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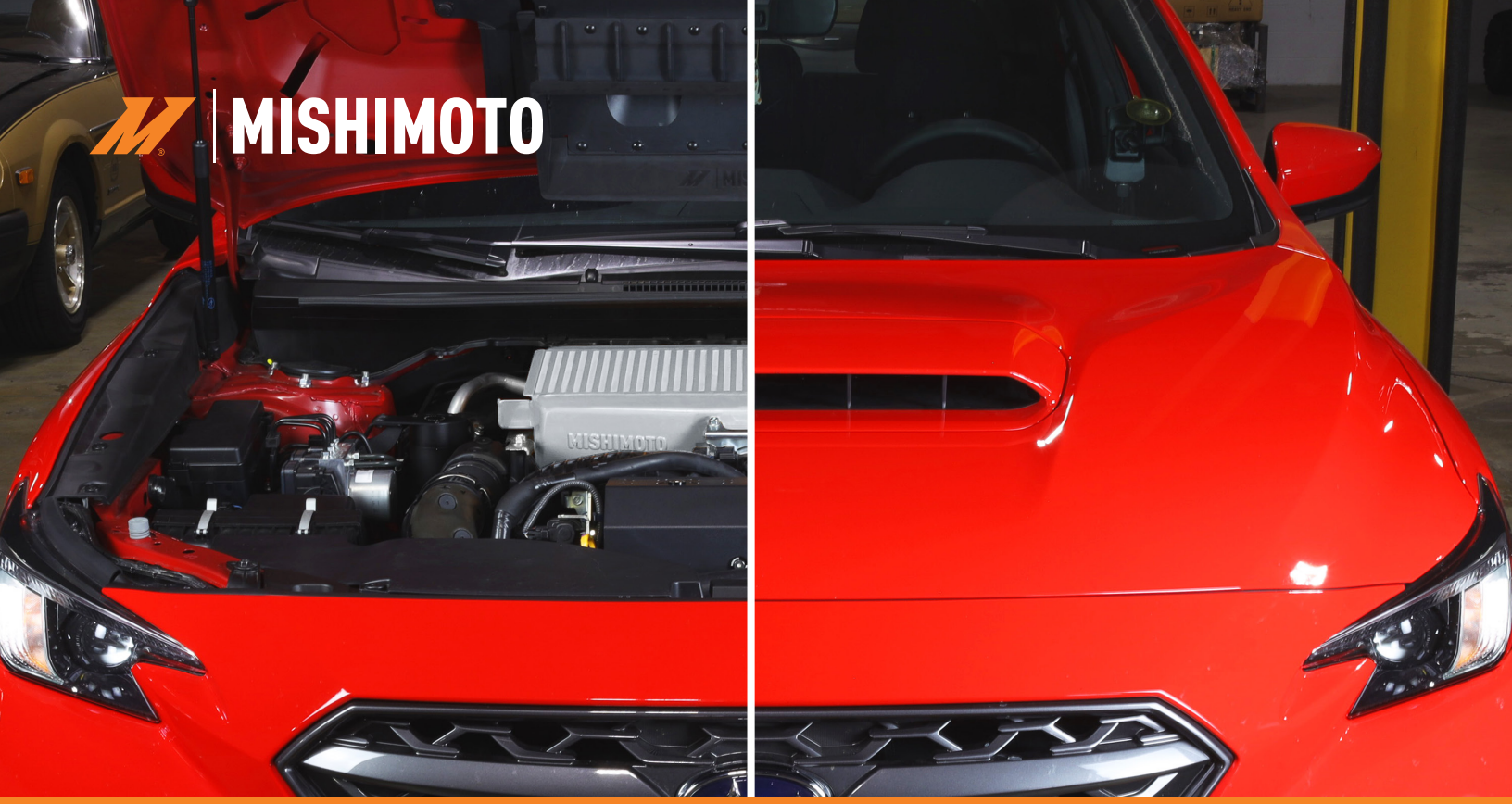

ENGINEERING REPORT

Testing of the 2022+ WRX Direct-Fit Top Mount Intercooler | SKU: MMTMIC-WRX-22

By: Anthony Feola, *Mishimoto Product Engineer*

REPORT AT A GLANCE

- **Goal:** To create a direct-fit performance top mount intercooler that outperforms the stock intercooler.
- **Results:** The Mishimoto intercooler increased airflow through the intercooler by 40.6% and reduced pressure drop by 35.73% compared to the stock intercooler.
- **Conclusion:** The Mishimoto intercooler is a great upgrade for anyone looking to get the most performance out of their Subaru WRX.

