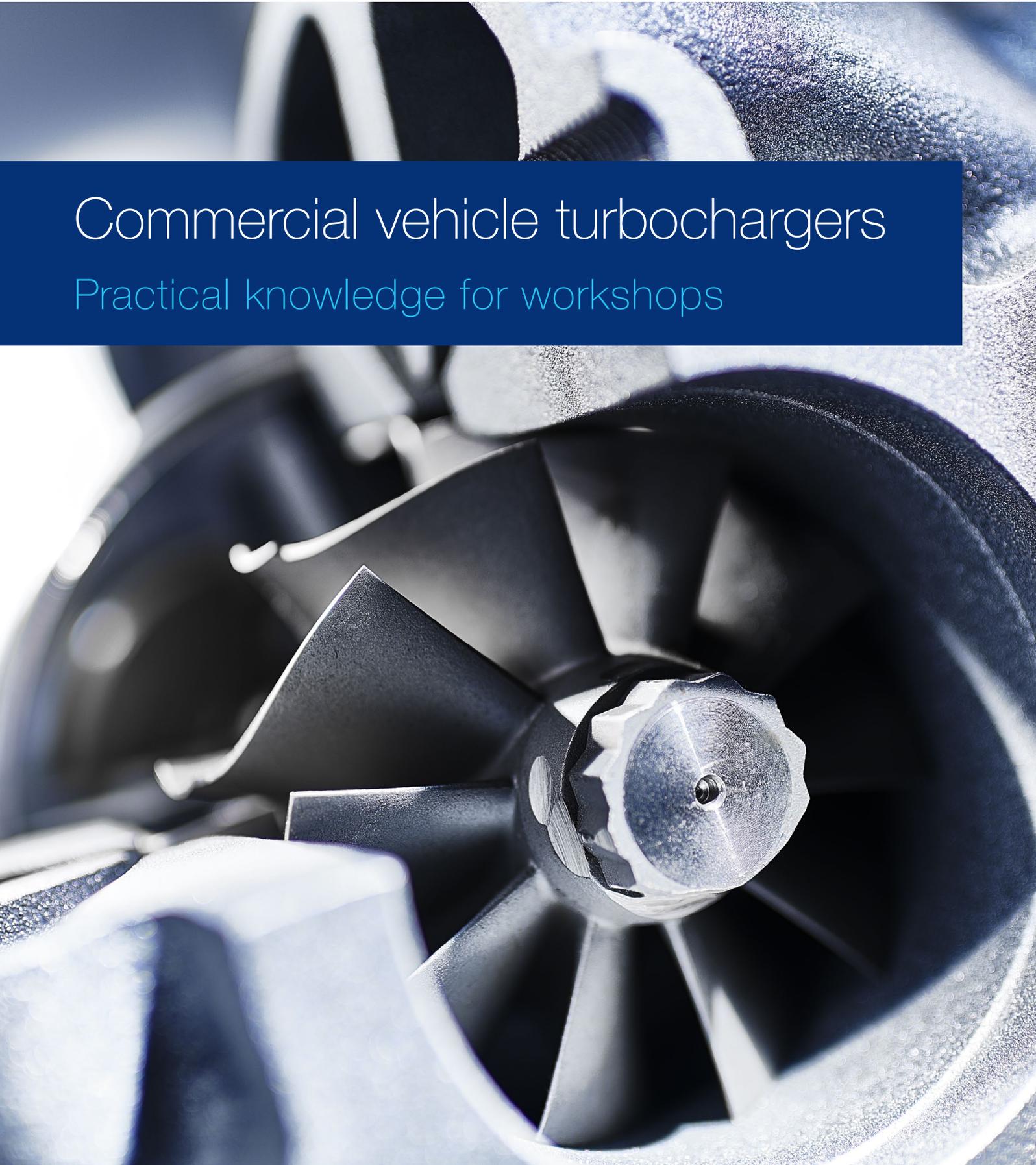


**MAHLE**

# Commercial vehicle turbochargers

Practical knowledge for workshops



# The number one choice for higher performance

*MAHLE turbochargers are used in many modern trucks and commercial vehicles. Our commercial vehicle turbochargers are the number one choice when it comes to increasing engine output and torque while reducing fuel consumption and emissions. They are designed for high mileage, deliver uncompromising quality, and boast an attractive price-performance ratio.*

Long distances, heavy loads, high mileage, and long working hours: commercial vehicles are subjected to extreme loads. To function cost-effectively, with low emissions, and above all, reliably, even under challenging climatic and geographical conditions, they need parts and components that are able to cope with these demands.

