Effect of Twin Turbocharger on Eicher Dump Truck

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Abstract

The purpose of this project is to understand the effect of twin turbo on Eicher dump truck. We all know that the turbo charger can significantly boost an engine horse power without increase in weight which is the huge benefit that makes the turbo so popular. Normally in India the dump trucks are working on single turbocharger and perform their work. The dump trucks has do more work as they are mostly working at mine areas and carry a huge amount of loads(self +loaded)on an inclined roads which requires huge power and high fuel consumption. MERCEDES, VOLVO, BMW'S, FORD trucks and cars they all are having twin turbocharged engines with greater efficiency.

Keywords: Turbocharger, Dump Trucks, Boost Pressure, Turbo Lag

I. INTRODUCTION

A. Turbocharger:

The performance of an internal combustion diesel engine can be increased by adding turbo charging. Turbo chargers compress the air so that more oxygen flows in the combustion chamber. In this way, more fuel is burned and the power output of engine increases accordingly. The turbo charger is driven by exhaust gases, which makes turbo charged diesel engine very efficient. Turbochargers are a type of forced induction system. A turbocharged engine produces more power overall than the same engine without the charging. This can significantly improve the power-to-weight ratio for the engine. In order to achieve this boost, the turbo charger uses the exhaust flow from the engine to spin a turbine, which in turn spins an air pump. The turbine in the turbo charger spins at speeds of up to 1, 00000-1, 20000 rotations per minute (rpm) -- that's about 25 times faster than most car engines can go. And since it is hooked up to the exhaust, the temperatures in the turbine are also very high.

Fig. 1: Turbo Compressor Blades (Holster)

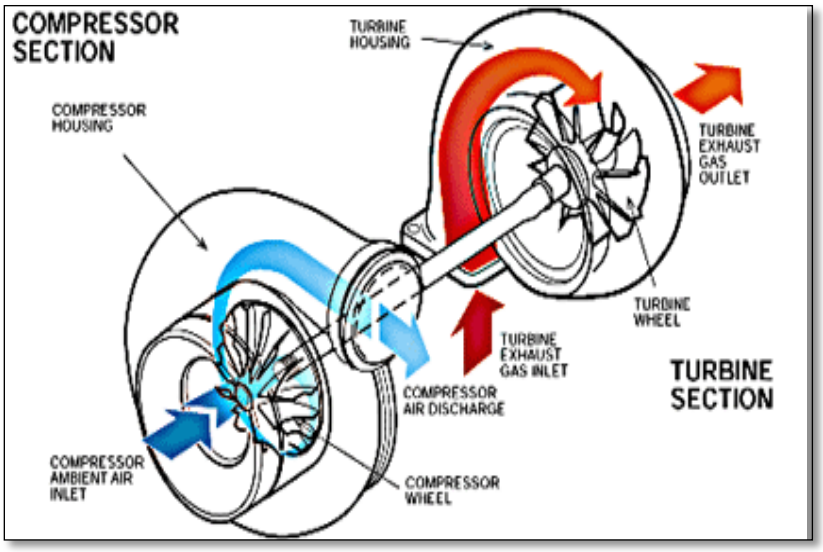

Fig. 2: Inside A Turbo Charger

B. Twin Turbocharger:

The underlying basic truth about engine performance is that power output is directly proportional to the total amount of fuel that can be burned in the engine. However it takes air to support the combustion of fuel to create usable power, so increasing power begins with increasing air flow. There are many ways to increase total engine airflow, such as simply building a bigger engine. In dump trucks constructing bigger engine involves more money and space too and the cost of vehicle also increased. So the elegant solution for above dilemma is twin turbo charging. Twin turbo or bi turbo means two turbo in its small block in dump trucks. Utilizing two turbo chargers assures that there would not be excessive exhaust restriction, and the intake boost pressure always exceeds exhaust back pressure.

Maintaining boost pressure above exhaust back pressure is one of the secrets to making big power. Additionally, two medium sized turbo will respond quicker than huge turbo, eliminating any perceptible lag when the throttle is depressed.

II. TURBOCHARGER ON DIESEL ENGINE

A diesel engine is an internal combustion engine. The cycle of the cylinders is the same in a diesel engine as it is in a gasoline engine, assuming it is a four-stroke engine (ref. Figure 1). Aside from the fuel type, the major difference between the two engines is the combustion itself. A gasoline engine uses a spark plug to initiate combustion. A diesel engine compresses the air then injects the fuel into the cylinder at the top of the stroke. The high temperature of the compressed air ignites the fuel. The hot gases expand, force the piston down, and create a torque on the crankshaft. The final stroke is the exhaust stroke, which releases the hot gases into the exhaust system.