CONTENTS

DESIGN OBJECTIVES

- Create an intercooler that performs better than the stock intercooler.
- Mishimoto intercooler must not show a significant pressure loss compared to the stock intercooler.

DESIGN AND FITMENT

We began the R&D process by evaluating the stock Subaru WRX intercooler to find potential room for improvement. The stock intercooler core is a 20.16" wide x 6.18" high x 2.44" thick, 36-row tube-and-fin design. The Mishimoto intercooler was designed as a much larger, 20.49" wide x 6.18" high x 3.98" thick, 33-row bar-and-plate intercooler to increase the amount of cooling surface area and core volume. This design makes the Mishimoto intercooler 88% larger than the stock Subaru WRX intercooler. The bar-and-plate design also features fully welded end tanks and a brazed core. This construction is much stronger than the plastic end tanks crimped to the core that the stock intercooler uses. This gives the Mishimoto intercooler a much less chance of developing a leak and will allow it to handle much higher boost pressures. Figures 1 and 2 below show a comparison of overall core volumes and fin surface areas for the stock and Mishimoto intercoolers. Figure 3 shows a physical comparison of the stock intercooler and the Mishimoto intercooler.

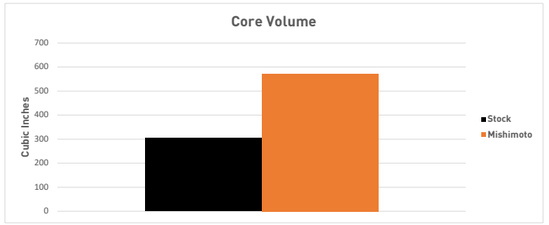

Figure 1: The Mishimoto intercooler has an 88% increase in overall core volume compared to the stock intercooler

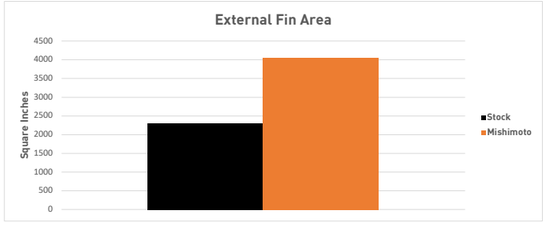

Figure 2: The Mishimoto intercooler has a 76% increase in fin surface area over the stock intercooler

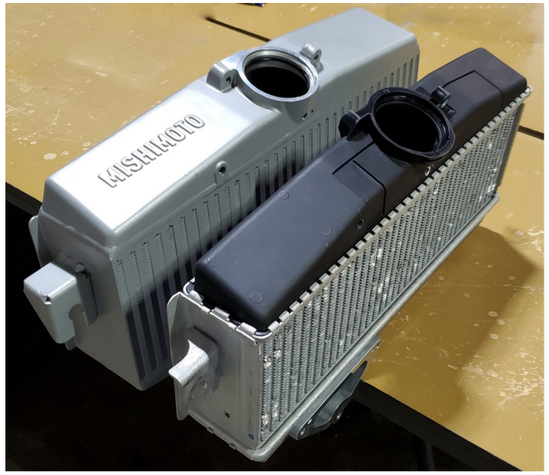

Figure 3: The 2022 Subaru WRX being set up on a Dynapack dynamometer and prepared for testing

Due to the increase in size of the Mishimoto intercooler, the stock shroud would be insufficient to provide full airflow from the hood scoop to the core. A custom Mishimoto shroud was designed to replace the stock shroud and match the new larger core size. This ensures that maximum airflow is being provided through the Mishimoto intercooler. Figure 4 below shows a SolidWorks model of how the Mishimoto shroud seats onto the intercooler when the hood is closed. Figure 5 shows the Mishimoto shroud installed on the vehicle.

