cp-e™ MZR 2.3 DISI TMIC

cp-e™, Inc.
6802 Mid Cities Avenue
Beltsville, MD 20705

www.cp-e.com

By: Alexander (Sander) I. Marques

The cp-e™ Top Mount Intercooler for the MazdaSPEED3, MazdaSPEED6, and CX-7 is a high performance stock replacement intercooler. It features cast end-tanks with capped 6mm threaded holes, a 3.25" high flow core, factory geometry constraints (able to be directly bolted in place of the stock unit), and machined billet aluminum mounting brackets.

We will cover the following topics through out this publication:

-Design Points
-Pressure Drop Statistics
-Thermal Efficiency Data
-Dynamometer Testing Data

Design Points:
When we set out to design a replacement top mount intercooler, we wanted to make the most efficient intercooler we possibly could within the constraints of the stock location. This is a difficult task, considering the lack of available space above the engine and below the hood. We chose a 3.25" core because it is the thickest possible core we could fit underneath the hood of the vehicle. Generally speaking the thicker the core, the better the flow. We will discuss flow testing later in the document.

We utilized cast aluminum end-tanks in our design; this is to provide smooth transitions, and smooth inner radiuses of the end-tank. Often times with fabricated sheet metal end tanks, you may have welding "slag" on the inside of the end tank, causing flow obstructions. Also, with a cast end-tank, you remove the possibility of leaks from improper weld junctions on fabricated end tanks.

Cast end-tanks also provide the ability to cast-in threaded holes for bolting on required mounts or charge pipe outlets. Having a cast-in threaded hole, you don't need to worry about using any type of "sealant" on the bolts that are threaded into the end-tank (like is common on some fabricated end-tank intercoolers).

We chose to use billet CNC machined intercooler brackets because we feel that the current top mount intercoolers on the market for the MazdaSPEED vehicles have insufficient core support. Our brackets are sturdy and allow the installer to adjust the position of the top mount slightly with the design of slightly oversized mounting holes. This is to accommodate different types of charge piping etc.

Pressure Drop Statistics:

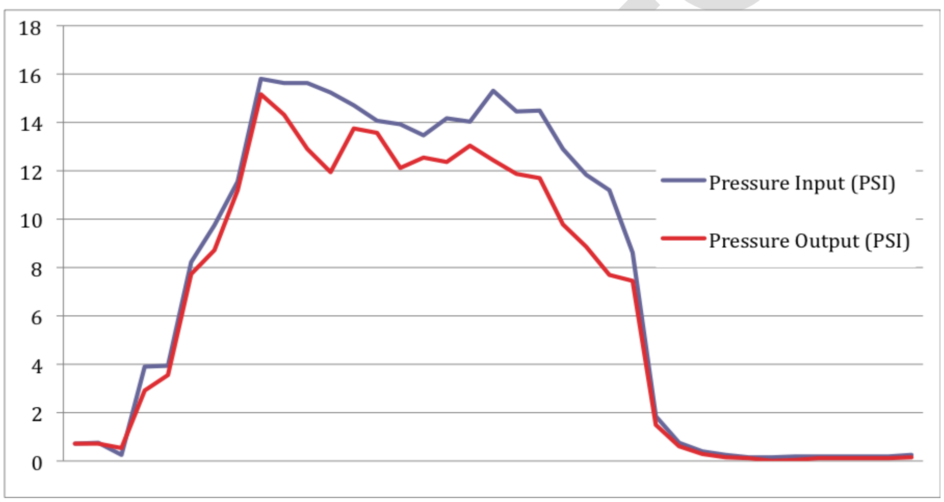
Intercoolers are often times just released into the market and sold based off looks and claimed core efficiency (usually cited with out compensating for end tank design). We strive for proper engineering in our product line, and this intercooler is no exception.

We completed our testing on the intercooler with a completely stock 2010 MazdaSPEED 3. This vehicle had no modifications what so ever. This was done to show that even in stock form (at lower boost levels than most with modified MazdaSPEED vehicles run) our intercooler would shine above the stock unit. These tests were conducted on the same day, with varying temperatures. The stock TMIC was tested at 62 degrees F, and the cp-e™ TMIC was tested at 71 degrees F.

These pressure and temperature drop tests were conducted with pressure and temperature sensors on both the inlet and outlet of the intercooler. These sensors operate in a 30-psi (pressure) and 150 degree C (temperature) range.

2010 Mazda MazdaSPEED 3 Stock Intercooler Pressure Drop

Here is the pressure drop chart from the stock intercooler. It is important to note the difference between the inlet and outlet pressure. There is an average pressure drop of approximately **2 psi** under load (boosted scenario). This is due to the flow obstruction of the stock core. This obstruction can be attributed to its relatively small size (1.5” thick) and less favorable core design (than our bar and plate design).

