

# **AEDT - FUEL INJECTION SYSTEM**

**(Q.1) Describe the procedure of calibration of fuel injection pump.**

**OR**

**Describe calibration and phasing.**

**OR**

**Explain the calibration of in-line plunger type F-I. pump.**

## **Phasing & Calibration:-**

The essential functions of the injection pump when fitted to the engine are to ensure that an accurately metered quantity of fuel shall be injected into each cylinder and at exact point in the stroke at which the engine requires it. The latter point is the first for which adjustment is made, and this of course, will affect the timing of the pump to the engine.

It is essential, therefore, during adjustment of pump, to ensure that the subsequent pumping elements commence to inject at exactly the correct interval in the camshaft degree after No.1 element. Assuming that the injection sequence of a 6-cylinder pump is 1, 5, 3, 6, 2, 4, then No.5 element must commence injection 60 degree after No.1 pump and No.3 at the same interval after No.5 and so on. The interval on all types of pump is 360 degree camshaft angle divided by the No of elements in the pump. This adjustment for correct timing interval is known as “phasing” or adjusting the phase angle of the pump.

## **Point of port closure:-**

It is next necessary to determine the point to which the adjustment has to be made. This is generally referred to as “the point of port closure” which occurs shortly after commencement of plunger stroke, when the rising plunger closes the port through which the fuel has entered the element barrel. The actual commencement of injection occurs after this point of port closure, the interval depending mainly

upon the plunger diameter, cam profile, pipe length and the starting of the injector spring.

Finally, adjustment is made for the balance of fuel output, or in other words, the pump is calibrated.

### **Calibrating the injection pump:-**

This carried out by slackening the screw which clamps the quadrant to the sleeve, and moving the sleeve with plunger into the required position. This adjustment is accurately carried out at factory when pump is new, and a line is scribed across the quadrant and sleeve to indicate the correct setting. Wear on the elements etc., may necessitate some slight alteration to this setting after several hundred of hours of running, but in no circumstances should the setting deviate more than a few millimeters from the original adjustment. It is consequently advisable before testing to see that these calibration markings are lined up as this will certainly reduce the amount of adjustment to be made.

**(Q.2) What is Bleeding of injection system?**

**OR**

**How did you remove air from F.I. pump unit?**

The fuel injection system works correctly only when there is no air bubble in pipe lines. To remove air bubble from pipe line, filters and injection pump is called bleeding. To remove air bubble, there is bleeder screw or air vent screw on the filter and the pump in the fuel gallery. Bleeding is done by opening the bleeder screws.

(**Note:-** Whenever the filter or pipe is replaced, bleeding should be done.)

**(Q.3) What does a split-cut- off indicate?**

- Every F.I. pump has limited R.P.M. proportional to engine R.P.M. and it rotates  $\frac{1}{2}$  the speed of engine R.P.M.
- Suppose the limit is 1000 R.P.M. of F.I. pump than it will provide fuel to engine till engine rotates 2000 R.P.M., at high speed i.e., < 2000 R.P.M. F.I. pump will not supply fuel. This blocking of delivery of fuel is called “**split-cut-off**”.

(**Note:-** This is adjusted when F.I. pump is send to servicing to calibrate the F.I. pump.)

**(Q.4) Explain the effects of worn-out injection pump plungers on performance of diesel engine?**

- Clearance more, thus resulting in decreased pressure.
- Insufficient pressure, resulting in less power.
- Fuel drip-off.
- Insufficient fuel delivery.
- Engine cannot reach its maximum speed.
- Engine overheating.
- Black smoke.

**(Q.5) State the reasons for smoky exhaust from diesel engine.**

➤ **If blue smoke is coming out from the silencer, then possible causes are:-**

- Excessive diesel mixture ratio.
- Excessive oil in clutch chamber.
- Crank case oil seals worn out or damaged.
- Worn out, stuck or broken piston rings.
- Worn out cylinder bore.

➤ **If black smoke is coming out from the silencer, then possible causes are:-**

- Choke in operation.
- Clogged air filter.
- Worn out or wrong size jets.
- Worn out, stuck or broken piston rings.
- Worn out injection plunger.

**(Q.6) State the causes of engine hunting of a diesel engine.**

➤ This is the name for a periodic variation in the speed of a governed engine due to inertia, lag or friction in the mechanism.

**CAUSES:-**

- Injection control rod not moving freely. The inspection cover must fit properly to prevent dirt getting into the injection pump.
- Worn governor control linkage.
- Idling damper not functioning.

**(Q.7) Explain dribbling.**

**OR**

**Explain ill-effects of dribbling injectors.**

**OR**

**Eliminating the fuel to dribble.**

The delivery valves on the injection pump helps to ensure that the injectors will close quickly at the end of each injection. The injectors must close quickly in order to prevent fuel “**Dribble**” which can cause pre-ignition during the next combustion cycle.

**Ill-Effects:-**

- High fuel consumption.
- Excessive wear to piston and combustion chamber.
- Abnormal detonation.
- Back fire.
- Valve burning.
- Engine continues to run after ignition switch is turned off for few seconds.

