CHARGED AIR-COOLERS

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How It All Works

The charged-air-cooler, also known as a pre-cooler or an air-to-air-after-cooler (ATAAC) plays a vital roll in your vehicle's performance and fuel efficiency. Primarily developed and tested by Mack in 1973, the charged-air-coolers proved to be much more efficient than that of standard after-coolers. However, the use of these coolers did not catch on until the mid 80's.

The job of the charged-air-cooler is to except high temperature, dense and compressed air from the turbo-charger. Its purpose is to cool that air before routing it into the intake manifold. Most engine manufacturers have a maximum manifold temperature of 120 degrees Fahrenheit. What most people don't realize is that an average 12L diesel engine rated at 400HP will generate compressed air temperatures leaving the turbo-charger in excess of 385 degrees Fahrenheit. This means that an average charged-air-cooler must lower the temperature of the dense compressed air by more that 265 degrees Fahrenheit. All charged-air-coolers are engineered to achieve such high demands, but only based on specific conditions that often do not reflect the actual operating conditions. For instance, cold weather fronts installed throughout the winter months can restrict the much needed air flow required to allow the charged-air-cooler to perform properly. As well, Extreme summer temperatures can significantly decrease the efficiency of your charged-air-cooler. These units are engineered to perform at an ambient temperature of 77 degrees Fahrenheit with no additional restrictions in air flow than the vehicle's grille.

What Does It All Mean?

Your vehicle's charged-air-cooler can often be your worst nightmare, but can also be your best friend. With temperatures entering the charged-air-cooler at nearly half of the melting point of the aluminum alloys used to construct these units, we find extreme cases of thermal expansion throughout the core. An average 30.00" long charged-air-cooler core tube can and will expand 0.125" (1/8") at temperatures of 400 degrees Fahrenheit. This thermal expansion is the most damaging force on your vehicle's charged-air-cooler. Improper mounting along with metal fatigue will work to destroy these units. Metal fatigue often allows for tube to header leaks to occur along with cracks in tubes and tanks. Obviously these cracks and leaks cause a loss in turbo-boost resulting in lower power and poor fuel efficiency.

Currently there are several standards used by service and maintenance shops that have been set by the Original Equipment Manufacturers that allow for imperfect or defective charged-air-coolers to be installed on your vehicles. We have come to know this as the "Allowable Leak-Down Standards" Such standards

adversely effect your vehicle's performance as mentioned above through a loss in boost pressure.

Electronically controlled engines will make adjustments to the fuel and air mixtures along with adjusting timing to attempt to compensate the loss in boost pressure. This attempt made by the control system does not however fix the problem. You still suffer a loss in power and fuel efficiency with these adjustments made.

Engine OEM	Allowable Leak	Test Rate
Caterpillar	5 psi @ 15 secs.	30 psi
Detroit Diesel	5 psi @ 15 secs.	25 psi
Cummins	7 psi @ 15 secs.	30 psi
Mack	5 psi @ 15 secs.	30 psi

These figures reflect data obtained from individual manufacturers in 1996

The Future Of C.A.C.'s

In October of 2002, nearly all U.S. based diesel engine manufacturers will be required to produce engines that conform to these new EPA air quality mandates. From several sources including *Heavy Duty Trucking* (HDT) we have learned that most engine manufacturers are prepared to meet the EPA's new requirements with the use of Exhaust-Gas Re-calculation (EGR). *HDT* says that most engine manufacturers understand that the EGR systems are an interim technology that very well could go away with developments of engines to meet both the 2007 and 2010 emissions requirements.

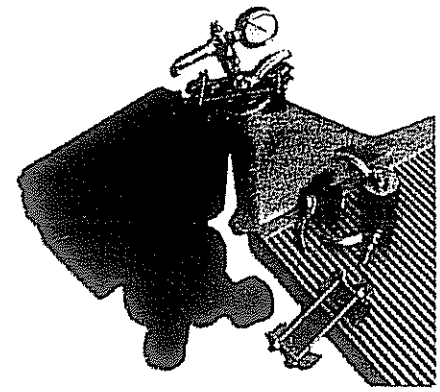
What does all this have to do with your charged-air-cooler? Well, several trucking and supplier executives have voiced the following concerns about EGR engines.

- Reliability and durability of EGR engines has not yet been adequately tested
- Fuel economy may be as much as 5% worse with an EGR engine than existing conventional engines
- EGR engines will run hotter and place more impact on other components potentially causing premature failures, says engineers

Lets face it, if your vehicle runs hotter and costs you more fuel to run it, you just might need every ounce of performance and efficiency that you can get. A leak free charged-air-cooler can save you money over time verses a leaking one.

We tested a fleet of Navistar class 8 trucks using OEM style charged-air-coolers that met the "Allowable Leak-Down" test specified by the engine manufacturer. We installed a charged-air-cooler that was leek-free and compared the difference in the fuel mileage calculated from one (1) full year of data entries. When we compared that full year of data to the two previous years of data using the OEM style charged-air-cooler, the results were obvious that fuel mileage is directly effected by loss of boost. One of the trucks saved nearly $2,100.00 over the course of one year. Another truck saved the fleet $1,600.00 over one year in fuel. These figures are based on an average cost of diesel fuel at $1.30/ gallon. The actual mileage increase was found to be over four (4) tenths of a mile per gallon on one truck and three (3) tenths for the other truck.

Rumors have it that the real jump in the diesel engine world won't be seen until the 2007 and 2010 EPA regulations kick in. Will the engines run hotter yet? No one really knows outside of the engine manufacturers. Speculations say that tier 4 engines will require more compressed air from the turbo-charger resulting in higher temperatures on the inlet side of a charged-air-cooler. That may not be a good idea for the use of aluminum in these coolers. Metal fatigue will set in rapidly and cause self-destruction. Some say that materials such as ceramics could be the future. The problems with ceramics is that it is brittle and tends to be extremely fragile. Will we return to brass and copper? Maybe the use of bolted tank to header joints will be required. Steel and cast would be the optimum choice for tanks in that situation, however, brass and copper may not have a long enough life expectancy due to corrosion. It's all just speculation right now, but be sure that none of it will come cheap.



This charged-air-cooler test kit fits 2 1/2" to 4 1/2" connections. These kits can be supplied by Cincinnati Radiator, Inc

"Pocket your pennies today", I say. Test your truck's charged-air-cooler and have them repaired or replaced if needed. You'll save in the end with returns of greater power and fuel mileage.

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