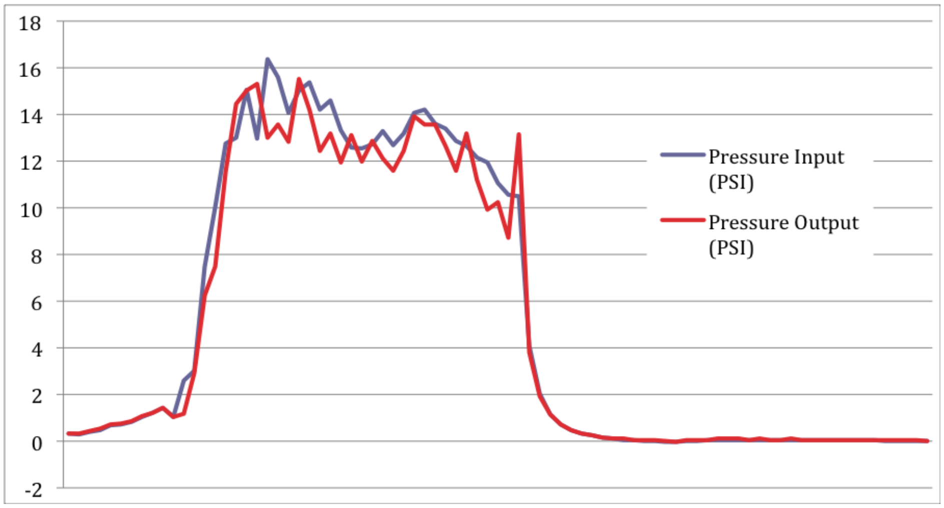


2010 Mazda MazdaSPEED 3 cp-e™ Top Mount Intercooler Pressure Drop

Contrary to the pressure drop differences of the stock intercooler, our design has less average pressure drop from the inlet to the outlet, demonstrating it’s superior flow characteristics.

For those individuals who are observant, you will notice that the cp-e™ TMIC actually has a lower boost inlet pressure than the stock intercooler on average. You may think to your self

“Well that would mean that the car is going to make less power!” **This is not true**. The stock intercooler in this case is just acting as a restriction, making the turbocharger work harder to create the boost on the outlet side of the intercooler (where the vehicles MAP sensor is located). When this pressure restriction happens the turbocharger works harder to develop the boost the ECU is commanding, which inevitably creates more heat, which then leads to substantial heat soak! Our aim in designing the intercooler was to combat this effect and create an intercooler with the lowest pressure drop possible.



Thermal Efficiency Testing:

Another critical design aspect of an intercooler is it’s thermal efficiency rating / percentage. The thermal testing was done at the same time as the pressure drop graphs pictured above. The ambient temperature data is also the same, 71 degrees for the cp-e™ TMIC, and 62 degrees for the stock intercooler. They were both conducted in the same direction of wind travel.

Before we talk about this testing, it is important to understand how thermal efficiency is calculated. The equation for thermal efficiency is:

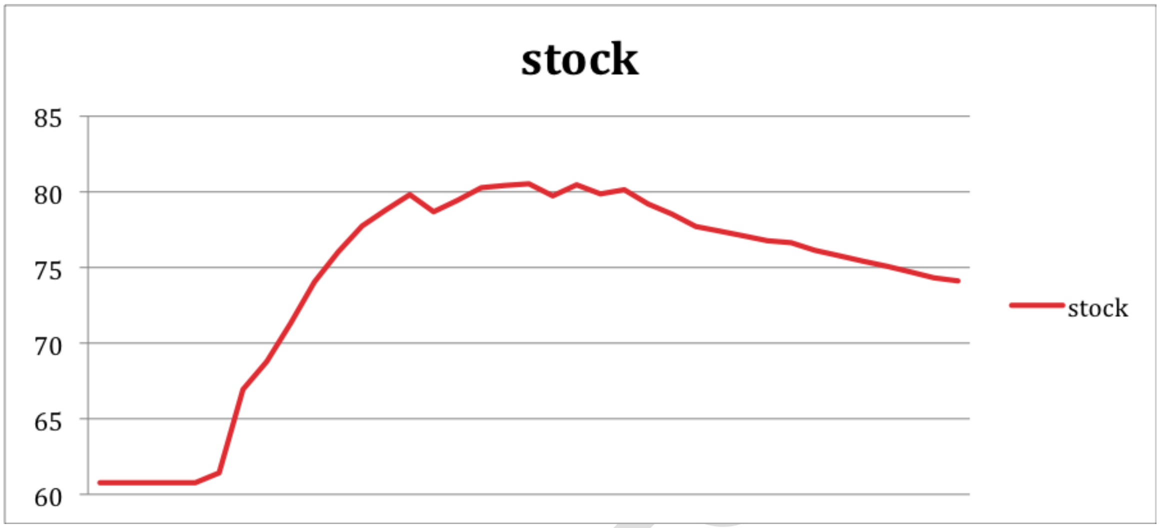
*(Inlet Temperature – Outlet Temperature) / (Inlet Temperature – Ambient Temperature) * 100*

