

Trouble Shooting Guidelines



COMPANY PROFILE

Turbo Energy Private Limited (TEL) was incorporated in the year 1982, as a joint venture company between Brakes India Private Limited, Sundaram Finance Limited and BorgWarner Turbo Systems (formerly known as KKK – Germany).

TEL is engaged in the manufacture of turbochargers and turbocharger components. TEL products find its application in automotive, industrial, off-highway and marine engine segments.

TEL caters both to the domestic and the international markets. TEL has been able to achieve customer satisfaction by providing products and services of high quality at globally competitive prices.

In line with the corporate values of the TVS Group, TEL has a firm commitment towards its stakeholders, ensuring sustained growth of the organization. TEL also recognizes its vendors as partners. Emphasizing team work, trust and care among the employees, TEL always strives for higher standards of performance.

TEL has state-of-the-art manufacturing facilities at Paiyanur and Pulivalam in Tamilnadu and an assembly plant at Rudrapur in Uttarakhand.

TEL has been accredited with ISO 14001:2004, ISO/TS 16949 and ISO/IEC 27001:2005 Certification by Bureau Veritas Certification (India) Private Limited for its Environmental Management, Quality systems and Information security management systems.

TEL is synergized to provide complete turbocharging solutions to its customers,. TEL is a pioneer and market leader in supplying turbochargers to major engine manufacturers in India and exporting turbocharger components.

TEL has an extensive network of aftermarket support system for providing reliable service at reasonable cost viz. technical support through its Customer Support Engineers (CSE), service support through Authorised Service Centers (ASC) and parts supply through Distributors.

REGIONAL OFFICES :

NORTH		
Mob	:	098718 76342 098719 58652 096507 53754
E-mail	:	csnorth@turboenergy.co.in
EAST		
Mob	:	097713 11349 098308 88763 097130 71019
E-mail	:	cseast@turboenergy.co.in
WEST		
Mob	:	099755 01323 098903 77319 099609 77377
E-mail	:	cswest@turboenergy.co.in
SOUTH		
Mob	:	098412 83380 098418 10548 091760 26982
E-mail	:	cssouth@turboenergy.co.in
Parts		
Help line	:	095363 48288 098417 25909



PRINCIPLE OF EXHAUST GAS TURBOCHARGER



In a turbocharged engine, the exhaust gas which would normally be wasted, is used to drive a turbine. The turbine in turn drives a compressor, which draws in air and compresses it and supplies it at a higher pressure to the engine. Due to higher air availability and by supplying more fuel, engine power output can be increased. Higher air availability helps in better combustion, thus leading to reduced fuel consumption and less emission.

Advantages Of Turbocharger



Lower fuel consumption



Better torque characteristics



Lower engine noise



650 lbs 250 lbs (295 Kg) (114 Kg)

Lower weight and a smaller engine package



Reduced power loss at high altitude

As a result, turbochargers contribute significantly to the protection of the environment and better utilization of energy resources.



2

CONSTRUCTION & FUNCTION OF A TURBOCHARGER

Turbocharger (TC) primarily comprises of a compressor section and a turbine section. The turbine and compressor wheels are mounted on a common shaft, hence they rotate as a single unit. This sub-assembly is known as the rotor assembly. The rotor assembly is supported by journals placed inside the central housing.



Turbine section consists of the turbine wheel and turbine housing. The pressure energy available in the exhaust gases is converted into Kinetic energy by the turbine housing and is used for rotating the turbine wheel.

- H. H.



The compressor consists of the compressor wheel and compressor housing. The compressor wheel draws in air axially and delivers it radially at a higher velocity. The compressor housing converts higher velocity air into higher pressure.

The central housing consists of all the supporting & sealing components required for the rotor assembly. Journals & thrust plate for supporting rotor assy., and the lubricating oil passages for oil supply & drain. Piston rings for sealing.

