throttle shaft
4) As gov plunger moves further - main fuel passage closes - this point called “Gov cut off”
5) Gov. cut off - balance between gov. weight force (Engine Speed) & gov. spring pressure
6) Weights & spring determined by power requirements - variable factor - spring tension governor speed control
7) Higher spring tension - higher engine speed

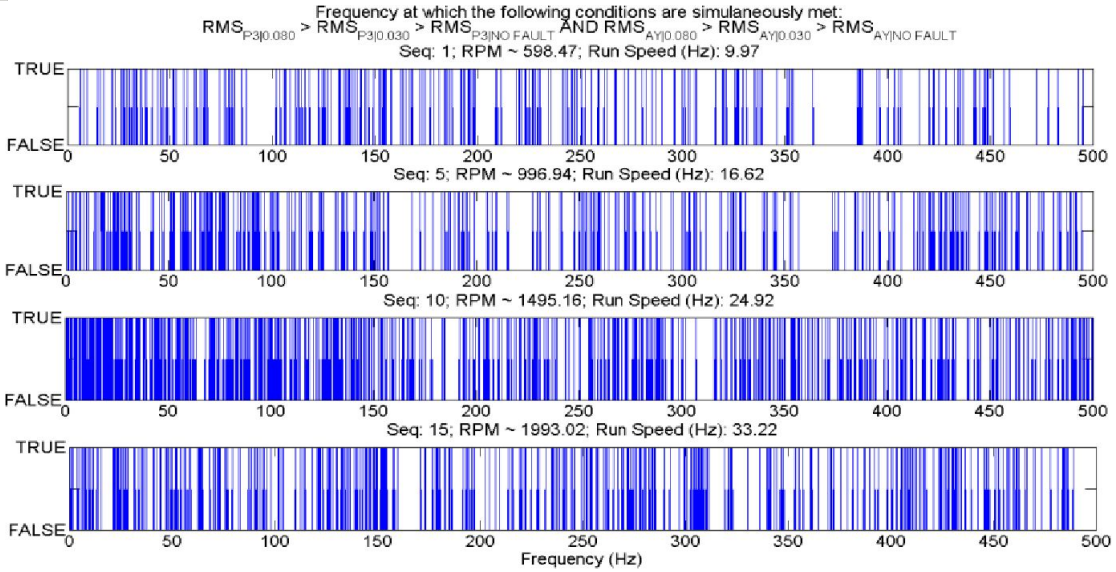


Figure-11: Freqency and RPM control chart

8) Weak spring - low engine speed
9) Each spring colour coded - selected by factory - field adjustment - by shims between spring & circlip
10) Use tachometer to check speed accurately
11) Use rated & idle speed as check points
12) If speed is high - remove shims, if low - add shims (0.001 shims - 2 rpm affected)
13) If rated speed correct - high idle speed is also correct Fuel pressure control
14) Second function of P.T.pump - to control pressure
15) Gear pump pressure considerably high than engine requirement
16) Gov. Plunger has a drilling through centre
17) Idle spring pressure holds plunger against button till fuel flows
18) Fuel pressure forces them apart &quantity of fuel is by-passed to gear pump suction Fuel pressure control
19) Button by-pass - first & largest controlling factor – inaccurate
20) Size of button selected - - to reduce pressure passing to throttle - still 12 to 15 % more than final requirement
21) Buttons have numbers - larger More the counterbore - more is the fuel bypass

