KMP BRAND TECHNICAL BULLETIN

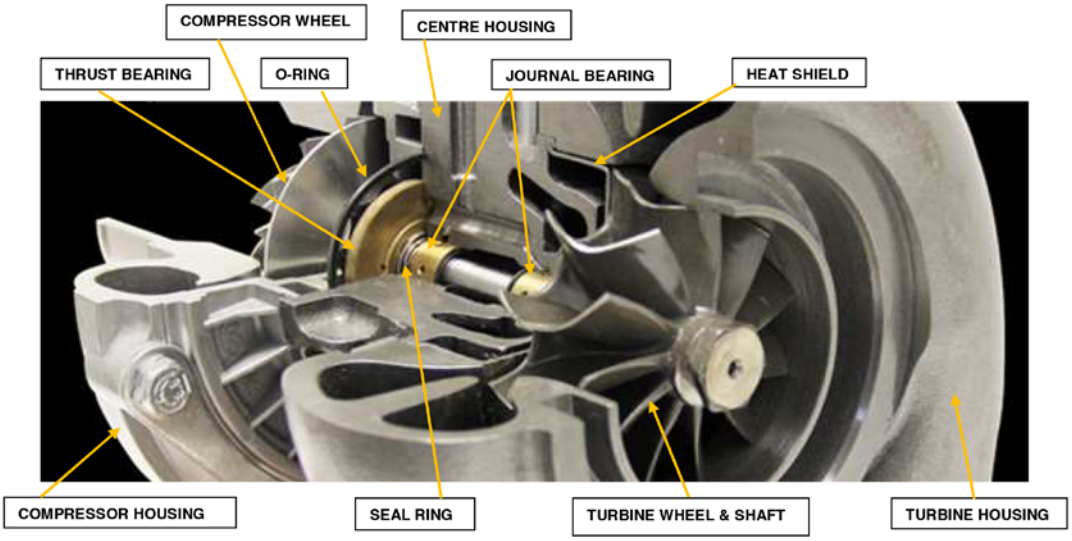
Turbocharger Failures

KB-15008

TECHNICAL BULLETIN

TURBOCHARGER FAILURES

The function of the turbocharger is to compress and increase the inlet air supply to the engine and this is achieved by utilising the exhaust gases from the engine cylinders to turn the turbine wheel and shaft which has a compressor wheel fitted on the opposite end; the compressor wheel draws in air and then delivers the increased air mass into the engine.
Not only does the turbocharger improve engine performance and operating economy, it also reduces exhaust emissions.



This bulletin will illustrate the types of damage that occur when turbochargers are subjected to adverse operating conditions.
But how sure are we that the turbocharger is actually faulty ?
All too often a perfectly good turbocharger is removed because no troubleshooting was carried out.

- If the engine is giving low power and emitting black smoke you should first check that the air filters do not require servicing, check for loose air ducting connections or maybe an over-fuelling situation exists.
- Blue smoke could be an indication that other engine components are worn, such as valve guides, piston rings or cylinder liners.
- A noisy turbocharger could possibly be traced to a leaking gasket either on the inlet or exhaust side.

Turbocharger failures can be grouped into three main categories, lack of lubrication, contamination of lubrication and the ingestion of foreign object.

LACK OF LUBRICATION

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CONTAMINATION OF LUBRICATION