=***Thermal Efficiency (%)***

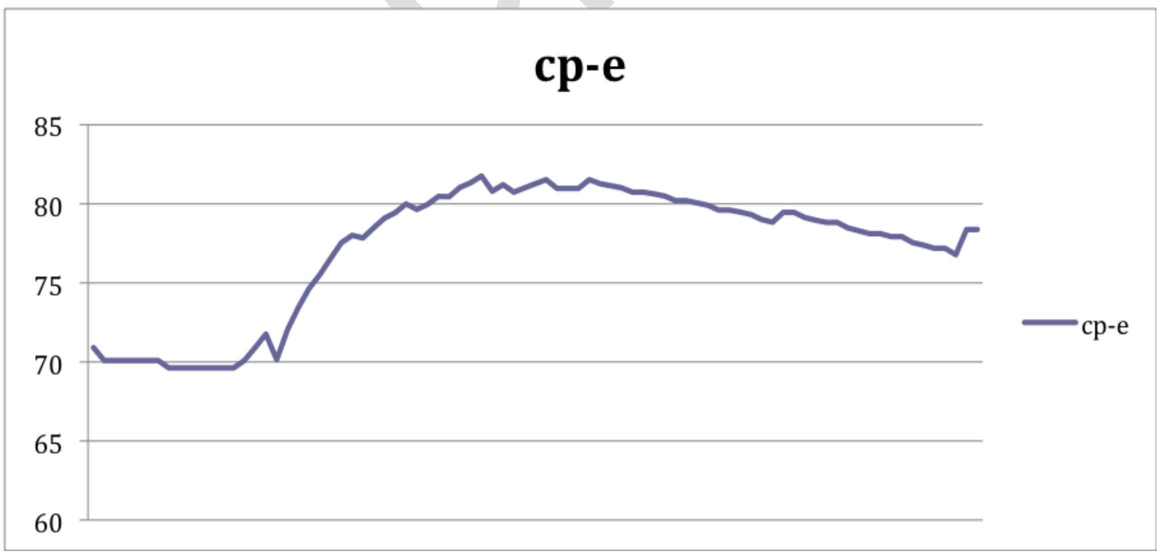
When looking at these two attached charts, it is important to note a few important factors. As we’ve seen from the pressure drop graphs above, the stock intercooler has an approximate pressure drop of about 2 psi. This pressure drop indicates that there is a flow restriction in the intercooler; however this flow restriction will actually show up as a better theoretical thermal efficiency than an intercooler with a lesser pressure drop. Why? Well, the flow restriction will also come with a larger temperature difference from the hot side of the intercooler to the cold side of the intercooler. You are getting good thermal efficiency at the cost of boost pressure / volume. When we wanted to design a good TMIC, we wanted the best of both worlds. Our TMIC is an efficient core (low pressure drop), and has good thermal efficiency characteristics (better than stock!).

Note: These thermal efficiency percentages are generally higher than our last publication due to the fact that repeated loading of the engine was not performed in a long-term (more than 5-10 minutes) fashion.

This is a thermal efficiency representation of the stock intercooler on a 2010 MazdaSPEED 3. This represents a 3rd gear pull from 3000 RPM to redline, and a brief period of coasting down. The peak value is approximately 80%



This is a thermal efficiency representation of the cp-e™ intercooler on a 2010 MazdaSPEED 3. This represents a 3rd gear pull from 3000 RPM to redline, and a brief period of coasting down. The peak value is approximately 83%