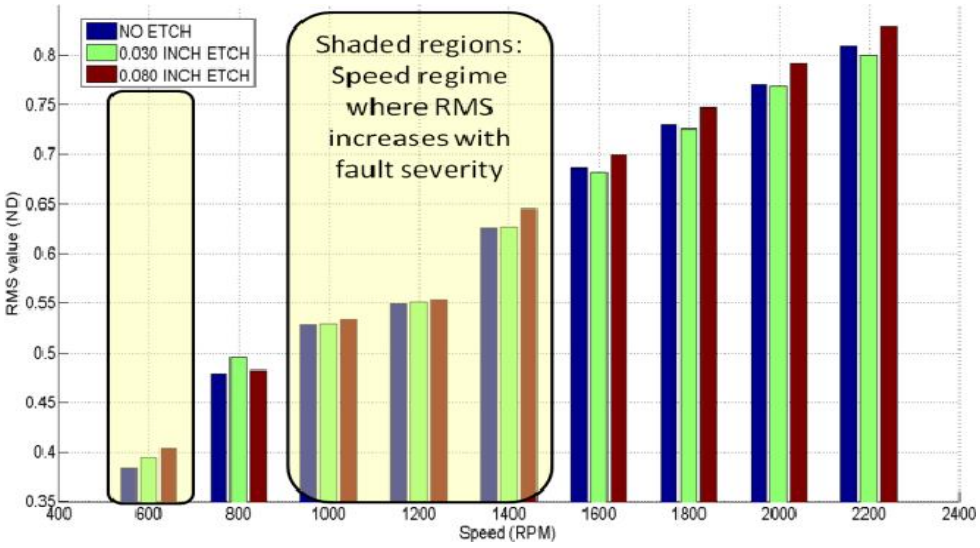


Figure -12: speed and RMS graph

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22) For above - an adapter is used to prevent plunger locking into button accurate control of fuel pressure
23) Throttle has a restriction plunger held by a plug
24) If throttle orifice full open - more fuel - if closed - no fuel
25) Shims between restriction plunger & internal drilling determine opening of the throttle orifice
26) 3 - 6 psi pressure more than required is adjusted by proper shims
27) 3 - 6 psi more for some control over fuel pressure in field
28) Shims available in 0.003, 0.005, 0.010, 0.025 inches Accurate control of fuel pressure
29) Final & exact requirement adjusted by rear throttle screw
30) Fine adjustment - with locknut arrangement
31) Restrict no more than 6 psi with R.T.screw
32) Thus 3 steps for fuel pressure control are - - Idle button - Throttle internal adjustment - Rear throttle screw Shut down valve Electrically operated valve Consists of - Solenoid - Sealing plate - Sealing ring - Spring washer - Disc valve - Housing - Override screw Mounted directly onto top of the pump Function of components Shut down valve
33) Solenoid is energized with current from battery
34) Disc valve opens to allow fuel flow
35) Spring washer closes fuel supply when current to solenoid stops
36) Current is through all safety controls • Only in case of emergency use override screw to start engine Function of components Injectors
37) Activated by a series of mechanical components - crankshaft - camshaft - cam followers - push rods - rocker levers
38) Profile of cam lobe is Fuel manifold
39) For supplying fuel from S.D,valve to injectors
40) Various configurations
41) Copper tubings, aluminium housings with drilled passages
42) Copper washers / “O” rings for proper seatings Function of components Injectors
43) Two types - flange type & Cylindrical type
44) Flange type - 495 & 743 series • Flange type - External fuel lines
45) Cylindrical type - 855, 1710. 1150, 2300, 3067 series engines

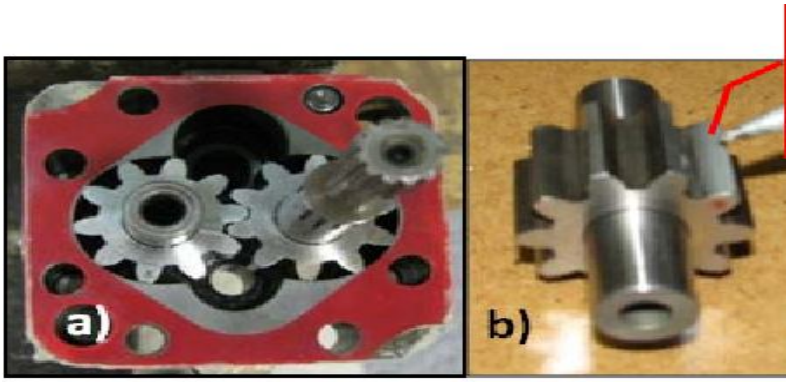


Figure-13 a & b Gear pump assembly aluminium coating

46) Cylindrical type - internal drilled passages in cyl. head Parts of Injector - Inlet pasage - Filter screen - Orifice plug - Body or barrel, retainer, check ball - Plunger & link - Spring - Cup - Drain passage Cylindrical Injector Plunger Seated Metering Injection Injectors Filter screen - last point for filtering fuel
47) Orifice plug - to adjust correct quantity as per calibration code
48) Barrel - internal passages are drilled for supply & drain
49) Check ball - prevents reverse flow of fuel
50) Cup - collects the fuel for injecting in combustion chamber Injector codes
51) Values of interest - Flow code - Number of spray holes - Diameter of each hole - Angle of spray into combustion chamber
52) Flow code - Qty. of fuel at 120 psi. 1,000 strokes, 900 F
53) No. of holes - as per the requirements of engine