INGESTION OF FOREIGN OBJECT

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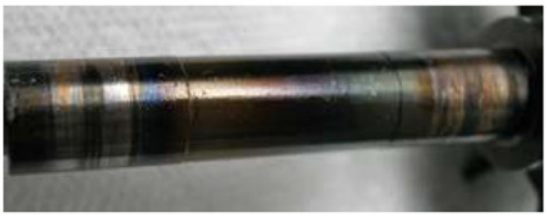
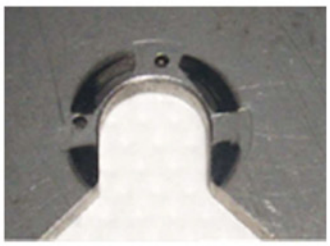
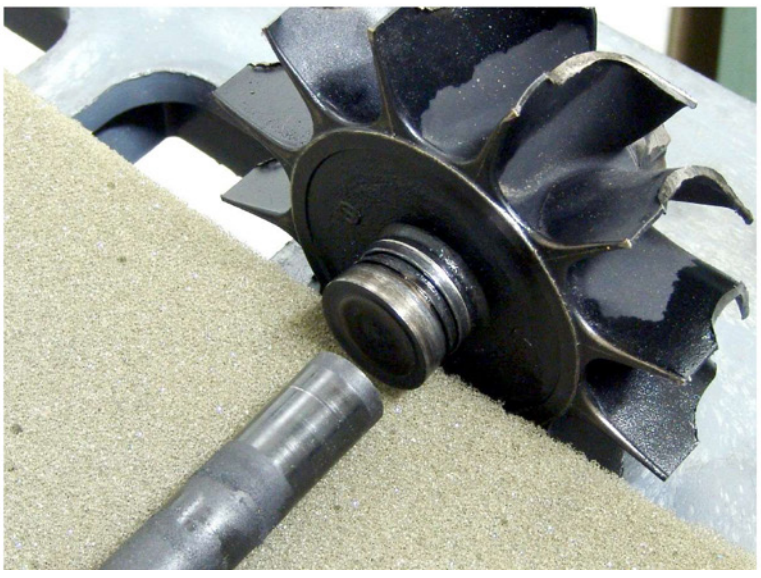
Lack of lubrication can ruin a turbocharger in a very short space of time because of the extremely high rotational speeds of the shaft, in some applications as much as 100,000 rpm - so it is imperative that all bearings must receive a supply of oil that will stabilise, lubricate and cool them.
If lubrication is slowed, stopped or interrupted for any reason, metal to metal contact occurs at the journal bearings, shaft journals and bearing bores in the centre housing.
Without the oil, friction will generate enough heat to turn the shaft and bearings blue.
The thrust bearing, thrust collar and/or backplate mating surface will also show signs of damage.
Once the bearings and shaft journals are damaged then shaft motion increases and instead of rotating in a perfect circular motion, the shaft begins to oscillate and bearing clearances are enlarged, shaft motion becomes more intense, and damage accumulates.
After shaft motion reaches a certain point, the turbine and compressor wheels will contact their respective housings damaging the blades and possibly backing off the shaft nut.
When blades are damaged by housing rub, the precise balance of the wheel/rotating assembly is destroyed which results in even more shaft motion and ultimately the shaft may eventually break from a combination of motion stress, fatigue and destabilization, and all this can be attributed to the original problem, insufficient lubrication.





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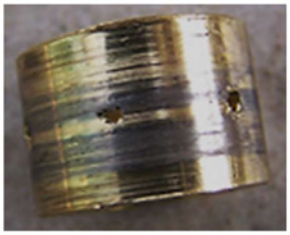
Contamination of lubrication by fine abrasive contaminants will score and wear virtually every bearing surface, but if material particles are large enough, the damage related to the contamination will be more confined to the journal bearing outside diameters and the centre housing bearing bores because the centrifugal force will keep the contaminants away from the spinning shaft.
This is because the majority of the turbochargers have what is termed a full floating bearing/bearings which support the rotating group and have a minimal amount of clearance between components; as a consequence any contaminants in the oil will result in immediate damage to surfaces.
It is a common belief that any contamination that may have been introduced into the oil will be removed by the oil filter/filters before it reaches the engine, or in this case, the turbocharger bearings.
This assumption is totally incorrect and can prove to be a costly mistake.



Another source of contamination can be the oil itself because if temperatures are forced high enough during operation or shutdown this can result in the formation of deposits.
These deposits then contaminate the oil supply and drain lines and the granular carbon deposits become part of the oil supply to the bearings; these will ultimately cause damage to surfaces and increase clearances, which can create a failure very similar in appearance to a lack of lubrication type failure.