1 1



TURBOCHARGER TECHNOLOGY



Waste Gated Turbocharger



For reasons of improved TC response, turbine housing with a smaller cross sectional area is chosen so that sufficient boost pressure is available at lower engine speeds. Part of the exhaust gas is by-passed once the required boost pressure is reached. This is achieved by

opening a valve, operated by a spring loaded diaphragm (actuator assembly) with the help of boost pressure available in the compressor housing or with the help of external vacuum supply.



The turbine flow cross-section varies in accordance with the engine ECU demand by variable guide vanes placed in the exhaust gas flow area of the turbine housing. As a result of continuous turbine cross section adjustment to the engine airflow requirements, high engine

- 10 10

torque at low speeds and with adequate control strategy ensures a significant improvement of dynamic performance of vehicle. Guide vane control is mostly electronic through a vacuum regulated actuator.

R2s Turbocharger



Regulated two stage turbocharger (R2S). This system uses one low pressure turbocharger and one high pressure turbocharger i.e. two turbochargers for one engine. This technology helps in increasing the engine's specific power output (power to weight ratio) and also helps in downsizing the engine while meeting the performance requirement.

- 10 10



TC Complaint diagnosis

Each Turbocharger part no. is specifically matched with engine to deliver requisite performance. Every TC manufactured passes through quality checks before it is sent out. TC along with the engine is tested to ensure the performance matches with the design release at the engine manufacturing plant before it is sold to customer.

TC once fitted onto the engine / vehicle becomes part of the whole system and its performance is primarily dependent on other engine systems. Hence for any complaints ex. Poor pickup, Noise, oil leak, smoke etc. it is advisable to check the other system instead of suspecting TC first.

The following procedure explains the basic inspection to ascertain if the TC in the complaint vehicle is O.K OR not O.K:

TC VISUAL INSPECTION PROCEDURE









Fallow the same inspection procedure for turbine side also.



Check the TC actuator assembly for its proper functioning i.e. check for damages, tampering, loose or open connections.

VTG TC VACUUM ACTUATOR CHECKING PROCEDURE

The normal working condition:

When the engine is switched off, TC actuator will be in OPEN condition i.e. Actuator control rod length will be maximum.

When the engine is switched-on (while engine in running condition), TC actuator control rod will be in closed condition i.e. Actuator control rod length will be minimum.

During the engine operation the TC actuator control rod moves freely without restriction.



VTG TC Vacuum Actuator Not OK:

Symptoms: Vehicle speed is not O.K, Check Engine light is ON. -

Diagnosis on the Vehicle: Connect the engine diagnostic and check for fault code (Ex.: Engine airflow deviation - Not O.K)

Checks on vehicle:

The vacuum hoses for correct fitment, Open / damaged hoses will cause actuator malfunctioning.

Switch controlling vacuum supply to actuator for proper functioning.

The vacuum pump is functioning correctly.

Sufficient vacuum supply is there to TC actuator while the engine is in running condition.

Checks on TC:



Check if the actuator control rod is proper (ensure that it is not tampered), the adjusting nuts are in place, the control rod is not damaged, rusted, excessively worn-out.



Move the control rod with hand confirm its movement is free.

Remarks: If all checks on vehicle found O.K and the TC actuator operation is not O.K i.e. the actuator control rod does not move up when the engine is switched-on and moves down when the engine is switched-off OR the TC actuator control rod movement is not free - Replace the TC.



TC COMPLAINT DIAGNOSTICS

Turbocharger Noise

Turbocharger rotor rotates at very high speeds (around 2,00,000 RPM).

The air & exhaust gas entering & exiting the TC are travelling at very high velocity / speed.

TC Compressor wheel & Turbine wheel are individually balanced to very fine balancing limits (0.05 gmm). The core assembly noise / vibration is measured and corrected on a high speed balancing machine to ensure TC noise levels are under acceptable level.

TC once fitted onto the engine with Air inlet & outlet and exhaust inlet & outlet systems, it becomes part of the engine. Hence the TC & its connected systems proper fitment and function is important for its satisfactory operation.

The TC intake & exhaust connections and the respective piping are carefully selected to ensure that there are no leakages more importantly they are made with specific shape, size & material to avoid noise amplification.