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54) Diameter - in thousandths of an inch
55) Angle of spray - degrees to horizontal Injector operation
56) Affected by - Adjustment - Calibration - Non-operation Adjustment –
57) Travel between seated position & lifted position is critical
58) If incorrect - metering & atomization affected
59) Use ST - 1270 to adjust correctly
60) Refer O & M manual for details Injector operation Calibration
61) Flow is controlled by orifice
62) Recommended to check & calibrate in "D" check
63) Calibrated on calibration stand
64) Must be calibrated at authorised dealer Injector operation Non-operation
65) Misfiring of injector can be identified from exhaust manifold - seized plunger - blocked orifice or filter screen - blocked spray holes
66) Clean orifice with compressed air
67) Check spray holes with diesel spray through cup
68) Seized injector needs repair / replacement All parts of injector are lubricated with diesel only Injectors Filter screen - last point for filtering fuel
69) Orifice plug - to adjust correct quantity as per calibration code
70) Barrel - internal passages are drilled for supply & drain
71) Check ball - prevents reverse flow of fuel
72) Cup - collects the fuel for injecting in combustion chamber Injector codes

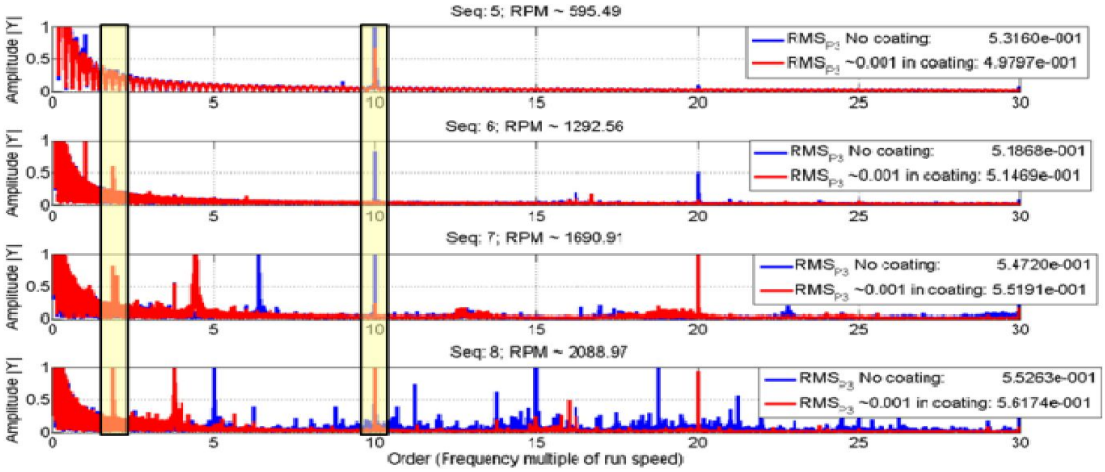


Figure-14 :RPM and Amplitude control chart

73) Values of interest - Flow code - Number of spray holes - Diameter of each hole - Angle of spray into combustion chamber
74) Flow code - Qty. of fuel at 120 psi. 1,000 strokes, 900 F
75) No. of holes - as per the requirements of engine
76) Diameter - in thousandths of an inch
77) Angle of spray - degrees to horizontal Step Timing Control During no load and light load conditions :
a) There is fuel that is not atomized enough to burn thoroughly, and
b) intake air that not only cannot support good combustion, but continuously cools the piston, liner, valves and cylinder head. These conditions cause white smoke, soot and carbon.
78) White smoke is formed by raw fuel and air.
79) Soot and carbon are the results of partially burned fuel. Step Timing Control Step Timing changes the timing from advanced to normal at a certified switching pressure. This pressure occurs between light and medium engine loads. Step Timing Control allows the engine to operate at ADVANCED injection timing during cold-starting and warm-idle conditions, and at NORMAL timing during medium to high engine load conditions.

Step Timing Control During ADVANCED injection timing, fuel is injected into the cylinder sooner. Ignition delay is longer under these conditions, giving the fuel more time to mix with the intake air. Thus, when ignition occurs, the fuel is burned more completely. The combustion temperature is higher, and the cylinder pressure is greater . So, controlling the pressure, that is, reducing it, means that we can put more air and fuel into the cylinder. This condition results in more power without sacrificing engine durability. Step Timing Control Step Timing Control Step Timing Control Step Timing Control Step Timing Control Step Timing Control Step Timing Control Several types of governors are used to handle many different requirements, such as desire reaction time, speed, and degree of precision.