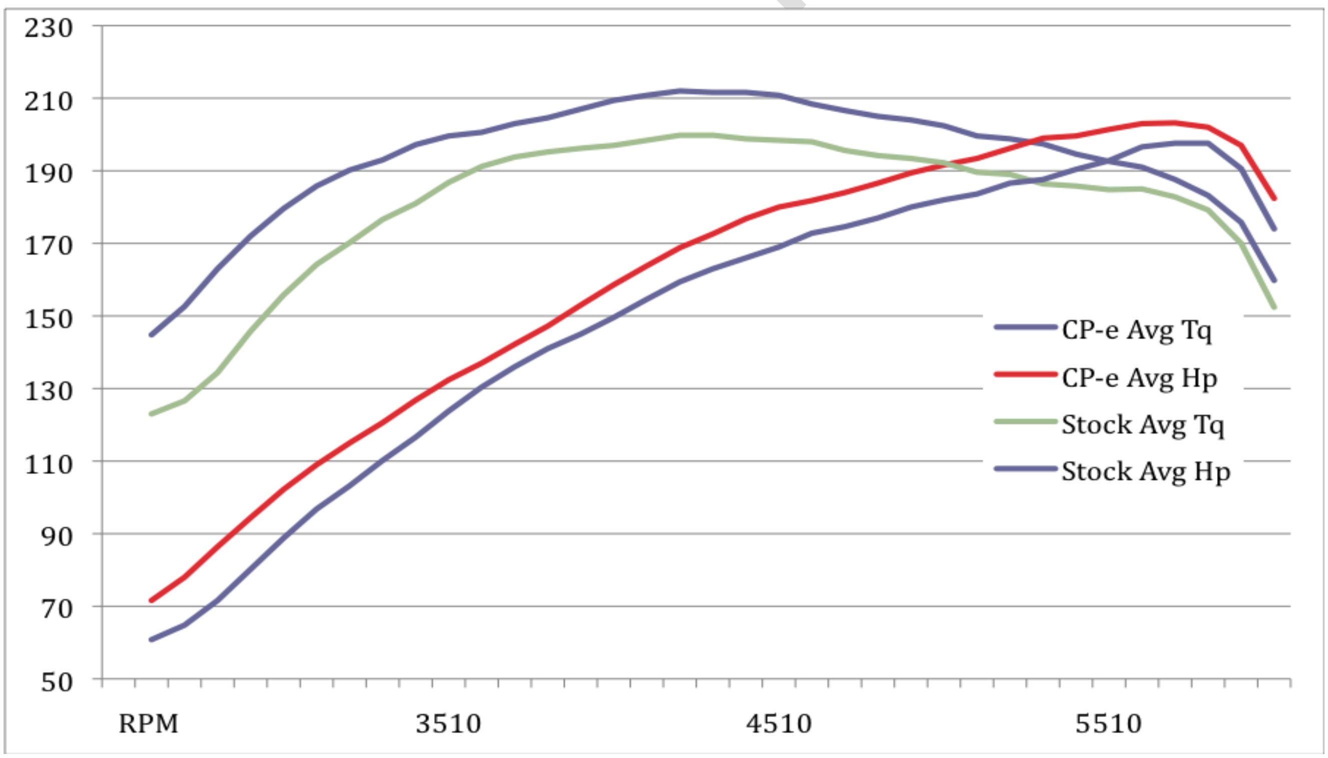
Dynamometer Testing:

The dyno testing that we did on this intercooler was to prove beyond a reasonable doubt that our intercooler drastically outperforms the stock unit in all ranges. Some manufacturers provide dyno charts of just a before and after pull of their products. With this TMIC, we chose to do an average of 5 runs, and then plot the before and after as an average of 5 (5 each for the stock and cp-e TMIC). The results really speak for them selves. There is an average gain of about 10 horsepower and 10 ft-lbs of torque, over an average of 5 runs, with no tuning to optimize for the TMIC, this is great!

Note: The ambient test data was as follows:

All Tests were performed on our Mustang Dynamometer MD-500-AWD-SE, In AWD Mode to prevent any DSC errors.

TMIC Test Data:	*cp-e™ TMIC*	TMIC Test Data:	*Stock TMIC*
Ambient Temp:	**51.642 F**	Ambient Temp:	**50.766 F**
Ambient Pressure:	**30.023" Hg**	Ambient Pressure:	**30.024" Hg**
Humidity:	**15.90%**	Humidity:	**22.52%**



In Conclusion:

We feel that this TMIC is the best option available for the MZR DISI engine. We have successfully engineered a TMIC that does the following:

-Engineered with cast end tanks for smooth inside surfaces, eliminating the possibility of "welding slag" from fabricated aluminum end tanks.
-Remains within the constraints of the stock location, while providing a dramatic increase in performance, even at the relatively low boost levels of a stock engine (our 2010 MazdaSPEED 3 test vehicle).
-Has excellent pressure drop characteristics (less than 1 psi on average).
-Has good thermal efficiency
-Makes more power as a direct replacement over the stock intercooler. (Proved over an average of 5 runs of each part)