**Eliminating the fuel to dribble:-**

- The delivery valves on the injection pump helps to ensure that the injectors will close quickly at the end of each injection. The injectors must close quickly in order to prevent fuel “**Dribble**”.
- When the pump plunger completes pumping the fuel for that cycle the pressure drops, causing the delivery valve to be pushed down by the spring.

- The relief valve therefore, closes off the fuel passage, then continues moving downward until the valve face is pressed lightly against the valve seat.
- Fuel trapped below the relief valve is drawn back into the delivery valve from the time the relief valve closes off the fuel passage until the end of the operating stroke.
- This ensures a sudden drop in pressure (caused by the expansion of the chamber above the delivery valve) and allows the injection nozzle to snap shut, thus eliminating the fuel “**Dribble**”.

**(Q.8) State the possible causes and remedies for:-**

➤ **Nozzle drips on delivery:-**

<b>CAUSES</b>	<b>REMEDIES</b>
1. Nozzle leak due to carbon deposit.	Clean nozzle.
2. Sticking needle valve.	Replace needle valve

➤ **Nozzle opening pressure too high:-**

<b>CAUSES</b>	<b>REMEDIES</b>
1. Compression screw shifted.	Adjust for prescribed pressure.
2. Needle valve seized up, corroded.	Replace nozzle and needle valve.
3. Needle valve seized up, dirty, sticky.	Clean nozzle.
4. Nozzle openings clogged with dirt or carbon.	Clean nozzle.

**(Q.9) Explain two methods of setting “injection pressure”.**

➤ **Method-1.**

- Clamp the injector on the tests and operate the tester pump.
- Note the reading of the dial indicator at which the injector nozzle starts spraying.
- It gives pressure reading.
- It should be the same as recommended by the company.
- If it is less, then tighten the adjusting screw of the injector.
- If it is more, then loosen the adjusting screw.
- Repeat the process until the correct pressure reading is obtained.
- Finally, tighten the lock nut.

➤ **Method-2.**

- To set the pressure at which the nozzle should open, slowly move the hand lever downwards and carefully, watch the pressure gauge for the highest recorded pressure before the needle “flicks”, indicating opening of the valve.
- Any necessary adjustment is effected by loosening lock nut and moving adjusting screw inwards to increase pressure, or outwards to decrease pressure, on the spring, or by changing the total thickness of shims.

**(Q.10) Describe different test carried out for serviceability of injectors.**

**OR**

**Explain how leak-off test is performed on injectors.**

➤ **Pressure test:-**

Refer to method-1 of Q.9.

➤ **Leak-off test:-**

Clamp the injector on the tester and build up the pressure about 150 kg/ (cm\*cm) by operating the tester pump. Keep this pressure for about 10 seconds. If the pressure drops, it shows that there is leakage in the injector. Check the nozzle seat and nozzle valve needle and nozzle body. Correct the seat and needle by grinding and lapping and after that again do the leak-off test.

➤ **Spray test :-**

Spray test is also done on the same injector testing machine. While operating the tester pump, see carefully the spray. It should not be like a current of oil, or with drops splitting away, but it should be fully atomized.

**(Q.11) Explain the fuel “Injection Timing”.**

Fuel from the injection pump must be injected at a particular crankshaft angle before T.D.C. of the compression stroke of piston. When injection timing for No. 1 cylinder of the engine is set 14 degree before T.D.C., for eg., the injection pump is adjust correctly if the plunger in the No. 1 pump element rises and closes off the feed hole of the cylinder at that angle for the start of injection.

The fuel pumping start timing of No. 1 plunger varies depending upon the pre-stroke of the plunger.

**(Q.12) State four probable causes of racing of diesel engine.**

- Maximum speed stop on venturi set too far open.
- Air leak into vacuum system.
- Air leak in induction system.
- Diaphragm spring too strong.



- Idling damper screwed in too far.
- Control rod sticking in maximum fuel position.

**(Q.13) Explain the testing procedure for fuel injector on test ring.**

➤ **Test oil:-**

Fill the fuel tank by pouring through the filler cap approximately one liter of calibrating special oil.

➤ **Air vent:-**

Before operating the outfit, air vent the system by removing air vent screw to allow oil to flow freely for a few seconds. Replace screw while oil is still flowing and operate pump several times until oil flows from pipe.

➤ Connect complete injector to be tested to the outfit by means of pressure piping. The length and bore of this piping are important and if a new piece is fitted this should be 75 mm approx., between the union nuts, of 2 mm bore.

➤ Examine the lapped pressure faces of nozzle holder and nozzle when assembling, to ensure that they are perfectly clean, otherwise leakages may occur.

➤ Close check valve to keep the pressure gauge out of circuit and smartly operate hand lever several times in order to expel all air from the system.

➤ **Pressure setting:-**

Refer to method-2 of Q.10

➤ **Seat tightness:-**

Wipe nozzle tip dry and with check valve open, build up the pressure to 20 kg/ (cm\*cm) below the opening pressure.

➤ **Spray form:-**

With check valve closed, operate the hand lever smartly at a speed of 90-100 strokes per minute

➤ **Pressure gauge:-**

Before removing the nozzle holder from the outfit, close the check valve to prevent damage to the pressure gauge which may result from a sudden drop of pressure.