



NRF TECHNICAL ARTICLE

THE INTERCOOLER/CHARGE AIR COOLER IN “DOWNSIZED” PASSENGER CARS



by Dave Talbot technical specialist

Nowadays all modern cars have so called “downsized” (turbo)charged engines, which only have half the displacement as some decades ago, but with the same performance and much lower fuel consumption/emissions. To reach the desired performance, they do require an intercooler, a heat exchanger in which by turbocharger and/or compressor compressed hot air is cooled with ambient air or in latest models with liquid/coolant. The turbo/compressor is used to increase engine performance and efficiency. The potential energy after combustion in the engine exhaust gas runs the turbine wheel of the turbo (Fig. 1/Pos. 8). Because of this also the compressor wheel (Fig. 1/Pos. 2), mounted on the same shaft is driven.

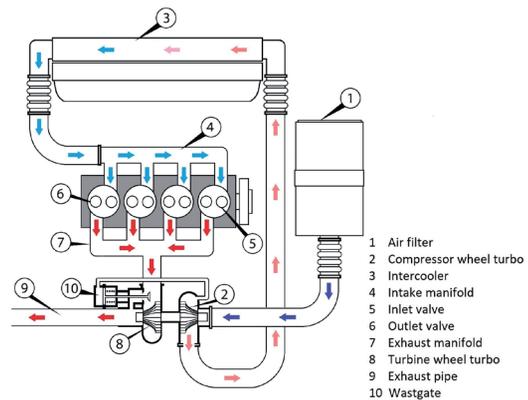


Fig 1

The compressor wheel sucks fresh air through the air filter (Fig. 1/Pos. 1) and compresses it to a higher pressure. The intercooler (Fig. 1/Pos. 3) purpose is to cool the compressed (< 2 bars) and hot air (< 150°C), before it is charged in to the intake manifold/cylinders (Fig. 1/Pos. 4). The lower the intake air temperature, the smaller the volume, because the air contracts and results in increased air density. Hence more air/oxygen can be charged into the combustion chambers of the cylinders and more fuel can be injected, resulting in a more efficient combustion, means more power and torque without increasing the engine displacement.

THE TECHNOLOGY - AIR TO CHARGE AIR COOLED INTERCOOLERS

For a long time air to charge air cooled intercoolers (Fig. 2) in so called direct systems were and still are used. They are usually positioned in front or underneath of the radiator and are mostly made of aluminum and using heat resistant ‘PA’-material with glass fiber reinforcement on manifolds) and basically are made of three main components: Manifolds on each in- and outlet side and in between the brazed core, that consist of tubes and louvered/cutted fins. To maximize the internal cooling surface, hence performance and to increase strength, the tubes have inner separation walls or fins (Fig. 3 – NRF AS200).

This results in an increase of efficiency and a significant lowering of fuel consumption and emissions.

Disadvantages are: Large and heavy (up to two/left and right) cooler(s). Large charge air pipes/hoses. Not controllable and less performance than liquid to charge air coolers.

This is also called “supercharging” and has a positive effect on the engines durability. The lower the intake air temperature of the compressed air, the more efficient the engine burns the fuel. A positive side effect: If the supercharging is not used for more power, the engine will consume less fuel and hence produce less exhaust emissions.



Fig 2



Fig 3



THE TECHNOLOGY - LIQUID TO CHARGE AIR COOLED INTERCOOLERS

On most of the latest models we more and more see liquid to charge air cooled intercoolers (Fig. 4) using a separate cooling circuit with a low temperature (LT) radiator (Fig. 6), beside the main engine cooling radiator. As this intercooler heat exchanger is very compact it can be placed almost anywhere and often forms a single unit with the intake manifold (Fig. 5). Even the LT-radiator is smaller/thinner than a conventional air to charge air cooler and hence creates more space. Also the large charge air pipes/hoses are no longer needed

In addition to increasing the cooling performance, there is another requirement for the charge air cooling: The temperature control of the engine combustion process by controlling the charge air cooling. The temperature control is necessary due to the constantly increasing demands on the exhaust emissions after treatment (# EURO 6). An electronic controlled auxiliary water pump (AWP - Fig. 7) will react to the required cooling performance situation. The temperature of the charge air plays an important role here. Cooling the charge air with coolant therefore also offers great advantages in vehicles as they are so called indirect systems and controllable by ECU.

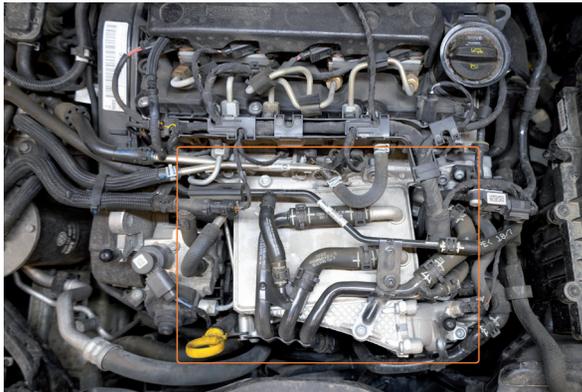


Fig 4

Beside saving space, more advantages of the liquid to charge air cooled intercoolers are:

- > Improved and more dynamic cooling capacity
- > Considerable reduced charge air pressure loss
- > Better engine dynamics thanks to a lower charge air volume
- > Increased engine efficiency due to a higher charge air density



Fig 7



Fig. 5

POSSIBLE ERRORS

Beside typical damage caused by accident, stone collisions and corrosion caused by dirt and salt residue, the high temperature stress and fluctuating pressures wear out the materials (Fig. 7 & 8). Small intercooler leaks will not immediately cause the same serious impacts as having these in a radiator. A small leak in an aircooled intercooler will decrease engine performance, which is inconvenient but not a huge problem.



LT-Radiator



HT-Radiator

Fig 6



Leakages are mostly characterized by a kind of whistling sound caused by the escaping pressurized air.



Fig 8

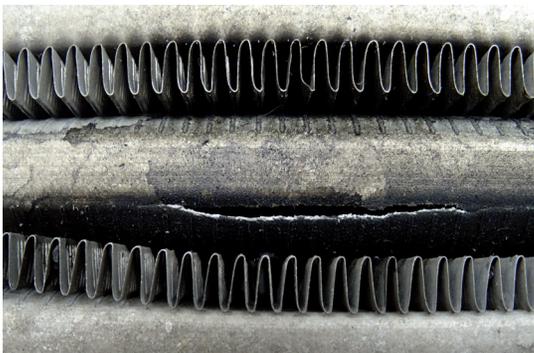


Fig 9

In the event of a mechanical turbocharger breakage, and here in particular the compressor wheel (Fig. 9), the intercooler and connected pipes/hoses must be inspected thoroughly for metal parts and oil contamination. In particular metal chips can cause blockage of the inner tubes/channels and hence reduce the performance! In the worst scenario small chips would pass the intercooler (or could come loose even after the turbo replacement was done long time ago) and enter the cylinders and cause serious damage to the engine. If you find metal chips, the intercooler MUST be replaced and the pipes/hoses must be cleaned/flushed with suitable means. To prevent engine damage, please always check/clean the engine air intake manifold for any contamination, before installing a new intercooler.



Fig 10

THE NRF RANGE

NRF offers more than 600 quality intercoolers (of which 480 for PC only) for your high expectations and demands. For more information please ask your (local) supplier or visit www.nrf.eu

Technical questions or interested in trainings? Please contact our specialist: Dave Talbot, [NRFITECHsupport UK](mailto:NRFITECHsupport@nrf.eu) +44 777 124 2767

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