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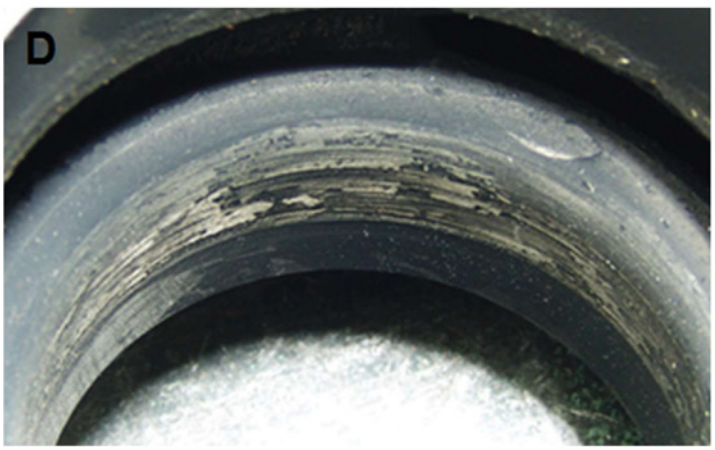
Illustrations A and B show the appearance of the compressor wheel and housing after bearing damage had taken place which resulted in contact of the two components; the same damage occurs to the turbine wheel and housing, see illustrations C and D.



Ingestion of foreign object can account for as much as 40% of turbocharger failures and the culprit can have a number of origins, a piece of burnt or broken valve exiting the engine through the exhaust will end up damaging the turbine wheel, damaged pistons or piston rings could also be a source.
Other possible sources can be from casting flash inside the cylinder head or exhaust manifold, these could become dislodged over a period of time – in instances such as this the cause of the turbocharger damage will seldom be traced.
The more obvious cause of damage is when loose hardware or other foreign material is left inside the exhaust manifold, air filter housing or the piping – if a nut, bolt or washer is dropped always establish where it fell, better safe than sorry.

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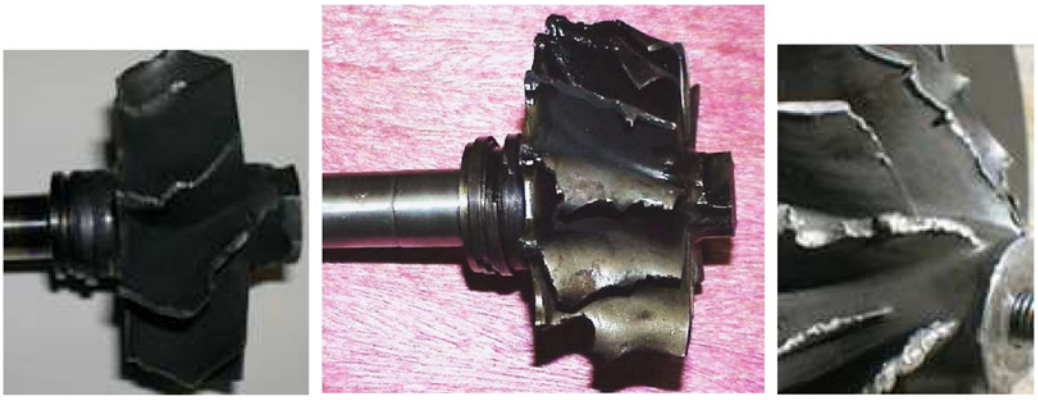
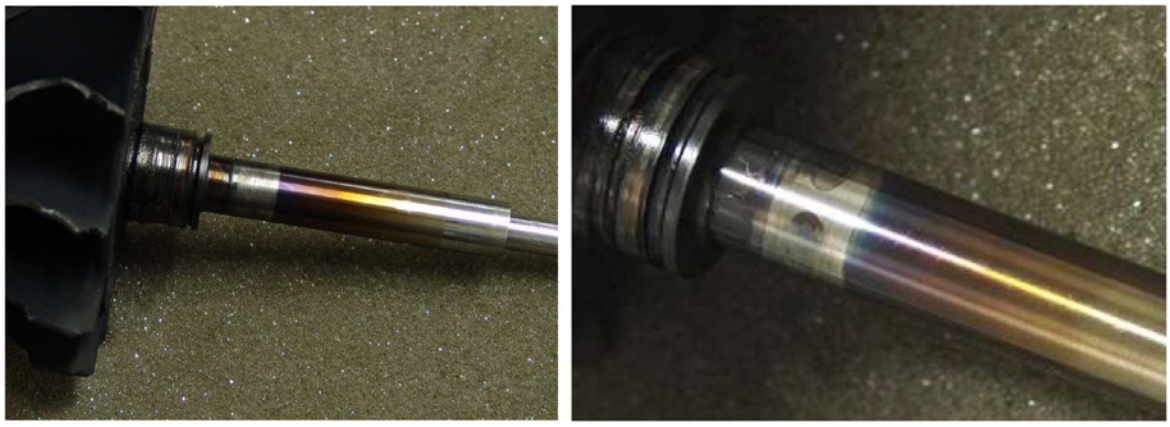
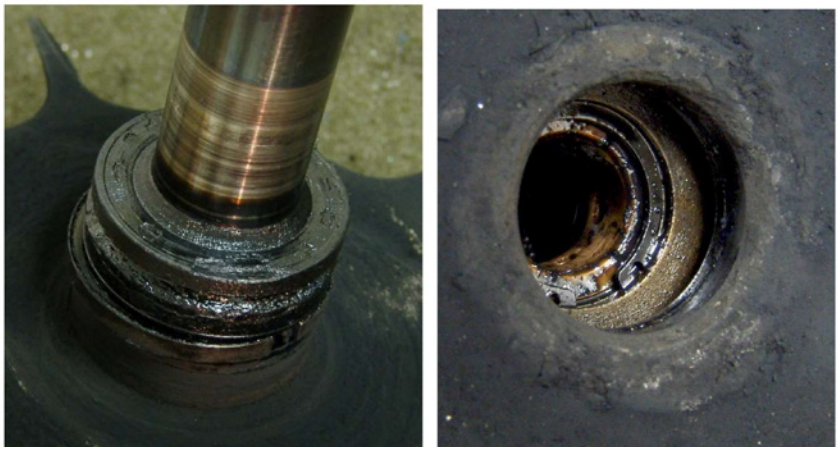