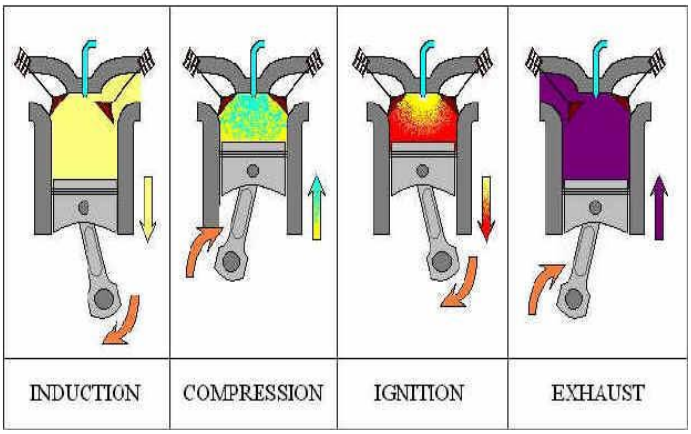

Fig. 3: Diesel Engine Four Stroke Cycle

The torque created from the downward motion of the piston acting on the crankshaft is transmitted from the crankshaft to the flywheel and into the transmission. To increase the power to transmission, the power must be increased in the cylinder. There are several ways to increase the power of an engine. One of the more common ways of increasing engine power is to increase the airflow into the cylinder by increasing the density of the air entering the cylinder. A turbocharger uses waste energy from the

exhaust system to compress air entering the cylinder, thus increasing engine power. A turbocharger consists of a turbine and a compressor connected by a shaft. The turbine section is mounted to the exhaust line from the engine. The compressor is connected to the turbine by a shaft and its outlet is routed to the engine air intake. Exhaust gas from the engine enters the turbine and expands, performing work on the turbine. The turbine spins the shaft connected to the compressor. The compressor draws in ambient air and compresses it. Figure 2 is a cross-section of a turbocharger. Turbocharger systems are measured by the amount of pressure the compressor can output above ambient. This pressure is commonly called boost pressure or boost.

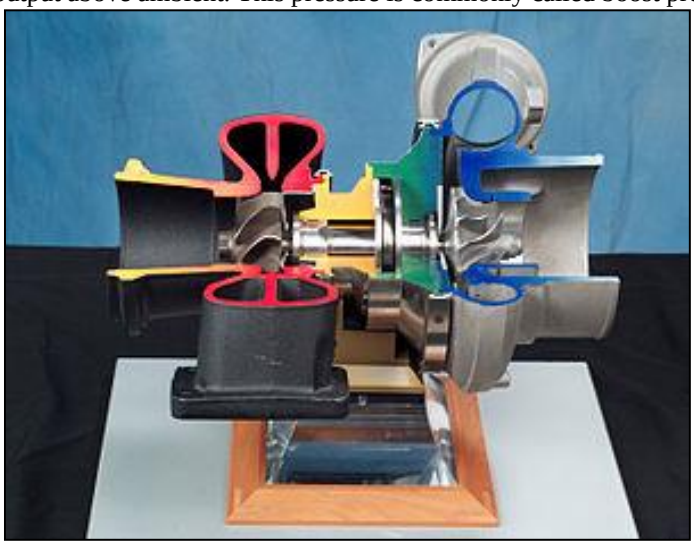

Fig. 4: Crossection of Turbo Charger

Compressing the air increases its temperature, which lowers the density of the charge air and creates a less efficient cycle and loss of power. The higher temperatures can also have detrimental effects on the materials and structure of the engine. To counteract this issue the compressed air needs to be cooled in order to achieve maximum power and maintain the structural integrity of the pistons. A heat exchanger, or intercooler, is installed between the compressor and engine inlet to cool the charge air. There are two different types of intercoolers, air-air and air-water. As in EICHER dump trucks air-water intercooler is present. In an air-water intercooler, air from the compressor is the external flow and the water is the internal cooling flow. The water cools the air exiting the compressor. A second cooling cycle is needed in the system to cool the water. The water is routed to a radiator, to be cooled by the moving air caused by the movement of the vehicle. The water flows through the radiator and into the water pump, which forces the water through the system. The pump adds a small amount of heat to the water, but not enough to affect the heat transfer in the intercooler.

