

INSTALLER CONNECT TURBO EXPERT TRAINING COURSE

LEVEL 3, ANIMATION 5

The take-aways below relate to the sequence of each instructional video and will help you gather the knowledge you need to complete the Garrett Motion Installer Connect training modules. You can return to the video as often as you wish.

The Turbocharger Oil and Gas Sealing System

This is the module for the Level 3 training course. In the previous training modules, we have seen how the oil passing through the bearing system is critical to the correct operation of the turbo. The sealing system is designed to keep the oil where it should be; inside the centre housing, but it is the most misunderstood feature of a turbocharger.

Please use these notes in conjunction with the course video. Using both resources will help you succeed in gaining Level 3 certification on the road to becoming a turbo expert!

Oil Seals

About the critical role of oil seals:

Knowledge booster

- Many instances of oil leakage are wrongly blamed on a perfectly functioning turbo. Understanding how the sealing system works helps greatly in diagnosing possible root causes on the vehicle and will minimise wasted workshop time.
- Vehicles and engines use a variety of oil seals. The most common of these is the lip type contact seal, which are highly effective, working with rotating shafts like the crankshaft. If one of these starts to leak, it is relatively easy to diagnose and rectify the problem, by replacing the seal.
- A turbo does not use this type of seal, due to the high speed, extremely high temperatures and the large shaft clearances necessary for correct operation. If oil is found to be leaking from a turbo, firstly it is more complex to diagnose correctly and secondly there is no possibility to just change a seal, like on a crankshaft.
- The sealing systems on turbos have evolved over many years as engines and their associated systems become more complex. The sealing system has been proven to be exceptionally efficient and robust, so leakage from either the turbine or compressor end seal is almost always due to some external influence.
- *Important note: changing the turbo may not cure the problem, as the oil leak is very often just a symptom of some other problem on the vehicle.*

Dynamic, Differential Pressure Sealing System

About the turbo sealing system:

Knowledge booster

- Turbochargers use a dynamic, differential pressure sealing system.

- Dynamic, because it utilises the rotation of the shaft and differential pressure because it takes advantage of the normal pressure differences between the three housings of the turbo.
- Under most running conditions, the pressure in the turbine housing is higher than the centre housing and the pressure in the compressor housing is higher than the centre housing.

Turbine End Sealing System

About the turbine sealing system:

Knowledge booster

- At the turbine end, the sealing system is simple. After the oil has finished its work in the bearings, it travels along the shaft until it reaches the hub, where the spinning oil thrower literally throws the oil outwards by centrifugal force and it meets the inside face of the centre housing where it drops down under gravity to be collected by the oil drain and returned to the engine sump.
- In addition, one or two piston rings are used which fit into a very accurately machined “stepped bore”. Unlike the piston rings inside the engine cylinders, these piston rings do not move. During the assembly process, the piston rings are compressed and once they are correctly located, the piston ring never changes position.
- A natural feature of any piston ring is that it can never be a 100% seal, because there must be a running clearance at the two ends, plus clearances all around the rectangular section of the ring.
- However, in the turbo, this natural feature is used to advantage as some of the high-pressure exhaust gas from the turbine inlet passes behind the turbine wheel head to provide a very effective pressurised seal around the piston ring, to prevent any oil from passing out of the centre housing.
- The tightly controlled piston ring clearances allow a very small flow of exhaust gas to pass from the turbine housing into the centre housing, further helping to keep the oil where it should be. On some turbos, we may use bleed holes in the heat shroud to further increase the pressure in the piston ring area.

Compressor End Sealing System

About the compressor sealing system:

Knowledge booster

- At the compressor end, the sealing system is more complex and there are many different designs to work with specific turbo models and applications.
- As the oil finishes its work in the journal bearing, it spills out and is thrown outwards under centrifugal force by the back face of the thrust collar, whilst the oil from the thrust bearing is also thrown outwards by the rotating thrust collar where it again drops down under gravity to be collected by the oil drain. The thrust collar may be a simple disc, or it may be a combined thrust collar incorporating an oil/air separator and thrust spacer incorporating one, two or even three piston rings depending on the application for the turbo.
- To understand how the seal works, we need to see the compressor working in two different conditions. Firstly, at high speed, there is a large flow of air through the compressor and some of the high-pressure air from the diffuser section bleeds behind the wheel and pressurises the piston ring seal. A small flow of air helps to keep the oil where it should be.
- Secondly, at low speed the flow of air through the compressor is much lower, so the pressure at the diffuser section is also much lower and under these running conditions, the pressure behind the compressor wheel can be negative allowing a small flow of air to be drawn from the centre housing, past the piston ring and into the compressor. Under these conditions, it is essential that the oil and air in the centre housing are separated, to prevent any oil from also being drawn into the compressor housing.

- Any oil splashing around internally may pass around the rotating thrust collar and down towards the piston ring area. As oil travels towards the inner part of the thrust collar, it passes a row of radial holes; the heavier oil is thrown outwards under centrifugal force and into the oil gallery. The holes are a two-way passage, so as oil is thrown outwards, air is drawn down through the same radial holes and then along past the piston ring into the compressor housing. So, the oil and air has been separated, to prevent leakage into the compressor.

Oil deflector

- Another way to separate the oil and air is to use an oil deflector, which collects oil passing out from the thrust bearing, reducing the amount of oil which can reach the oil thrower. A “knife edge” type of oil thrower is used and very effectively helps prevent any residual oil from splashing into the piston ring area.

Dual sequential turbo sealing

- On dual sequential turbos, where only one turbo runs full time and the secondary turbo only operates on demand, effective oil sealing is required even when the turbo is not rotating. This is achieved by pressurising the piston ring seals, using air provided by the primary turbo. An air pipe connects to the centre housing and the high-pressure air travels through internal feed channels providing a flow of air between the piston rings. This helps to prevent oil leakage from the center housing, even when the turbo is not rotating.

Backplate sealing

- The center housing to backplate joint includes a square section “O” ring, which is compressed as the backplate bolts are tightened during assembly. One part of the sealing system that is often overlooked is the sealing of the backplate retaining bolts. On many turbo models, the backplate bolts pass through the oil gallery and into threaded holes in the centre housing. This means that the bolts often have additional seals, to prevent the hot, thin oil from travelling up the thread, passing under the bolt head and into the compressor housing. We may use bolts with an annular (or circular) V shaped ridge, which bites into the backplate surface to create a permanent seal, or bolts that have washers with a rubber seal, which is compressed under the bolt head and prevents oil from leaking into the compressor.

Our next animation will show what may cause a perfectly functioning turbocharger to suffer from oil leakage.

Knowledge Check

After watching the animation, your new understanding should enable you to answer the following questions.

- What is the primary purpose of a turbo oil sealing system?
- What is the function of an oil thrower?
- What is the effect on the sealing system of exhaust gas passing behind the turbine wheel?
- Are backplate retaining bolts part of the sealing system?

Remember to use these notes in conjunction with the Installer Connect videos as you take the tests that support your journey to becoming a certified Garrett Motion turbo expert.