Noise measurement

Although the TC is balanced to acceptable unbalance levels, due to minor variation within the TC and its connections, the noise level might vary from one engine to another engine. However an acceptable level is agreed during the installation sign-off and any noise within this accepted limit is O.K. please check the installation is as specified i.e. the TC installation & its connections are not tampered.

There are other rotating parts like Alternator, Power steering pump and other pulleys & belts fitted onto the engine which can also contribute to the noise. Hence identifying & elimination of such noise sources is important.

"Noise is observed while the vehicle is in stationary condition during acceleration / deceleration, the noise could be due to leak from exhaust system. If the noise is only observed when the vehicle is in use i.e. while acceleration on the road / with load, the noise could be due to Air leakage after the TC".

The evaluation of noise complaint should be done only with the engine in normal operating temperature.

The noise should be checked with vehicle windows closed and with Air conditioner ON.

In a case where the vehicle is reported with abnormal noise, please check the following:







Complaint : Noise

System : Exhaust side

Possible causes

Remedial actions



- Damaged gaskets, Improper / leaky joints due to cracks, Misalignment / damaged connections (inlet, outlet & EGR)
- ✓ Correct leaks & misalignments, Correct / replace damaged parts



- Loose, damages, incorrect heat shields
 Replace with correct parts & ensure its proper fitment
- Defective silencer / exhaust brake valve
- $\ensuremath{\boxdot}$ Correct / replace the defective parts



 Foreign object / Loose particle in the exhaust system

10 M

☑ Remove particle

Complaint : Noise

System : Turbo Charger

- Possible causes
- Remedial actions



O Defective TC✓ Replace the TC

Fig:010

- Wheels rubbing with excessive dust/ carbon
- ☑ Replace the TC





Air leakage from boost pressure pipe connections

II II

☑ Correct the leakage

TC sealing principle

Turbocharger does not have seals like engine seals, sealing is realized by piston rings (similar to engine piston rings) on both compressor & turbine side. The purpose of this sealing is to prevent oil leakage from bearing housing towards the compressor and turbine housings. TC Sealing system works on pressure differential. The design principle of this



piston ring sealing allows leakages there is a clearance available between rotating parts & stationary piston rings. Under normal engine operating conditions, there is a gas leakage from the turbine & compress housings into the bearing housing and consequently to the engine blow-by system.

Oil Leak from TC compressor outlet

In some of TC operating conditions if the compressor pressure is lower than the bearing pressure Ex.: due to choked air filter, the blow-by from the bearing housing goes towards the low pressure compressor housing. This blow-by will carry oil traces. This oil can be found deposited on the piping downstream of the compressor outlet.



TC oil leak from compressor outlet **should not be checked** with compressor outlet in open condition (open to atmosphere) while engine is in running condition.

Some oil traces at TC compressor outlet and its upstream connections to the intercooler are normal.

The factor which favors this phenomenon are as follows:









Oil Leak from TC turbine outlet

Engine oil to TC after lubricating drains down into the engine crankcase under gravity, the ability of oil to drain into crankcase from the TC depends on the height difference between TC to the crankcase, the pipe area (diameter) & inclination. Since TC drain connection is connected to the crankcase and oil is only getting drained on gravity, the pressure in the crankcase is very important for proper oil drain from TC.

The bearing housing is disproportionately small compared to the amount of oil being drained. Hence any restriction of oil drain will result in oil accumulation & consequential leaking from TC turbine outlet.

The factor which favors this phenomenon is as follows:







Remedial actions



Wheels rubbing with excessive dust/ carbon

Replace the TC



- Bearing housing sludged & choked
- Replace the TC



Some oil traces at compressor outlet and its upstream connections to the intercooler are normal.

Cases where you are able to find the cause of oil leak into TC compressor turbine & housing and it is corrected, wherein the TC is found O.K, the TC can be reused. However all the compressor upstream (Intercooler) connections need to be thoroughly cleaned for oil accumulation before engine restarting.

While replacing the defective TC with a new TC on an engine also it is mandatory that all the compressor upstream (Intercooler) connections need to be thoroughly cleaned for oil accumulation before engine restarting.