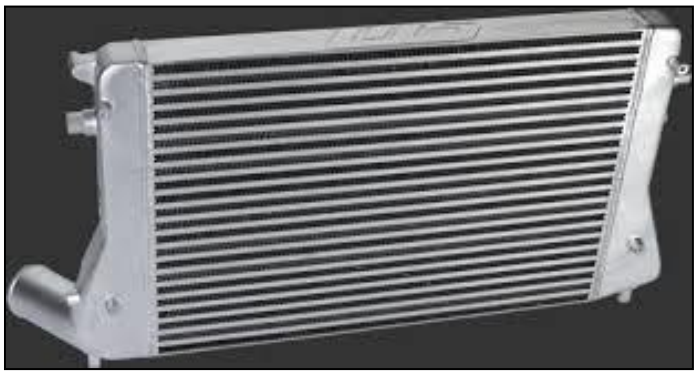

Fig. 5: Air-Water Intercooler

III. TWIN TURBO SYSTEM FOR EXISTING ENGINES

In the existing trends of the automobile,the twin turbo charger has been used in many engines like V-shaped engines,Inline engines. Some of them are as follows

1) Nissan's RB26DETT
2) BMW's N54 and Volvo's B6284T
3) Mitsubishi's 6A12TT

Fig. 6: Twin Turbo in Different Engines

IV. TWIN TURBO IN EICHER DUMP TRUCK

A dump truck or tipper truck is a truck used for transporting loose material (such as sand, gravel, coal, etc) for construction. A typical dump truck is equipped with an open-box bed, which is hinged at the rear and equipped with hydraulic pistons to lift the front, allowing the material in the bed to be deposited ("dumped") on the ground behind the truck at the site of delivery. In this paper we are choosing the Eicher Terra 16 HDR dump truck whose having 3200 rpm and 147HP power.

Fig. 7: Eicher Terra 16hdr Dump Truck

The twin turbo will increase the power of engine but the arrangement of twin turbo is very much important .The arrangement of twin turbo in such a way that there must be a minimum turbo lag and can generate maximum amount of power .The solution for above condition is sequential turbo. As the trucks are not working continuously at high rpm so this method would be very much important. Sequential turbo refer to a set-up in which the motor utilizes one turbocharger for lower engine speeds, and a second or both turbochargers at higher engine speeds. Typically, larger high-flow turbochargers are not as efficient at low RPM, resulting in lower intake manifold pressures under these conditions. On the other hand, smaller turbo spool up quickly at low RPM but cannot supply enough air at higher engine speed. During low to mid engine speeds, when available spent exhaust energy is minimal, only one relatively small turbocharger (called the primary turbocharger) is active.

Fig. 8: Single Turbo Arrangement in Dump Trucks

During this period, all of the engine's exhaust energy is directed to the primary turbocharger only, providing the small turbo benefits of a lower boost threshold, minimal turbo lag, and increased power output at low engine speeds. As RPM increases, the secondary turbocharger is partially activated in order to pre-spool prior to its full utilization. Once a preset engine speed or boost pressure is attained, valves controlling compressor and turbine flow through the secondary turbocharger are opened completely. (The primary turbocharger is deactivated at this point in some applications.) In this way a full twin-turbocharger setup provides the benefits associated with a large turbo, including maximum power output, without the disadvantage of increased turbo lag. The two turbo chargers are Garrett because the size of turbocharger is less and the cost is also low due to which the arrangement of turbo can possible. Sequential turbocharger systems provide a way to decrease turbo lag without compromising ultimate boost output and engine power. Perhaps the most noteworthy application of this system is the fourth-generation Toyota Supra (1993-1998), which is generally regarded as having the most reliable sequential turbo system yet fitted to a production automobile, with a reported failure rate of less than 1%.

V. CONCLUSION

This paper shows that the proposed twin turbo charger is viable solutions to be adopted when the engine is require extra high power in existing combustion engine. The solution is simple and elegant which can be done by using existing technologies.

In above work it is very clear that if we use twin turbo then there would be increase in power about 25% or ¼ of the generating power from an engine. which very much sufficient to carry the load on inclined or elevated areas.
This new twin turbo should be a must in next generation of Eicher dump trucks.

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