VII.METHODOLOGY

A. Methodology

Both cummins N and NH series diesel engines adopt PT fuel system, which has two types: pt-g Pump, system governor - controller, and pt-r pump, pressure - regulator.

Methods to achieve Pt Fuel Pump Pressure are different Quantity - Factors controlling the quantity of liquid collected in a container depends on –

1) Pressure of the liquid
2) Length of time the passage is open
3) Size of the passage In Cummins engines
4) Pressure is controlled by fuel pump
5) Time is controlled by Injector plunger & engine speed
6) Size is dependent on the injector P.T. fuel system,

P - pressure & T - time Quantity is dependent on - Time for which the orifice is open - Fuel pressure developed by the pump - Size of the orifice Correct instant depends on - accurate setting of injection time Condition depends on-size & number of spray holes of cup Engine speed is governed by Governor incorporated in the fuel pump.

The basic flow of fuel into and through the PT pump assembly will vary slightly depending on the actual model. A simplified fuel flow is as follows:

As the operator cranks the engine, fuel is drawn from the fuel tank by the gear pump through the fuel supply line to the primary filter. This filter is normally a filter/water separator.

The filter fuel then flows through a small filter screen that is located within the PT pump assembly, and then flows down into the internal governor sleeve.

The position of the governor plunger determines the fuel flow through various governor plunger ports.

The position of the mechanically operated throttle determines the amount of fuel that can flow through the throttle shaft.

Fuel from the throttle shaft is then directed to the AFC needle valve. The position of the AFC control plunger within the AFC barrel determines how much throttle fuel can flow into and through the AFC unit and on to the engine fuel rail, which feeds the fuel rail. The AFC plunger position is determined by the amount of turbocharger boost pressure in the intake manifold, which is piped through the air passage from the intake manifold to the AFC unit.

At engine start-up, the boost pressure is very low; therefore, flow is limited. uel under pressure flows through the electric solenoid valve, which is energized by power from the ignition switch.

This fuel then flows through the fuel rail pressure line and into the injectors. A percentage of the fuel from both the PT pump and the injectors is routed back to the fuel tank in order to carry away some of the heat that was picked up cooling and lubricating the internal components of the pump and the injectors.

The main features of the PT pump fuel system are: in the PT fuel system of Bosch, the fuel oil production pressure, timing distribution and oil volume adjustment are carried out in the fuel pump;In the fuel pump and fuel injector fuel system, fuel to produce high voltage, time distribution and fuel control in fuel pump and fuel injector, its enter only about 20% of the injector fuel injector is sprayed into the combustion chamber, the rest of the fuel injector for cooling and lubrication return tank.Because only a PT fuel pump in the fuel system output low pressure oil without high pressure tubing, does not exist the problem of pressure wave under high speed, and fuel injector piston downward speed, nozzle size, and the maximum injection pressure is 100 mpa, which is beneficial to fuel atomization, combustion efficiency fully, sewage, and good;When the diesel engine stops, it uses the cut-off valve to close the oil circuit to cut off the flow of oil.

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The field adjustment of the diesel engine PT fuel pump depends on the state of the diesel engine, the parasite load and the accuracy of the instrument used. The speed and adjustment methods of the different working conditions are as follows:

1) *Idle Speed:* In the case of diesel engine operation, all the air in the oil road is eliminated and the diesel engine reaches the working temperature;Screw the plug under the cover of the pt-g two-stage governor spring assembly;Adjust the idle speed, adjust the adjustment screw to increase the idle speed, and adjust the adjustment screw to reduce idling speed;After the idle speed is adjusted, return the screw plug.On the PT fuel pump equipped with full speed governor, the maximum speed and idling adjustment screw are located on the governor cover, then tighten the nut immediately after the adjustment, in case the air enters the fuel pump. For each series of diesel engines, the factory has recommended idle speed, which allows for reasonable changes. If too large, it is difficult to register, and if too low, it is easy to stall.If the idle speed is not stable, this is related to the governor plunger, and should check the outstretched of the flying hammer booster piston.
2) *Maximum speed (Pedal to the Bottom):* The maximum speed is usually calibrated on the test bench of the PT fuel pump, which is generally used to increase or reduce the speed of the governor's high-speed spring gasket.If it has been raised in the test bed, there is no need to change it.Maximum no-load speed of on-site inspection method is: make the transmission in neutral or clutch in the separation of state, open the throttle valve and keep the full open position, the maximum speed of diesel engine at this time should be 10-12% higher than the breaking point of speed governor;When this speed exceeds the regulation value, it is appropriate to check or check the parts of the governor assembly.
3) *The Governor Disconnects the Point Speed:* When the throttle valve fully open, increasing the load until the speed drops to at least lower than the rated speed 100 r/powder, then gradually reduce the load, at the same time observe the fuel outlet pressure gauge, (as the load decreases, fuel outlet pressure will increase until the governor has restricted oil supply, and then as the load decreases, fuel outlet pressure will begin to decline), breaking point, this is the governor before this speed than the rated speed diesel engine will not limit role (such as diesel engine rotating speed is 2100 RPM, the breaking point of speed governor for 2120-2140 revolutions per minute).Breaking point speed above or below the specified value, if the governor is accordingly reduce or increase the gasket from behind the governor high-speed spring adjustment, until check again breaking point of speed governor conform to the specified value.

4) *Fuel Outlet Pressure.*

a) *Method 1:* The use of diesel engine and dynamometer on diesel engine load, check the breaking point of speed governor, when the throttle valve fully open, increase the load to the rated speed of diesel engine, and to observe the outlet pressure of fuel oil.When pressure is below or above the limit, adjust according to the following methods: screw out of the opening of the throttle valve biggest adjusting screw, remove the throttle valve shaft and add proper thickness of cushion, can increase the pressure, take out the appropriate thickness of the gasket from the throttle valve, can reduce the pressure.Under no circumstances should the pressure of the PT fuel pump be adjusted to exceed the maximum value.
b) *Method 2:* At the full opening of the throttle valve, the maximum pressure of fuel outlet is checked from low to high speed.If the pressure is lower than the minimum value specified by the machine or the maximum value specified, the method should be adjusted according to the method.
c) *Method 3:* This method also called "instantaneous", pressure inspection method;This method is better than one, two precise but simple, namely unscrewing oil cut-off solenoid valve and install a pressure gauge, remove the throttle valve rocker arm (throttle rocker arm) on the fitting, the throttle rocker rotate clockwise to the end;Start the diesel engine and make it run at a speed of 250 RPM higher than the idle speed;Then accelerate to the maximum speed of the diesel engine and check the instantaneous pressure indicator of the pressure gauge. The adjustment method is described in the method.After the adjustment is completed, Remove the pressure gauge, install the oil solenoid valve, and plug the pipe that flows through the smoke limiter.

5) *Leakage of Throttle Valve:* When the accelerator is wide open, the blood flow to the fuel injector fuel pressure should meet the pressure, the Maximum oil conform to the specified value, when the gas full close, use limit screw make oil way to open a small amount of fuel flow, this part of the fuel that is called the throttle valve leakage.The leakage of the throttle valve is large, which causes the engine to slow down slowly and the leakage volume is too small, which will cause the diesel engine to slow down after the throttle is closed.

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Throttle valve leakage is usually on the PT fuel pump test bench, if the scene must adjust the throttle valve leakage, the throttle valve fittings must be adjusted to make the position of the throttle valve is closed (at this point, the throttle valve on the PT fuel pump just contact with former throttle set screw), or make the throttle valve fully open, make diesel motor with maximum no-load speed running, check with a stopwatch or other appropriate timer and tachometer to complete, the steps are as follows:

a) Quickly open the throttle valve or move the throttle to the closed position and press the stopwatch.

b) When the diesel engine reaches 1000 RPM, stop the stopwatch and pay attention to the deceleration time, and re-test several times to take the average value.

c) When the diesel engine from the rated no-load speed to loosen the accelerator pedal, a stall (idle speed control of diesel engine) and the phenomenon, the throttle valve leakage must increase, but twist through the throttle valve leakage into adjusting screw (former throttle set screw) to adjust.Whether to adjust the proper inspection method is: slow down time (according to the average measured in step 1, 2) should add 1-2 s, will be in the position adjusting screw locking, and check the idle again speed, readjust if necessary.

