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Analysis of Low Torque Generation In Three Cylinders Diesel Engine

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ABSTRACT

Diesel engines are the primary source of power for the heavy duty vehicles. The advantages of the diesel engine are high fuel efficiency, reliability and durability. The heavy load vehicles required high power, hence multi cylinder diesel engine used. Fully over head controlled system (FOCS) are generally used in multi cylinder engine. This technique is mostly used in three cylinders Diesel engine. In this technique total system is controlled by the camshaft fitting such as governor mechanism, injection timing, feed pump operation and valve mechanism.To evaluate engine efficiency, different parameters are considered such as Flow rate, SFC, Brake power, Injection timing, stroke Length, EGT & torque of three cylinder diesel engine. When vehicle is running on the normal road, power of engine does not vary, but whenever vehicle is running on an inclined surface load on the engine increases. Hence it's effective speed as well as the power of the engine decreases. The speed of the engine decreases hence desired power obtained is also less. At this point torque of vehicle is considered. If the desired specific range of torque is less than the required value, then vehicle gets stopped. To avoid this condition it is necessarily to test engine at different torque values.

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I. INTRODUCTION

The four stroke CI (compression ignition) engine operates at much higher compression ratio. The Compression ratio is defined as the ratio of total cylinder volume when the piston is at the bottom dead centre, to the clearance volume. The compression ratio is designated by the letter "r". The compression ratio of diesel engine varies from 16 to 20. Due to higher CR of diesel, diesel engine has higher thermal efficiency, reliability and durability. Hence the diesel engine is manufactured in sizes from 50 mm to more than 1000 mm cylinder diameter and with the engine speeds ranging from 100 to 4500 rpm, while delivering outputs from 1 to 35000 KW.

Three Cylinders Diesel Engine.

The internal combustion engine is a heat engine that converts chemical energy in a fuel into mechanical energy, usually made available on a rotating output shaft. The chemical energy of the fuel is first converted to thermal energy by means of combustion or oxidation with air inside the engine. This thermal energy raises the temperature and pressure of the gases within the engine and the high-pressure gas then expands against the mechanical mechanisms of the engine. This expansion is converted by the mechanical linkages of the engine to a rotating crankshaft, which is the output of the engine.

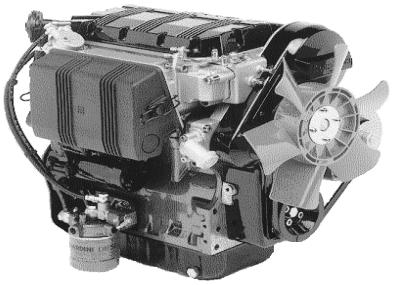


Fig.Three cylinder diesel engine

Testing specification of three cylinders diesel engine.

Feature	Unit	For Production
Displacement	Cm^3	1028
No of cylinder	No's	3 In line
Bore × stroke	mm	75×77.6
Cycle		4 Stroke Diesel
Air Intake		Naturally aspirated
Injection System		IDI
Cooling System		Water cooled
Injection timing @ static condition	BTDC	11°±1°
Max power	KW	16.2 -17.7
Rated Speed	RPM	3600
Consumption at power point	100cc/sec	61.7 -63.5
Max Fuel consumption @ max power	g/kw hr	286
Smoke @power point	FSN	2.2
Max Torque speed	RPM	2200-2600
Max torque	NM	45.8-50
Consumption at torque point	100cc/sec	98.3-101
Max Fuel consumption @ Torque	g/kw hr	218
Smoke at torque point	FSN	3.2
High idle speed	RPM	3850-3900
Low idle speed	RPM	1700±30
Oil sump Capacity	Liters	2.5

Minimize rejection of the three cylinders diesel engine due to the less torque.

In the multi cylinder diesel engine, when engine is test at different condition. First engine goes to warm-up level means full throttle performance (FTP) is done by increasing load on the engine. Full throttle performance is check at 3950 Nm. After that stage by the load on vehicle reduces then engine is check for power point at 3600 rpm speed. If the power is obtain in between 16.2-17.2Kw then engine is ok. When load on engine goes on increases the speed of engine decreases hence at this stage torque of engine checked at 2000-2600 rpm. If value of torque is obtaining 45-50Nm.then performance of engine is ok. If causes of some error in the value of the torque then less efficiency of the engine are obtain. Hence it is very necessary to eliminate or minimised rejection of the three cylinder diesel engine due to the less torque issue.