Figure 4: Mishimoto top mount intercooler with Mishimoto intercooler shroud

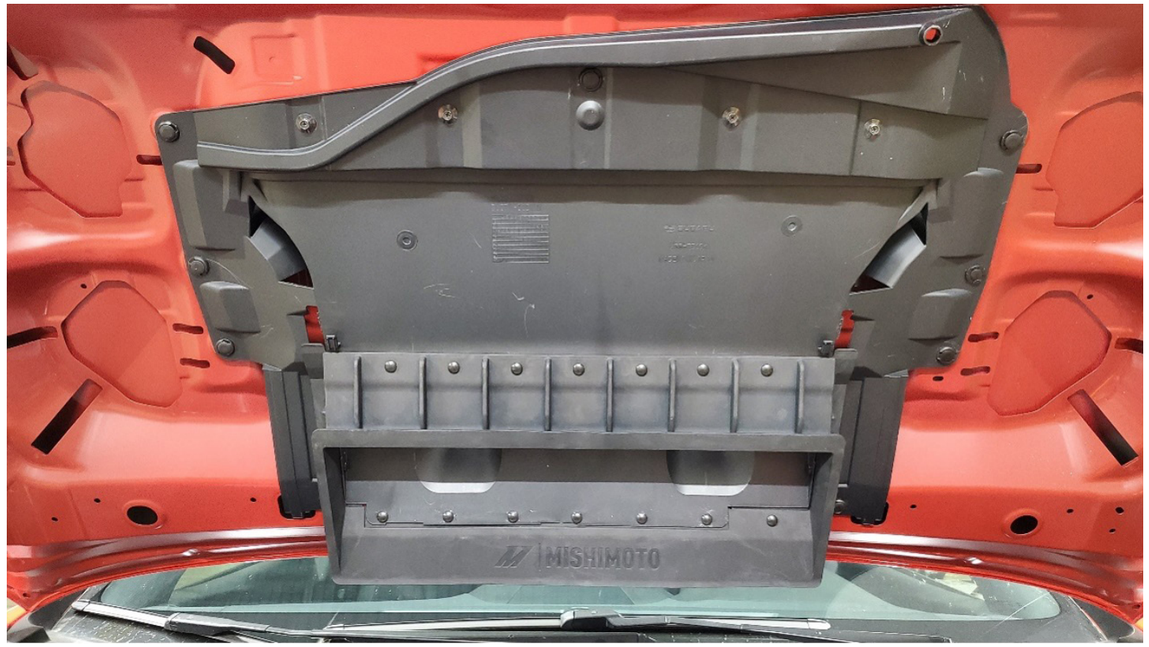

Figure 5: Mishimoto intercooler shroud installed on the 2022 Subaru WRX

In making the core larger, larger end tanks were needed as well. SolidWorks was used to perform CFD analysis to design end tanks that provide even and efficient flow of the charge air through the intercooler core. In addition, an 1/8" NPT port was added to the cold side tank to provide an additional port if the customer chooses to add any additional aftermarket sensoring.

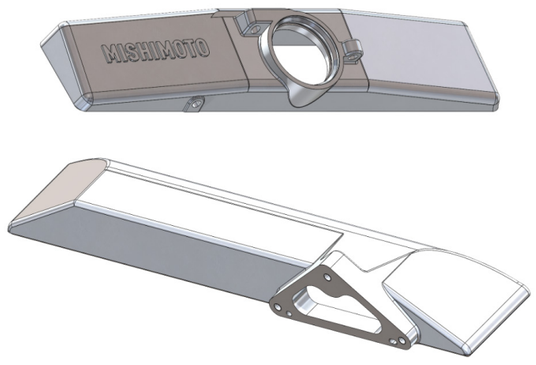

Figure 6: SolidWorks models of the Mishimoto end tanks

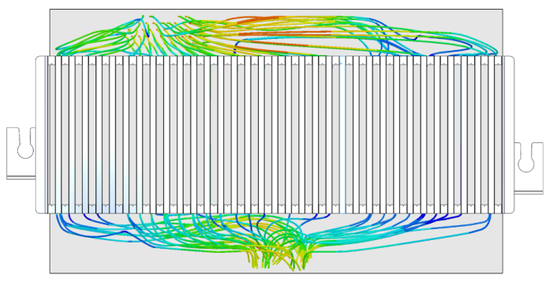

Figure 7: SolidWorks was used to perform CFD analysis on the intercooler end tanks and core

APPARATUS

For hardware, Mishimoto chose to use the AEM AQ-1 driven by the AQ-1 Data Acquisition System.

Figure 8: AEM AQ-1 Data Logging System

Air temperatures and pressures were taken with AEM intake air temperature & pressure sensors from the inlet and outlet of the stock & the Mishimoto intercooler. A baseline of the temperature and pressure was recorded before the Mishimoto intercooler was installed. This allowed us to see how well the intercooler performed.