As original equipment manufacturers and partners to international automotive and commercial vehicle manufacturers, we have been developing products of the highest quality for over 100 years. The same exacting quality standards also apply to our aftermarket products. MAHLE Aftermarket has a global reputation for innovation, OE competence, and uncompromising quality. With our combination of products, workshop equipment, and workshop expertise, we offer complete solutions that enable automotive and commercial vehicle professionals to work competently, efficiently, and cost-effectively.

The following pages provide information on the design and operation of turbochargers, the diagnosis and professional rectification of malfunctions and damage, as well as tips for workshop professionals and their customers to ensure proper functioning and a long service life. More information about our products and services is available on our website or from your sales partner.



# Purpose, function, and design of turbochargers

## Purpose and function

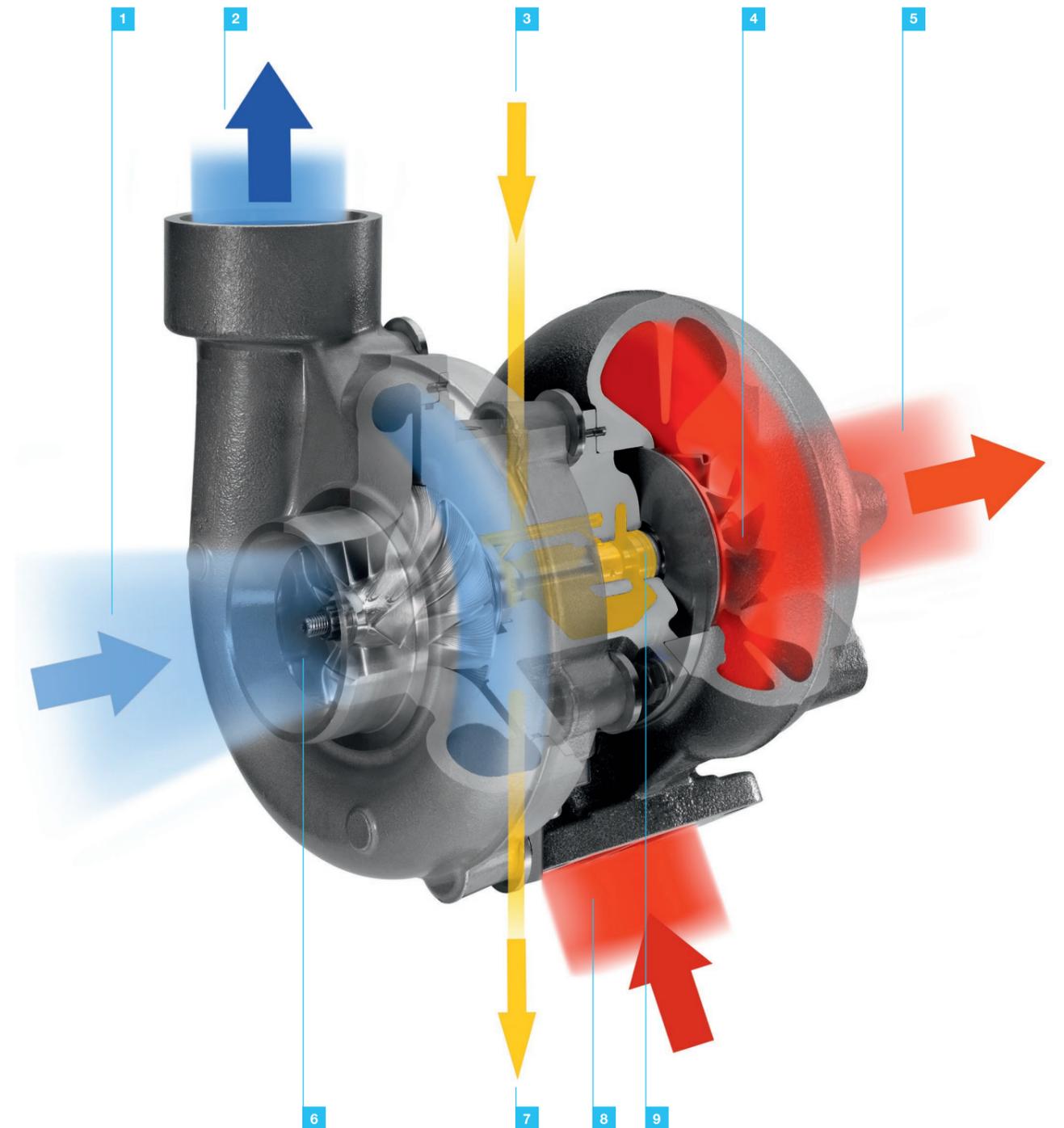
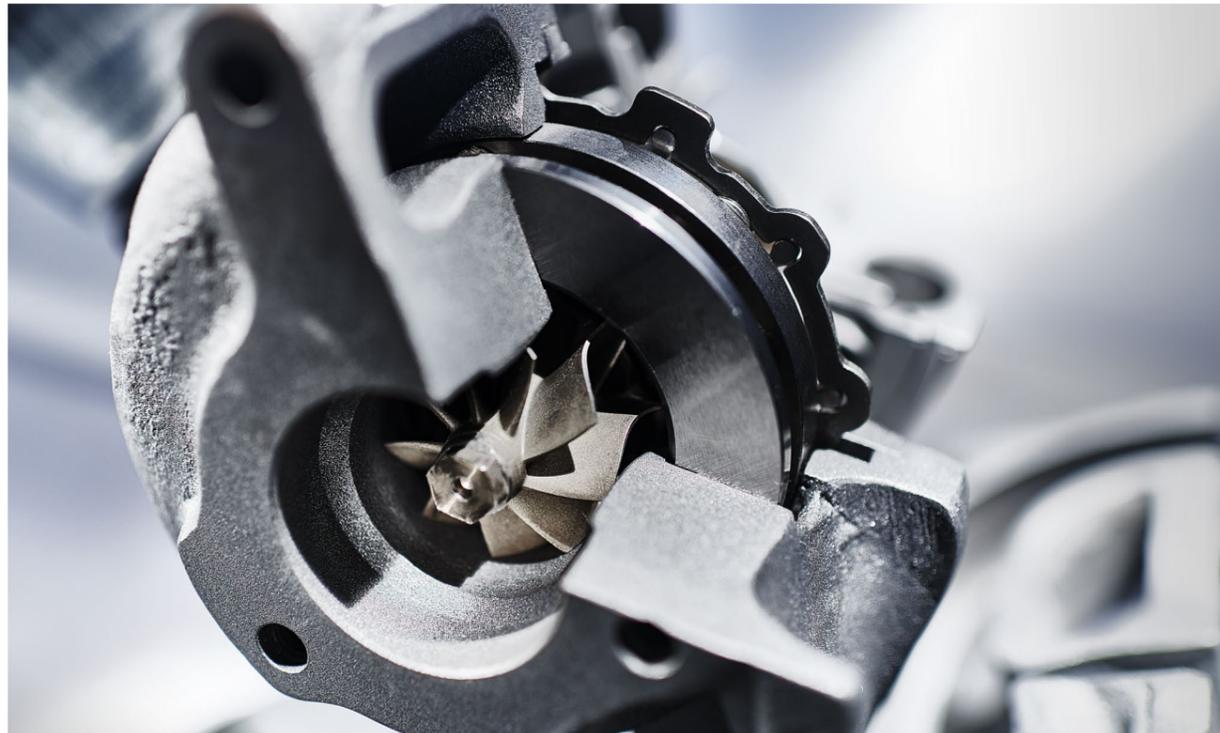
Turbochargers are used to increase performance and optimize combustion. Good and complete combustion in the engine requires a mixture ratio of 1 kg of fuel and approximately 15 kg of air (stoichiometric fuel ratio). This air volume corresponds to a volume of about 11 m<sup>3</sup>. During turbocharging, the density of the intake air is elevated and the air volume increased.

Turbocharging significantly improves the volumetric efficiency and thus the efficiency of the combustion engine. In addition, the torque can be increased considerably, which in turn serves to enhance the performance. A turbocharged engine with the same power output as a naturally aspirated engine can therefore be designed with a smaller displacement and hence lower weight (downsizing).