List of causes of generation of less Torque

- Centrifugal governor mechanism.
- Torque adaptor
- Fuel spring fitted on the lever
- Frictional losses
- Fuel quality
- Injection timing
- Tappet Setting.

TORQUE ADAPTOR

Torque adaptor is gearing device which control the flow of fuel. Which will increase the injection pump delivery and hence torque will hit its maximum value.

Torque adaptor is the device which is used to accelerate the vehicle at the required level. It is very small part of the engine likes bolt nut assembly. While the vehicle is running on any incline surface. The speed of the vehicle decreases hence, the power is also dropped. At that point the engine torque is necessary, hence to accelerate the vehicle with more speed torque adaptor required to provide torque of the engine.

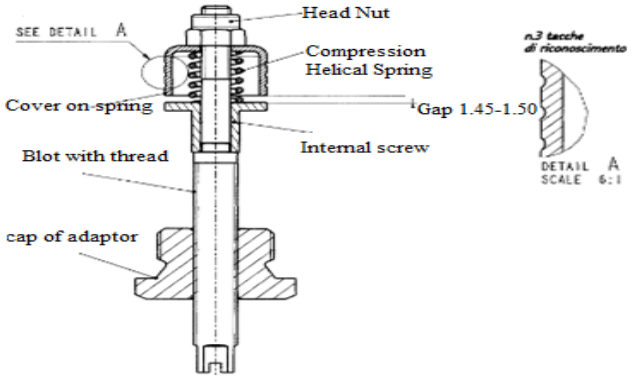


Fig. Section of Torque Adaptor

In above figure shows that detailed part of torque adaptor. It consists of an internal threaded screw, compression helical spring, outer cover, sleeve & cap of torque adaptor. In sleeve & cover on spring provided initially clearance 1.45-1.50 mm. At the end of the torque adaptor body tighten projection provided for accelerating the vehicle.

In the figure below shows that, Injection pump flow limiter and engine torque gearing device Flow limiter C has the function of limiting the injection pump's maximum delivery. The same mechanism acts also as a torque gearing device. Indeed, under torque, spring N operating lever L overcomes the resistance of spring M located in the plunger barrel. The stroke H that the torque gearing device allows to be carried out by lever L, will increase the injection pump delivery and the torque will hit its maximum value.

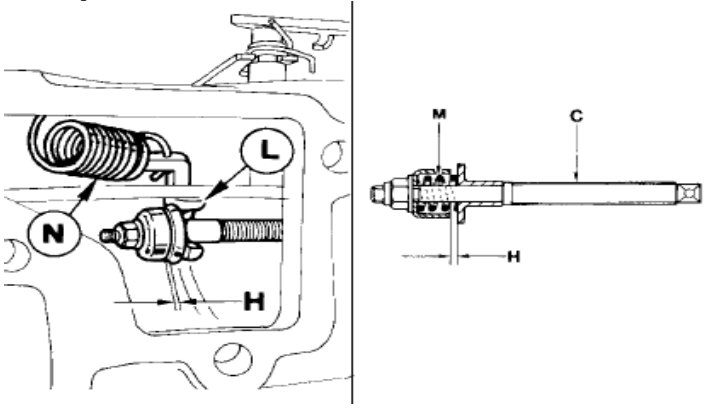


Fig. Torque Adaptor Setting

Injection Timing of three cylinder diesel engine.

In three cylinder diesel engine, the fuel is injected into the inlet manifold of each cylinder at different timing. The timing at which the injection of fuel takes place inside the inlet manifold is called injection timing.

The injection timing for one cylinder of this three cylinder engine is described as below.

In one cylinder, the piston moves up from BDC (Bottom dead Centre) to TDC (Top dead centre) during the exhaust stroke. Just before the piston reaches TDC during this exhaust stroke, injection of fuel takes place into the inlet manifold of this cylinder at about 60^0 crank angles before TDC. This injected fuel mixes with the air in the air intake chamber. Thus the air fuel mixture obtained. At the beginning of the suction stroke, intake valve opens and the air sucked during the suction into the cylinder during stroke.

According to firing order 2-3-1, the injection of fuel takes place inside the inlet manifolds of other two cylinders various timing.