d) When the deceleration time of the diesel engine is too long (relative to the mean value), the leakage volume of the throttle valve should be reduced, and the adjustment screw can be adjusted by adjusting the leakage amount of the throttle valve.Before adjustment, also need a stopwatch checks under no-load speed at high speed to disconnect switch key when the engine stops, deceleration time, if the measured time is greater than in the average measured in step 1, 2, not the throttle valve leakage problem.If the deceleration time is greatly reduced, the leakage of the throttle valve is explained.If measured deceleration time shorten, the throttle valve to reduce leakage, therefore, can twist the throttle valve leakage speed adjustment screw, as described above to check the reduction of diesel engine at the same time, if the diesel engine from the no-load speed to slow down and then have a stall is hot, you should set a screw in screw and to increase the deceleration time 1-2 s, and will be in the position adjusting screw locking;Then, adjust the idle speed according to the need.

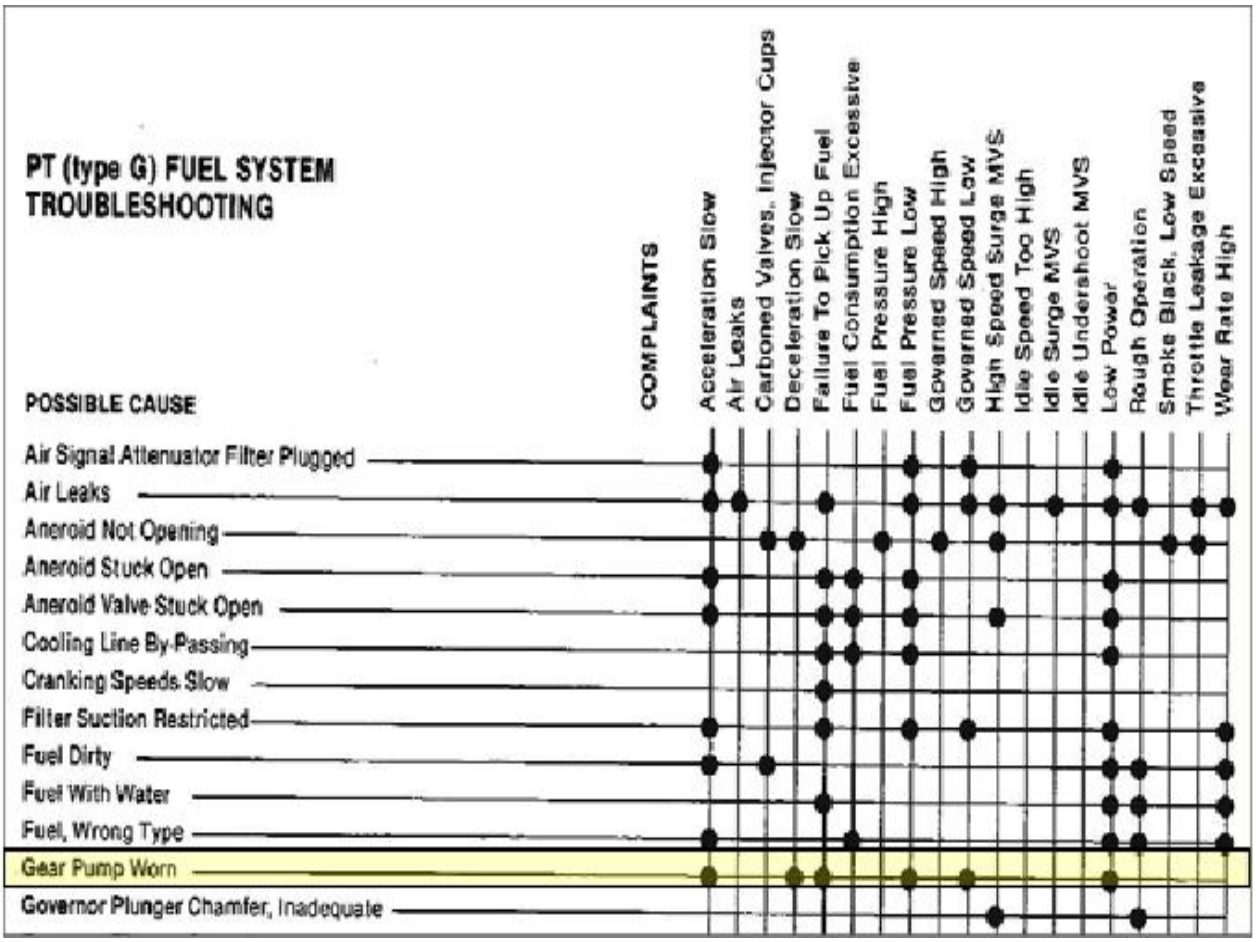