PERFORMANCE TESTING

First, the stock intercooler and the Mishimoto intercooler were both set up and tested on a SuperFlow flowbench. The total pressure was measured at various flow rates to evaluate the restriction of each intercooler. The Mishimoto intercooler was found to have 40.6% less flow restriction than the stock intercooler.

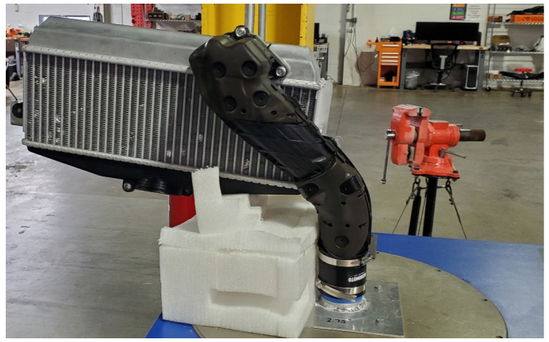

Figure 9: Stock intercooler set up on the flowbench

Figure 10: Mishimoto intercooler set up on the flowbench

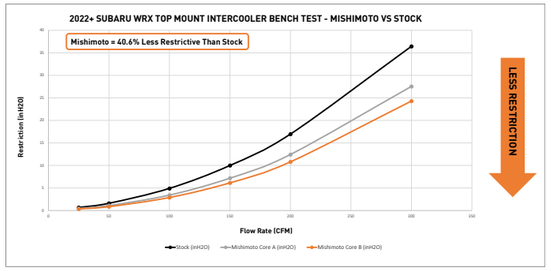

Figure 11: Flowbench test results. The Mishimoto core is 40.6% less restrictive than the stock intercooler

Figure 12: The 2022 Subaru WRX being set up on a Dynapack dynamometer and prepared for testing

Next, A 2022 Subaru WRX was used to test each intercooler. The ambient temperature on the day of testing was approximately 71.6°F (22.0°C). To test the performance of the intercoolers, a Dynapack™ dynamometer was used to conduct consistent ramp tests on the Subaru WRX.

The Subaru WRX was brought to an operating temperature of 190°F (88°C) by idling it on the dyno. Once the vehicle was at operating temperature, multiple dyno runs were conducted until consistent figures were recorded. The vehicles were kept idling between runs to maintain a consistent engine coolant temperature for every run. As a final test for each test configuration, dyno runs were made back-to-back to simulate heat-soak conditions.

The two configurations we tested were:

Configuration 1: Stock intercooler with stock intercooler piping

Configuration 2: Mishimoto intercooler with stock intercooler piping

Intercooler inlet and outlet temperatures were monitored during dyno testing. The peak outlet temperature of the Mishimoto intercooler was 78.7°F (25.9°C) compared to 82.0°F (27.8°C) for the stock intercooler. The Mishimoto intercooler resulted in a peak temperature reduction of 4.04% compared to stock.

