CHARGE AIR CHILLER

RESEARCH & DEVELOPMENT OF EFFICIENT INTERCOOLER SYSTEM FOR FORCED INDUCTION VEHICLES

WHAT IS INTERCOOLER?

An Intercooler is a heat exchange device used on turbocharged and supercharged(forced induction) internal combustion engines to improve their volumetric efficiency by increasing intake air charge density.

HOW DOES IT WORK?

As the air is compressed by a turbo/supercharger it gets very hot, very quickly. As its temperature climbs its oxygen content (density) drops, so by cooling the air, an intercooler provides a denser, more oxygen rich air to the engine thus improving the combustion by allowing more fuel to be burned. It also increases reliability as it provides a more consistent temperature of intake air to the engine which allows the air fuel ratio of the engine to remain at a safe level.

TYPES OF INTERCOOLERS

There are two types of intercoolers; Air-to-Air and Air-to-Water.

An Air-to-Air intercooler extracts heat from the compressed air by passing it through its network of tubes with cooling fins. As the compressed air is pushed through the intercooler it transfers the heat to the tubes and, in turn to the cooling fins. The cool air from outside, traveling at speed, absorbs the heat from the cooling fins reducing the temperature of the compressed air. This also makes it by far the most common form of intercooling.

An Air-to-Water intercooler uses water as a heat transfer agent. In this setup cool water is pumped through the air/water intercooler, extracting heat from the compressed air as it passes through. The heated water is then pumped through another cooling circuit (usually a dedicated radiator) while the cooled compressed air is pushed into the engine. These intercoolers (also known as heat exchangers) tend to be smaller than their Air-to-Air counterparts making them well suited to difficult installations where space, airflow and intake length are an issue. Water is more efficient at heat transfer than air and has more stability so it can handle a wider range of temps.

LIMITATIONS

AIR-TO-AIR INTERCOOLER: This system is dependant on air flow, so it is to be mounted in place where it can get maximum airflow. At ideal condition this system brings down the charge air temperature to ambient temperature. During summer, the ambient temperature is near 46 degree Celsius(Nagpur). This system performs worse during this time.

AIR-TO-WATER INTERCOOLER: This system uses radiator to cool the water which then pumped to intercooler to cool down the charge air. As water has a specific heat capacity of 4.18 J. This is a much higher value than that of air which has SHC of 1.01 J, which makes water four times more efficient at dissipating heat than air. It requires lesser space and can be mounted closer to intake manifold. It has its own complications. But it is still dependant on Ambient temperature to cool the charge air.

SCOPE OF IMPROVEMENT IN CURRENT INTERCOOLING SYSTEMS

AIR-TO-AIR INTERCOOLER: Water is sprayed from the water sprayer which are mounted in front of this intercooler, so that the heat soaked intercooler cools down which helps in bringing down the temperature.

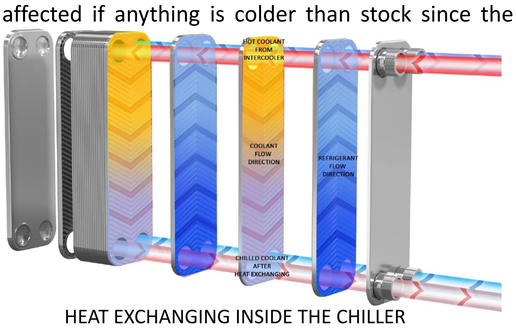
AIR-TO-WATER INTERCOOLER: Vehicle's air conditioning system can be used to cool the water eliminating the radiator. Which can help bringing down the charge air temperature below ambient, thus can help increase vehicle's performance without risking detonation.

CHARGE AIR CHILLER

The CHARGE AIR CHILLER is the cooling system that lowers down the intake charge air temperature from the turbocharger & supercharger, resulting in well below ambient temperatures that can be as low as 0 degrees Celsius.

WORKING

The refrigerant in the car's AC system is split 50/50 between the cabin AC and Charge Air Chiller. The core is made up of channels each consisting of 20 plates, in the first channel the intercooler fluid flows through, in the second the AC which super cools the intercooler fluid extremely cold. The cabin AC is not affected if anything is colder than stock since the refrigerant capacity of the system is almost doubled. There is no heat soak even while idling as it is continuously pumping colder fluid all the time just like cabin AC does and the engine is also protected from pre ignition since it is running a colder intake charge. Stock IC Radiator is deleted because it will only help in bringing the temperature towards ambient. As the temperature is well below ambient, it will work as a heater and not a cooler anymore.



HEAT EXCHANGING INSIDE THE CHILLER

TESTING

While running the tests at 28 degrees ambient temperature, the drop of 22 degrees is observed. The coolant temperature reached 6 degrees Celsius within 5 minutes of Idling. The test car (2012 1.3L Diesel Swift) has completed more than 5000kms of city and highway driving combined with this system ON.

OBSERVATIONS

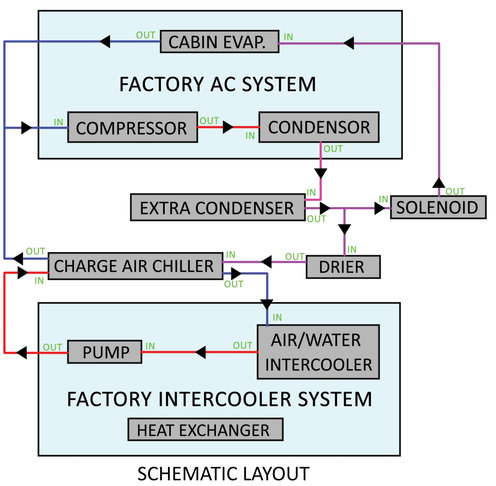
During the testing, significant increase in low end, mid and high end torque was observed. Reduced Turbolag, smooth power delivery.

APPLICATIONS

This CAC system is perfect to be used in daily drivers to High Performance applications like Drag Racing, Off road adventures, drifting, power cruise etc.

SUMMARY

We can say with the observation that how important it is to have good and efficient intercooler for better performance of the car.



SCHEMATIC LAYOUT

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EXHIBITION OF ALUMNI WORK 2019