Poor pickup black smoke

Correct Air Fuel ratio, requisite combustion system and appropriate operating conditions are prerequisites for an engine to develop specified power output. Apart from these a modern diesel engine has got additional components for performance & emission control, malfunctioning of these components will also affect the overall engine performance.



The above schematic diagram provides the details of additional components to an engine and its integration. Since the engine & the components are interconnected and are controlled by a single ECU. Proper functioning of each component is a must for engine to perform to its designed function.

Before suspecting the TC for performance it would be appropriate to ensure proper functioning of all the other components of an engine. It is advisable to use the recommended engine diagnostic tool to identify the exact cause of complaint.



The factor which favors Power loss are as follows:

Complaint : Poor pickup **Complaint :** Poor pickup System : Air side System : Turbo Charger Possible causes O Possible causes Θ ✓ Remedial actions ☑ Remedial actions _____ II II • Restriction in air intake passage to Air O Defective TC ☑ Replace the TC filter ☑ Remove / correct the restriction (Ref. Fig: 009) (Ref. Fig: 001) _____ II II O Wheels rubbing with excessive dust / Choked air filter elements carbon ☑ Replace the air filter elements (both ☑ Replace the TC primary & secondary) (Ref. Fig: 010) (Ref. Fig: 002) - - -- II. II. _____ B B I _____ **_**___ O Actuator (pressure type) is struck in hoses (inlet) open condition ☑ Replace the hoses as per OEM ☑ Replace the TC recommendations (Ref. Fig: 022) (Ref. Fig: 003) - - -_____ III ☺ VTG Actuator not working /defective Intercooler, leaky intercooler & ☑ Replace the TC intercooler to intake manifold & its connections ☑ Correct the leaks _____ R.R. (Ref. Fig: 018) blades _____ II II - - -☑ Replace the TC (Ref. Fig: 023) connections (outlet), blocked intercooler / intake manifold. ☑ Correct the alignment, replace the defective parts, remove the block (Ref. Fig: 005)





Complaint : Black Smoke

System : Air side

O Possible causes

✓ Remedial actions

- Restriction in air intake passage to Air filer
- ✓ Remove / correct the restriction (*Ref. Fig: 001*)
- Chocked air filter elements
 Replace the air filter elements (both primary & secondary) (*Ref. Fig: 002*)
- Incorrect hose material, withered hoses (inlet)

_____ = ___

✓ Replace the hoses as per OEM recommendations (*Ref. Fig: 003*)

_____ II II

- Compressed air leakage from TC to Intercooler, leaky intercooler & intercooler to intake manifold & its connections
- ✓ Correct the leaks (Ref. Fig: 018)

 Misalignment, deformed pipes / connections (outlet), blocked intercooler / intake manifold.

✓ Correct the alignment, replace the defective parts, remove the block (*Ref. Fig: 005*)

Complaint : Black Smoke

System : Turbo Charger

- Possible causes
- Remedial actions

_____ B.B

- Defective TC
 Replace the TC (*Ref. Fig: 009*)
- Wheels rubbing with excessive dust / carbon

_____ = 1

- Replace the TC (*Ref. Fig: 010*)
- Actuator (pressure type) is struck in open condition
- ☑ Replace the TC (Ref. Fig: 022)

- Eroded (reduced) compressor wheel blades
- Replace the TC (*Ref. Fig: 023*)



Complaint : Black Smoke

System : Exhaust Side

- Possible causes
- Remedial actions
- Foreign particle in exhaust system
 Remove the foreign particle (refer engine manufacturer manual)

 Restricted exhaust system, blocked catalytic converter

Remove the restriction (Ref. Fig: 037)

_____ **_**___

Complaint : Poor pickup

System : Engine

Possible causes

✓ Remedial actions

_____ II II

- Worn-out liner / piston, burnt valves / pistons
- ☑ Correct defect as per engine manufacturer's recommendation

- Faulty valve timing, Fuel injection system
- ☑ Correct defect as per engine manufacturer's recommendation