Figure- 15: Fuel System Troubleshooting

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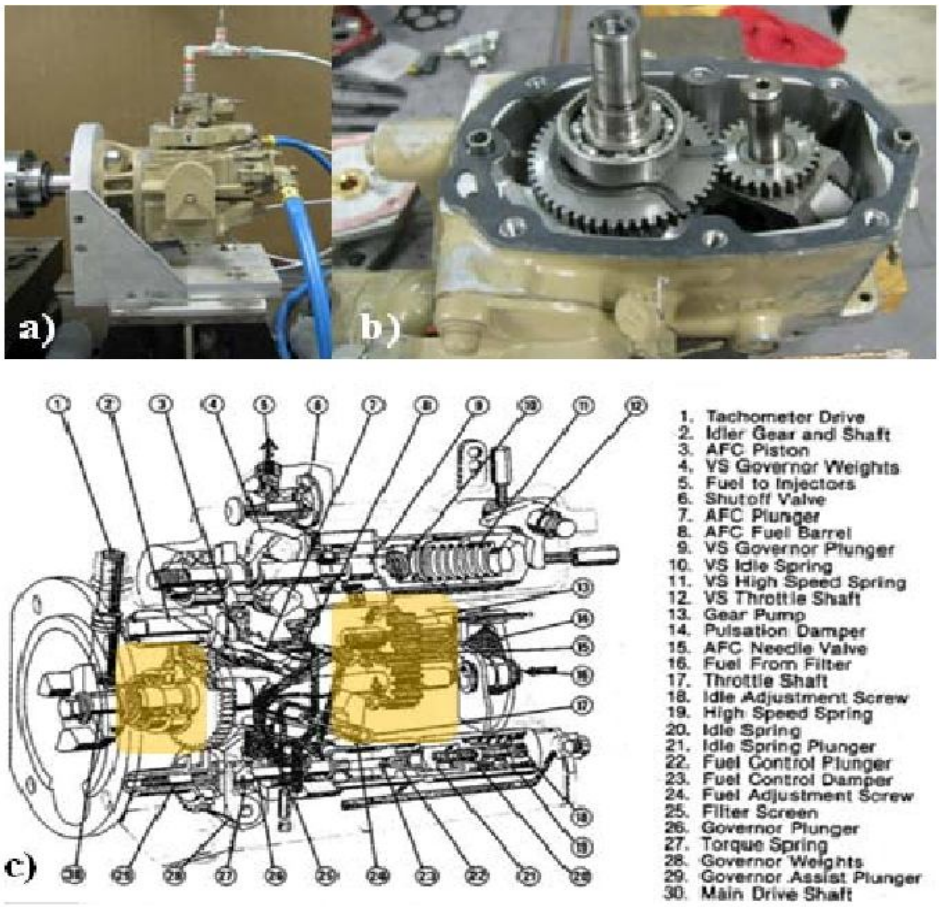


Figure -16: Familiarization of PT fuel pump assembly a,b&c

VIII. RESULTS AND DISCUSSION

The fuel pump can be calibrated while attached to the engine,Fuel pressure time standard data calibration and setting is the most important.Its effective to improve diesel engine efficiency,preliminary we have to check fuel oil temperature,set approximate governor speed and set pressure regulator spring load , Increase pump speed until manifold pressure gauge registers highest pressure .This should be rated RPM or higher .The approximate governor speed check assures that dump holes are not open during calibration at 100 RPM less than rated speed.If fuel manifold pressure gauge registers the highest pressure at less than rated governor speed,add shims to the governor high speed spring.On variable speed governor pump adjust maximum setting screw,lock screw at this setting. No need to buy new pump we can set and calibrate same pump within time or without delay.