The compressor wheel can also sustain damage from foreign object ingestion but this is not as frequent as turbine wheel damage.
Occasionally a piece of air cleaner could break loose and be drawn through the compressor side but usually damage can be traced to carelessness in allowing a nut, bolt or washer to get into the intake side of the turbocharger.

There is also another very important point to mention, and that is the correct start-up and shutdown procedure which can assist in the prevention of bearing damage.
Shutting down an engine after it has been heavily loaded and not allowed to idle for a short while can also result in bearing damage, because the turbocharger will continue rotating after the engine oil pressure has dropped to zero – heat and insufficient lubrication can result in the type of failure shown below.
A lubrication problem can also occur at startup because it will take a short while for oil to reach the turbocharger bearings, as a consequence it is good practice to allow the engine to idle for a short while before loading it.





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So a new turbocharger or core assembly has been purchased and is now ready for installation, but there are some very important steps to follow prior to this.

- Diagnose and rectify the reason for the failure of the old turbocharger.
- Is the new turbocharger the correct one according to the OEM requirement.
- Check that oil supply and return lines are clear and not deteriorated, if there is any doubt they should be replaced.
- Check that there is no foreign material in the compressor inlet, air intake or exhaust manifold.
- If the turbocharger is liquid cooled, check for adequate coolant flow.
- Check if any adjustment is required on the compressor or turbine housings.
- Torque fasteners to the required specification.
- All mating flanges and threads should be clean and free of damage.
- Always use new seals and gaskets and never use any other form of sealant.
- Change the engine oil and filter when a replacement turbocharger is fitted.

After installation prime the turbocharger with oil whilst rotating the compressor wheel by hand, this will help to prevent oil starvation to the journal bearing.
The next step should be to bleed out all the old oil and trapped air from the oil supply line, once a continuous flow of clean oil is achieved the line can be connected to the turbocharger.
With the drain line disconnected from the turbocharger the engine should be cranked for ten to fifteen second intervals until a constant flow of oil comes from the drain line – this is a clear indication that there is a good flow of oil through the turbocharger.

A turbocharger will give high performance and longevity providing it is fitted correctly, the engine is serviced in accordance with the manufacturer's specifications, and the correct start/stop procedures are adhered to.

Most importantly, if the true causes of damage or failure are not found and corrected, they will probably recur with the new turbocharger.

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