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Focus Rs ΔCore™ Real World Testing

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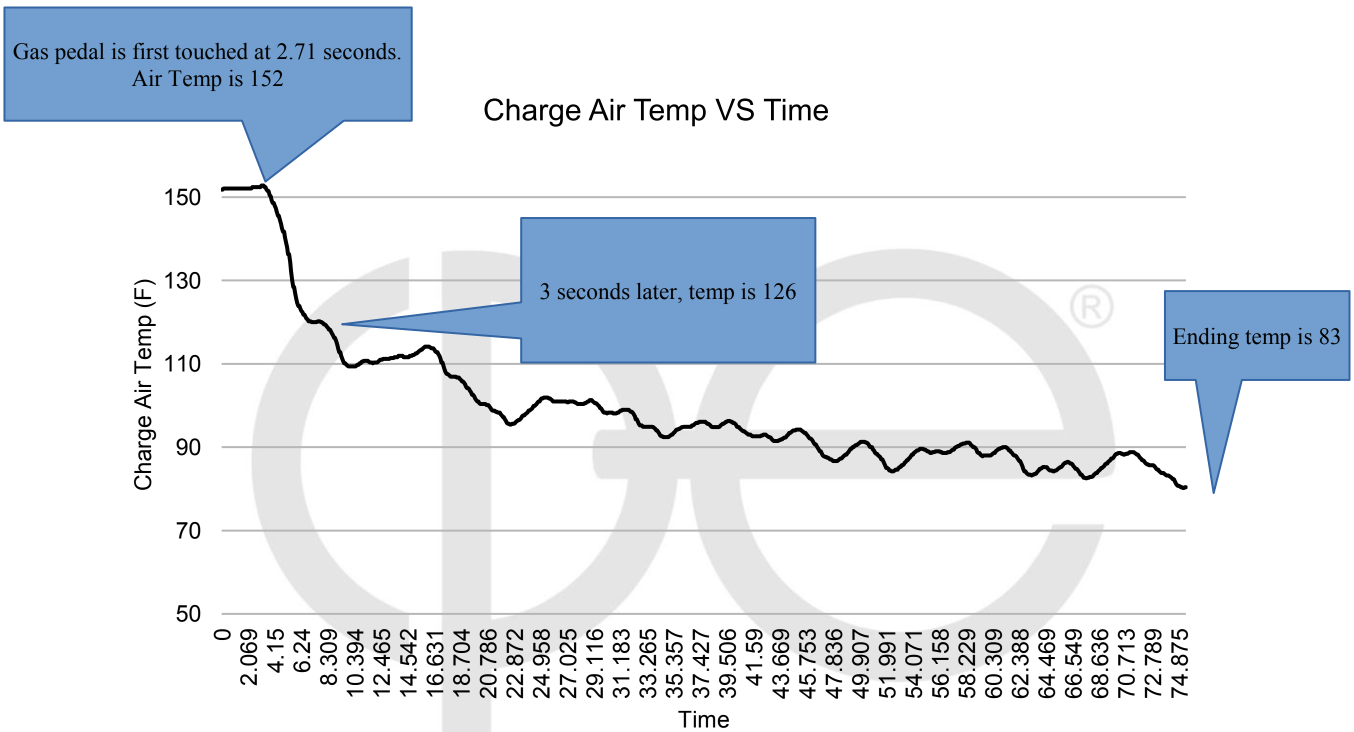

A few quick words on the cp-e™ Focus RS Deltacore FMIC in real world autocross applications:

When designing performance intercoolers for aftermarket applications, there are quite a few design considerations to consider. With the goal of keeping charge temps in control, within a small range of ambient, while also encouraging flow and discouraging pressure loss. One of the things that is often overlooked is an intercooler's ability to recover while sitting and getting heat soaked.

Two applications come to mind that really stress an intercooler's ability to perform. Autocross and Drag racing. If you think about it, in both situations you are likely waiting in line, engine

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running and not moving (sometimes even with the A/C on). An intercooler is highly dependent on air moving through it in order to cool the air going to the engine. This is why you have fans on your radiator, so that it does not overheat when you sit in traffic or just idle. Drag racing is even worse if you do a burnout, as you are putting a high load on the engine but the vehicle itself is not moving, so no airflow across the intercooler. The air is going to heat up. Performance is going to suffer when it matters the most.