 Faulty (open) EGR
 Replace the defective part (*Ref. Fig: 038*)

Complaint : Blue / White Smoke

System : Engine

- Possible causes
- Remedial actions
- Sensine oil level high
- ✓ Correct the oil level / quantity as per engine manufacturer's recommendation (*Ref. Fig: 024*)

- - -

 Restriction in TC oil drain
 Remove the restriction (*Ref. Fig: 025*)

 High crankcase pressure
 Correct the crankcase pressure (*Ref. Fig: 026*)

- 8.8

 Defective oil separator
 Replace the oil separator (*Ref. Fig: 027*)

Restricted engine breather

_____ B B

 Remove the restriction in the engine breather circuit (*Ref. Fig: 028*)



Complaint : Blue / White Smoke

System : Turbocharger

• Possible causes

- Remedial actions
- Damaged TC
 Replace the TC
 (*Ref. Fig: 034*)

- Wheels rubbing with excessive dust/ carbon
- Replace the TC (Ref. Fig: 035)

_____ II II

Bearing housing sludged & cocked
 Replace the TC
 (*Ref. Fig: 036*)

Actuator is struck in open condition
 Replace the TC
 (*Ref. Fig: 022*)

_____ **_**___

- Eroded (reduced) compressor wheel blades
- Replace the TC (Ref. Fig: 023)

Complaint : Blue / White Smoke

System : Air Side

Possible causes

✓ Remedial actions

_____ II II

- Restriction in air intake passage to Air filer
- ☑ Remove / correct the restriction (*Ref. Fig: 001*)

- Chocked air filter elements
 Replace the air filter elements (both primary & secondary) (*Ref. Fig: 002*)
- Incorrect hose material, withered hoses (inlet)

Replace the hoses as per OEM recommendations
 (*Ref. Fig: 003*)

- Compressed air leakage from TC to Intercooler, leaky intercooler & intercooler to intake manifold & its connections
- Correct the leaks (*Ref. Fig: 018*)

_____ B.B.

- Oil in the TC compressor inlet
- Check & correct the cause for oil in TC compressor inlet (*Ref. Fig: 019*)



Unique Features of a turbocharger:

The clearances between the rotor and the journal are extremely small and the parts are machined to very close tolerances (around 0.005 mm).

TC uses fully floating journals, which rotate at half the speed of the rotor assembly.

Filtered engine oil at the required pressure is essential to lubricate, cool and balance the rotor assembly. The TC components are balanced to very fine balancing limits.

Turbocharger components are made from special materials, processes and are precision built to work under specified operating conditions. It is important to strictly adhere to engine manufacturer's maintenance & operating recommendations for proper functioning and extended life of TC.

Using the recommended engine oil & filter and following the change interval.

Using the recommended air filter & following the change interval.

Failing to comply with manufacturing recommendations will result in damaged TC, some of the TC damaged cases with their causes are listed below:

THE FOLLOWING ARE FEW TYPICAL TC FAILURES AND THEIR CAUSES



Complaint: TC Damage

Observations: Blue colour formation on the shaft journal area. Seizure / excessive wear on the journals

Causes: Lack of oil supply



Complaint: TC Damage

Observations: Journal oil holes closed partially. Discolouration / glazing marks on shaft journal contact area

Causes: Insufficient oil supply / Low oil pressure





Complaint: TC Damage

Observations: Wear marks on turbine shaft journal area, journals, and bearing housing bore area

Causes: Bad oil condition (dirt in oil)



Complaint: TC Damage Observations: Compressor wheel damaged at entry area

Causes: Dust or dirt or metallic particles like nut/bolt/screws entry into compressor inlet



Complaint: TC Damage

Observations: Turbine wheel blades damaged at gas entry area

Causes: Broken valves, valve seats, core sand or any loose particle entry into Turbine housing



Complaint: Poor Pickup - Actuator Control Rod Movement Not OK.

- E - E

Observations: Excessive carbon deposit observed in the Turbine housing cartridge area.

Cartridge not free movement.

Causes: Poor fuel quality / Operating conditions



www.turboenergy.co.in