## Design

The core of the turbocharger is the rotor, consisting of a turbine wheel with a shaft and impeller. The turbine wheel is located on the exhaust side. It is firmly connected to the shaft, e.g., through friction welding or laser welding. The impeller is mounted on the other end of the rotor shaft, generally with a screw connection.

The exhaust gas flow from the engine is channeled through the turbine, causing the turbine wheel to rotate rapidly, which drives the impeller. The turbine speed depends on the design and the amount of exhaust gas. In small turbochargers, the rotor reaches speeds of up to 300,000 rpm. In order not to destroy the turbocharger and engine, the maximum charge air pressure is usually limited by boost pressure regulation.



- 1 Compressor inlet
- 2 Compressor outlet
- 3 Oil inlet
- 4 Turbine wheel
- 5 Turbine outlet

- 6 Impeller
- 7 Oil outlet
- 8 Turbine inlet
- 9 Rotor shaft

# Diagnosing and replacing turbochargers

In terms of construction and function, a turbocharger is designed to last the service life of the engine. In practice, however, the high-performance components in the exhaust gas system are subject to various risk factors that can lead to premature failure.

A successful repair depends on analyzing and eliminating the cause of the failure. Otherwise, the new turbocharger might fail again after a short period of time.

## Before installation

- Diagnose and eliminate the cause of failure of the old turbocharger (possibly defects in the engine and engine area)
- Compare the turbocharger model number with the engine specifications and/or the model number of the turbocharger manufacturer
- Make sure the engine ventilation is working properly
- Ensure the oil supply and that the oil can flow back freely from the turbocharger to the crankcase
- Intake, charge air, and exhaust gas areas:
  - Check that they are in working order
  - Eliminate any contamination due to foreign objects or liquids
- Ensure the absolute cleanliness and integrity of the air lines connected to the turbocharger
- For liquid-cooled turbochargers: ensure ventilation and the coolant supply
- Check whether the housing needs to be repositioned
- Observe assembly torques as per the engine and/or vehicle manufacturer specifications
- Make sure that the flange and thread are free of damage and wear
- Do not use a sealant
- Only use brand-new seals that are an exact fit
- Replace the engine oil and oil filters as per the engine or vehicle manufacturer specifications

## During installation

- Before mounting the oil feed line: fill the turbocharger with fresh engine oil through the oil feeder hole, while slightly turning the rotor by hand
- Change the boost pressure if necessary
- Ensure proper handling

## After installation

- After starting the engine: idle for approx. 120 seconds
- While the engine is idling: check all connections (air, exhaust gas, water, and oil) are properly secured and leaktight, possibly use soapy water to test for gas tightness
- When the oil pressure builds up, rev and run the engine
- After 20 operating hours or 1,000 km: check that all of the relevant connections are properly secured and leaktight

## Important information for workshops

- Turbochargers must only be installed by trained technicians
- Improper installation, use, operation, or modification of a turbocharger may cause damage to the turbocharger or engine
- Observe the manufacturer specifications and the installation and commissioning instructions
- Liability for material defects is excluded if a turbocharger that does not comply with the engine specification is installed or if the installation or assembly instructions are not observed
- Obvious defects must be reported immediately

# Diagnostic matrix

Our matrix helps you locate the causes of turbocharger malfunctions or damage more quickly.

	Type of malfunction								
	Compressor/turbine wheel defective	Poor performance/boost pressure too low	Boost pressure too high	Black smoke	Blue smoke	Turbocharger making noise	High oil consumption	Oil leakage at compressor	Oil leakage at turbine
Air filter system clogged		■		■	■		■	■	
Suction/pressure line deformed or leaky		■		■		■			
Flow resistance of exhaust system too high/turbine leakage		■		■	■	■	■	■	
Oil inlets and outlets clogged and/or deformed					■		■	■	■
Crankcase ventilation system clogged and/or deformed					■		■	■	■
Bearing housing of turbocharger coked or sludged up					■		■	■	■
Fuel system/fuel injection system defective or incorrectly set up		■	■	■					
Valve guides, piston rings, engine or cylinder liners worn/increased blowby		■		■	■		■	■	■
Clogged compressor or charge air cooler		■		■	■	■	■	■	
Boost pressure control flap/valve does not close		■		■					
Boost pressure control flap/valve does not open			■						
Control line to control flap/valve defective		■	■						
Piston ring seal defective					■		■	■	■
Turbocharger bearing damage	■	■		■	■	■	■	■	■
Foreign object damage on compressor and turbine	■	■		■			■		
Exhaust gas leakage between turbine exhaust and outlet manifold							■		
Engine intake plenum chamber torn, missing or loose seal		■		■			■		
Turbine housing/flap damaged	■	■		■		■			
Lack of oil supply to turbocharger	■	■		■		■			