It is important to note before reviewing data that the Focus RS (and Mustang EcoBoost) has its T-MAP (temperature and manifold absolute pressure sensor) located in the intake manifold, whereas the Focus ST has it on the intercooler outlet and the Fiesta ST has it located on the cold side charge pipe which leads to different charge temp readings. Sensor location is VERY important. With a goal of wanting to know the temperature of the air as it enters the engine, the closer this sensor is to the engine, the more accurate it is to the actual charge air temp. On the other hand, the closer it is to the engine, the more likely it is to be effected by heat soak and can be inaccurate in low airflow situations. We can go on for hours about this, however, it is not the point of the article.

Back to racing. You are sitting in the line at autocross ready to go, but your charge air temps are sitting at 150 degrees because you were idling for 20 minutes straight watching everyone else run their turn. There's not much you can do about this without modifications like CO2 intercooler spray or converting to an air to water intercooler with an ice tank or a separate radiator. However, our goal is to limit its effects of this heat soak to negate the need for complicated systems.

Furthermore, once the car keeps going, autocross is even less ideal as the speeds are very limited. Depending on the course and the car, the driver may not get past 2nd gear. The heat exchange ability of the intercooler is proportional to the velocity of the air going past it (the speed of the vehicle). The ideal condition for low charge air temperatures are high speeds and low engine airflow (less mass of air to cool).

Above is a graph of one of our tuning customers, running all cp-e™ parts and tune via COBB Accessport during an autocross event. The outside temperature that day was about 55 degrees. The intercooler is heat soaked sitting around 150 degrees, the fan is blasting, the heat coming from the 10 other cars idling around it doesn't help. Is this going to ruin the run? Is that 100whp Miata going to run a better time?

By the time the car is in the first corner, 3 seconds after the gas pedal is first touched, the temperature has already dropped by about 25 degrees. By 7 seconds in, the temperature is down to 109, over 40 degrees of drop. On a turbocharged car running 93 octane fuel, this allows more ignition timing and less chance of detonation. We do have safe guards in our tune that will limit torque targets based on charge air temperatures, so the risk of damage is low, but power is going to be quite limited.

20 seconds into the run we are down to 95 degrees and while still steadily decreasing, power is no longer really limited and torque and boost targets are at their max. By the end of the run, charge air temps reach about 82. 70 degrees of temperature drop while beating on the car, reaching a peak boost level of 24psi.

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What does this mean? The intercooler is able to quickly recover from a heat soak situation in order to give the customer safe power and a good run time and is very consistent (this was the customers 5th run of the day). While the actual charge air temperature is important, look at the trend in the graph. A heat soaked intercooler is still able to perform and keep control. What if the temperature trend went in the other direction? It can go into thermal runaway. If the core is gaining more heat from the hot turbo air than it is losing from the air going through it, the temperatures will continue to rise. If the intercooler cannot recover and the charge temps rise, it can lead to poor performance as well as a high risk of detonation and damage to the engine. The intercooler did its job quite well here.

What does this mean to us? How do we use this information? When designing these intercoolers, we are given a space constraint. While many people go with the “fit the biggest core you can in there,” we say there is much more to it. The larger the intercooler, heavier it is, the more time it will take to recover from heat soak as there is more mass to cool down, hurting transient performance and recovery times. If the intercooler is too small, the charge air temperatures may not stay in control and the intercooler won’t even be an upgrade. If the intercooler is big but does not have enough showing frontal area, it cannot exchange enough heat to keep the temps down. There will be a trade off in every design aspect.

The cp-e™ Deltacore FMIC has proven that there is more to an intercooler design than just the size. While there are larger cores on the market, cp-e™ maximizes available grill space (large useful frontal area), has internal diffusers to maximize core use, and a quick recovery time when it does get hot. We know that the intercooler performs both on the dyno and in real world applications, adding power and protection against detonation. We have data to compare it to if we do make an alternative version and we have useful knowledge for our next intercooler design.

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