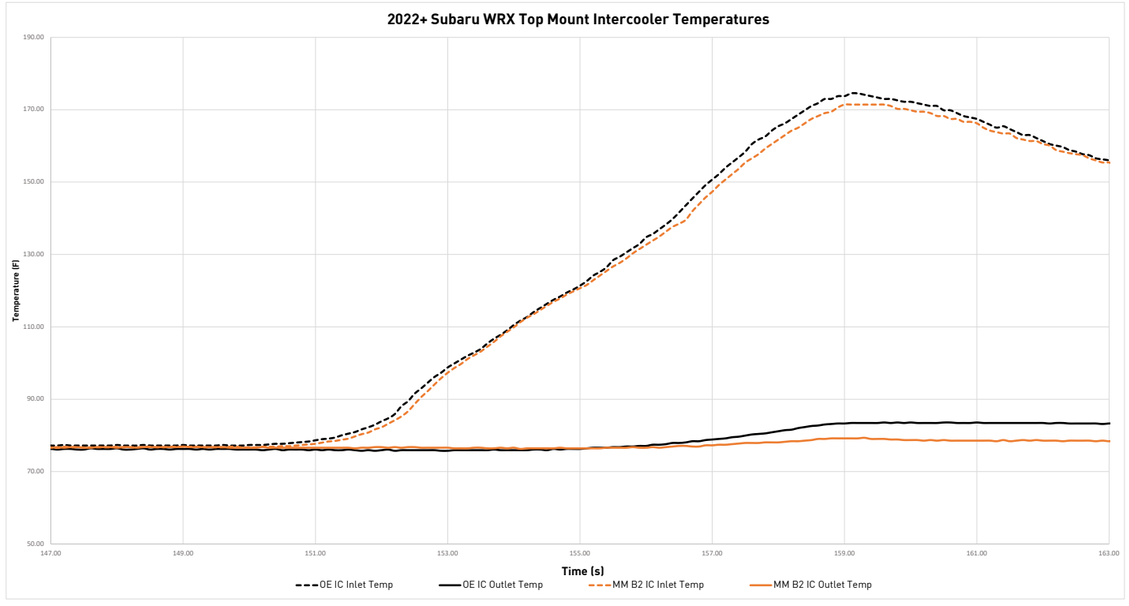

Figure 13: Stock and Mishimoto intercooler temperatures

Intercooler inlet and outlet pressures were also monitored to ensure that the Mishimoto intercooler did not add a significant drop in boost pressure from inlet to outlet. An increase in boost pressure drop from inlet to outlet could cause strain on the turbos, as well as add additional heat into the engine cooling and intercooling system, which could result in a loss of horsepower. The Mishimoto intercooler had an average pressure drop of 0.58 psi compared to a 0.90 psi drop on the stock intercooler. This is a 35.73% reduction in pressure drop with the Mishimoto intercooler.

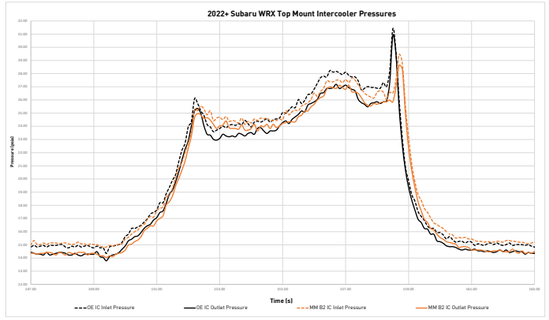

Figure 14: Stock and Mishimoto intercooler pressures

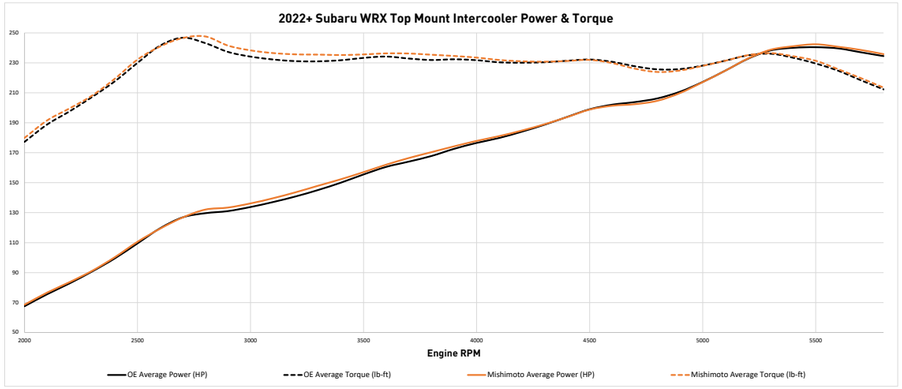

Figure 15: Stock and Mishimoto intercooler dyno chart

Figure 16: Mishimoto intercooler & shroud installed on the 2022 Subaru WRX

Although only a minimal temperature reduction and power gain were observed, the intercooler outlet temperatures approached ambient temperature during testing. The Mishimoto intercooler's peak outlet temperature was only 7.1°F (3.9°C) above ambient compared to 10.4°F (5.8°C) above ambient for the stock intercooler. This decrease in the intercooler's outlet temperature compared to stock provided by the Mishimoto intercooler is expected to be even greater in higher ambient temperature conditions. Similar power numbers between the Mishimoto and stock intercoolers were to be expected as the vehicle being tested was using the factory tune. Because the Mishimoto top mount intercooler provides much less restriction and reduces the pressure drop through the intercooler while making the same power and torque, even with the stock tune, as the stock intercooler, there is much less strain being put on the turbocharger.

TESTING DONE BY:

Anthony Feola, Mishimoto Product Engineer

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Mishimoto is very active on social media so we can be in constant contact with our customers. Our Social Media Team is available via Facebook, Instagram, Youtube, our Engineering Blog, and forums. We sponsor contests and promotional events, so be sure to follow us.

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