**Important:** Do not replace the defective turbocharger until the causes of the malfunction or damage have been eliminated. This is the only way to ensure the long-lasting and flawless operation of the new charger.

# Turbo tips for pros

## Care and maintenance

Turbochargers are designed to last the service life of the engine. Only a few periodic checks are required, which should be carried out during each engine inspection. However, longevity can only be achieved if the engine manufacturer's service instructions for oil change intervals, oil filter system maintenance, oil pressure checks, cleaning of filter systems, and regular, professional filter changes, etc. are strictly followed. Important points for maintenance work, especially on the air filter system: no foreign objects may enter the turbocharger!

## Power losses and malfunctions

Power losses and engine malfunctions are often attributed to a defective turbocharger, even though it is fully functional. For this reason, other components should always be considered in the failure diagnosis, e.g. the air filters, suction and pressure lines, oil supply and drain lines, piston ring seals, and charge air coolers.

## Turbochargers and charge air coolers

After mechanical turbocharger damage, it is always advisable to replace the charge air cooler and all attachments, in order to prevent consequential or combination damage.



You can find more tips and advice on maintenance and repairs in our Technical Messenger workshop newsletter.

[www.mahle-aftermarket.com/technical-messenger](http://www.mahle-aftermarket.com/technical-messenger)

## Custom-fit mounting kits

MAHLE Aftermarket offers a made-to-measure mounting kit for almost every type of turbocharger to ensure a professional and secure fit.



The kits contain all relevant assembly parts—in original equipment quality, of course. Included are seals (1), sealing rings (2), nuts (3), stay bolts (4), and oil (5) for initially filling the turbocharger—the exact contents of each mounting kit varies according to the OE manufacturer's specifications.

## Common causes of damage

Defects in the turbocharger are usually caused by one of the following factors:

- **Insufficient lubrication**  
In the case of insufficient lubrication, the bearings usually fail, causing the compressor and turbine wheel to rub against their housings.
- **Contaminated oil**  
Contaminated lubricating oil leads to scoring on the crank journals and the bearing. Oil feeder bores and seals become clogged, leading to high oil losses.

## Entry of foreign objects

Foreign objects, which may enter through a defective air filter, for example, can destroy the turbine or impeller. The resulting imbalance damages the turbocharger bearing.

## What to consider when dealing with turbochargers

The turbocharger is a technically complex component with precisely coordinated components. The following is therefore important when dealing with turbochargers:

- **Trained workshop personnel**  
Turbochargers reach rotational speeds of up to 300,000 rpm and their components are manufactured with minimum production tolerances. Maintenance and replacement should therefore only be carried out by appropriately qualified personnel. It is also important to use special tools and machines, for example for balancing.
- **Do not change anything on the turbocharger**  
Turbochargers are optimally set up for the engine type in question at the factory, so none of the settings should be changed. Increasing the boost pressure, for example, can cause the engine to run hot, resulting in damage to the piston, cylinder head, or engine bearing.
- **Use the correct engine oil**  
Important when changing oil: only use the engine oil specified by the manufacturer. Deviations, for example in viscosity, can result in incorrect lubrication and damage the turbocharger.
- **Comply with the approval**  
When replacing items, only parts and technical aids that meet the requirements of the vehicle and engine manufacturers should be used. Otherwise, there is a risk of power loss or even engine damage, plus loss of warranty, vehicle registration, and insurance coverage.