IX. CONCLUSION

I have studied and solved this Marine engine application fuel PT pump setting and calibration case study on site,I have done this work on site that engine required low idle 750 RPM and high idle 1800 RPM as per required pressure,time,flow and RPM setting and calibration has done by me. On site after that i have started engine and checked all the parameters found ok, as per standard values of given engine application and its working accurately,there is no any fuel leakages,no white smoke and no engine hunting issues.All the strokes operated and performed perfectly,due to setting and calibration of standard PT values engine efficiency improved and there is no any red alarm occurred for fuel system, because of this no need to buy new PT pump which is too expensive and time consume without delay. I have solved this problem and completed this work on site.Its difficult for marine industries to calibrate fuel PT pump in their suppliers workshop and its taking more time for the procedure, travelling time and distance far so marine industries don't have a more time to do this delay. As we known in marine industries time is very important so, I have susccessfully set the require fuel pressure, time,flow and RPM on site without any delay and also improved engine efficiency by setting and calibration of pressure,time,flow and RPM of diesel engine.

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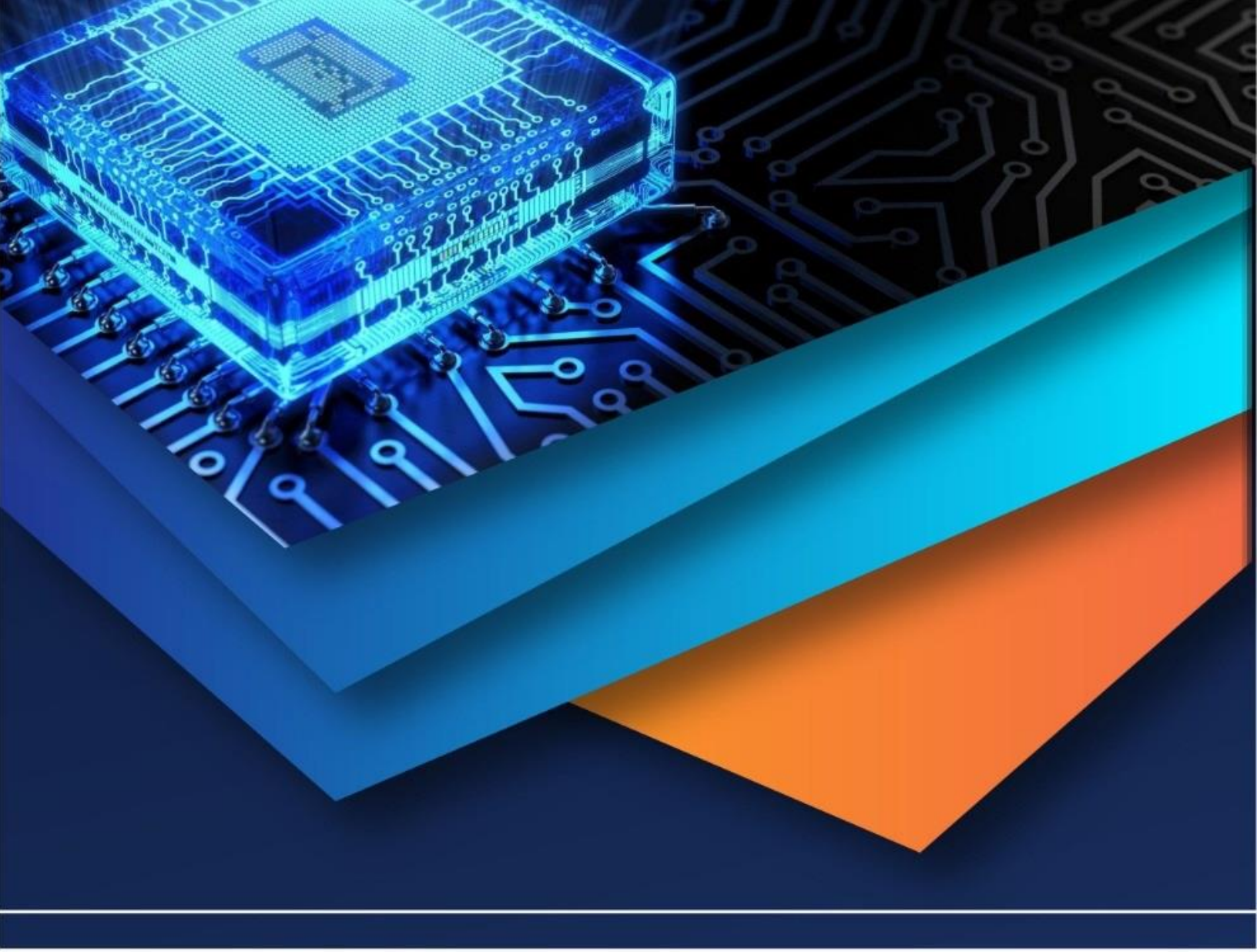
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