In three cylinder engine, the ECU (Electronic control Unit) calculates appropriates injection timing for each cylinder and air fuel mixture is made available at each suction stroke.

In order to meet operating conditions, the injection valve kept open for longer timing by ECU. For example, if the vehicle is accelerating, the injection valve opened longer time, in order to supply additional fuel to the engine.

The most responsible factor to generate less torque in the three cylinder diesel engine is injection timing, LAM machine used to set injection of three cylinder diesel engine. To set injection timing in FIP (Fuel injection pump) is essential for diesel engine. It's very essential to check the firing order of the cylinder. The ECU is used to run on the LAM machine.

Following stage should follow during working on LAM machine.

1) Fixed vertical clamp on the engine head.
2) Set fuel the injector on FIP
3) Checked TDC is ok or Not
4) Verify TDC
5) Set before TDC 9°or 0.93mm before TDC.
6) Set pressure in Between 3-5 mbar & set fuel drop Frequency. Set the injection as order to 2-3-1 position.

Result and Discussion of project

In PDI section during testing of three cylinder engine were different kind of trial was conducted such as fitment of extra fuel spring, variation in clearance between torque adaptors, checking of variation test bed to test bed reading. Mainly focus on torque adaptor because a lot of variations in clearance reading were observed during testing.

Initial condition of torque adaptor clearance (Gap)

In testing summary of 1000 engine batch it is observed that, most of engine is rejected due to improper clearance between torque adaptors. In PDI (Pre dispatch inspection) section when engine is running on full throttle performance then engine is check power point and torque point. It is observe that, while accelerating the engine.

Initial setting Torque adaptor maintains clearance between -1.45 +/- 0.05.

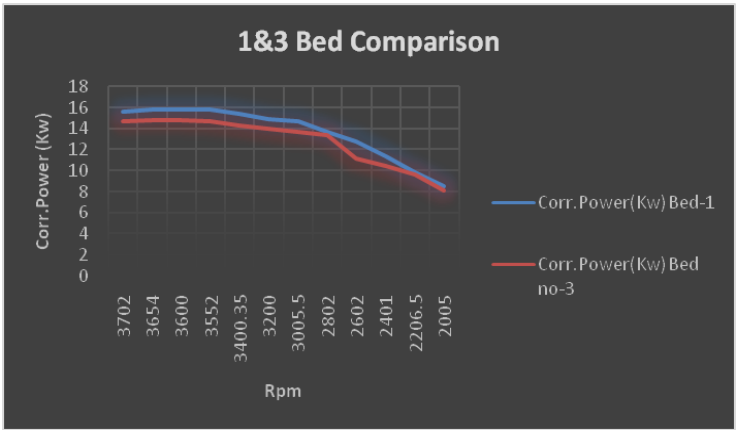
In above test cycle studies it shows that, the engine testing specification different speed range from low idle condition to FTP. During performing this cycle engine had passed on various stages. After FTP engine first checked power point at 3600 rpm. Then load on engine gradually increases, hence speed of engine decreases at that point need to maintain torque 45-50Nm accelerate the engine with help of torque adaptor .The standard limitation of torque adaptor as maintain clearance 1.45+\-0.005 at 2600-2400 rpm. But clearance gets disturbed during testing.

New condition of Torque adaptor clearance (1.65)

During testing it is conclude that if the clearance of torque adaptor varying in between one mm it is affect one Nm value.

During Trial on three cylinders diesel engine, if Clearance of Torque adaptor increases by 1.60 +/- 0.5 then that Engine checked different bed condition it shows following graphical Presentation. In this graph shows us by varying the value of graph 1.65 mm reading of different bed

Graph between Engine Speed (RPM) vs. Torque (Nm)



Dynamometer test Bed 1&3 comparison (Speed vs. Power)

Dynamometer test Bed 1&3 comparison (Speed vs Torque)

II. CONCLUSION

According to this project work study we had conclude that, to eliminate low torque generation. It has necessary to maintain torque adaptor clearance 1.65mm value. During testing it is concluded that if the clearance of torque adaptor varying in between one mm it affects one Nm value.. It must be necessary to calibrate dynamometer test bed to base bed reading.

This project work can be extended to reduce high smoke of the engine, power variation of the engine and also to maintain EGT (Exhaust Gas Temperature) of three cylinder difference about 60^0-70^0C. It can apply for single cylinder, two cylinders and any other multi cylinder engine.

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