## What competent workshops can offer their customers

These tips can help your customers ensure the turbocharger works properly:

- **Have the turbocharger checked if even the slightest anomaly is detected**  
If unusual noises, oil leaks, or vibrations are detected in the turbocharger, the engine must be stopped immediately and checked. Under no circumstances should the turbocharger continue to be used, because the high speed of the rotating parts mean that even minor defects can act upon other components, leading to further damage.
- **Do not bring the engine up to full speed straight away**  
After starting up the engine, it takes around 30 seconds for the oil circulation to be fully established. Only then should the engine speed be increased.
- **Do not stop the engine immediately**  
After running at a heavy load, the engine should idle for about a minute before it is switched off. This ensures that the turbocharger, which can reach temperatures of up to 1,000°C, continues to be supplied with oil while the speed of the rotor shaft and the temperature of the unit are reduced. If the engine is switched off immediately, the heat build-up can lead to irreparable damage, shortening the turbocharger's service life.

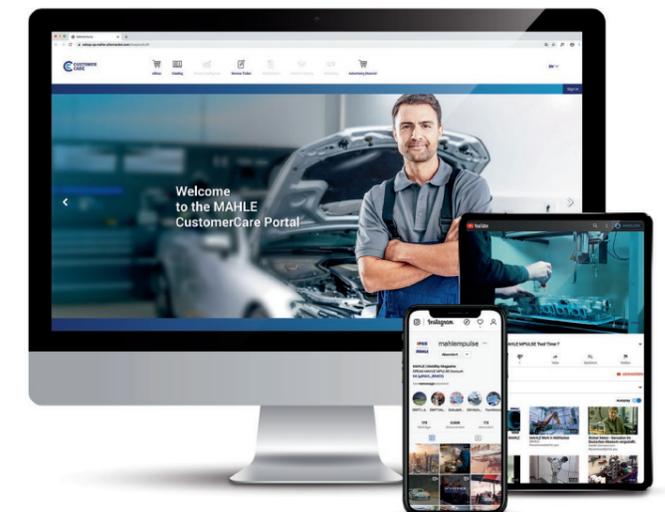
# Our product portfolio for commercial vehicles

<p><b>Engine components</b></p> 	<p><b>Quality built to last—precise fit and long life</b></p> <ul style="list-style-type: none"> <li>Pistons</li> <li>Piston rings</li> <li>Cylinder liners</li> <li>Bearings</li> <li>Valve train components</li> <li>Assemblies</li> <li>Turbochargers</li> <li>Controlled oil pumps</li> <li>Intake modules with flap control</li> <li>Oil mist separators</li> </ul>
<p><b>Filters</b></p> 	<p><b>Our filter range—a clean solution</b></p> <ul style="list-style-type: none"> <li>Air filters</li> <li>Oil filters</li> <li>Oil filter modules</li> <li>Fuel filters</li> <li>Cabin filters</li> <li>Air drier cartridges</li> <li>Transmission oil filters</li> <li>Urea filters</li> <li>CleanLine filters</li> </ul>
<p><b>Engine cooling &amp; air conditioning</b></p> 	<p><b>Comfort you can feel—now and in the future</b></p> <ul style="list-style-type: none"> <li>Radiators, charge air coolers</li> <li>Fans &amp; clutches, condenser/radiator fans</li> <li>Expansion tanks, cabin heat exchangers</li> <li>Exhaust gas recirculation coolers, oil coolers</li> <li>E-water pumps</li> <li>Thermostats, thermal switches</li> <li>A/C compressors, A/C compressor oils</li> <li>A/C condensers, filter-driers, and accumulators</li> <li>Evaporators, expansion valves, and orifice tubes</li> <li>Interior blowers, A/C switches</li> <li>A/C blower control units and resistors, electric control for blending flaps</li> <li>Sensors</li> </ul>
<p><b>Starter motors &amp; alternators</b></p> 	<p><b>Powerful and efficient—for the perfect start</b></p> <ul style="list-style-type: none"> <li>Starter motors</li> <li>Alternators</li> </ul>



# Our information services

- Technical Messenger: valuable technical information and the latest tips on all aspects of the maintenance and repair of MAHLE products**  
[mahle-aftermarket.com/technical-messenger](http://mahle-aftermarket.com/technical-messenger)
- Technical posters**
- Damage brochures**
- Installation videos and animations**
- Refrigerant and A/C compressor oil filling quantities manual**  
[mahle-aftermarket.com/filling-quantities/](http://mahle-aftermarket.com/filling-quantities/)
- Training portal**  
[training.mahle.com](http://training.mahle.com)
- TechTool**  
[techtool.mahle.com](http://techtool.mahle.com)
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