MISHIMOTO

ENGINEERING REPORT

2015+ Subaru WRX Street Performance Top-Mount Intercooler | SKU: MMTMIC-WRX-15X

By Jason Wettig, *Mishimoto Product Engineer*

REPORT AT A GLANCE

- **Goal:** Design a direct-fit intercooler that keeps charge-air temperatures and pressure drop across the core as low as possible.
- **Results:** The Mishimoto intercooler showed temperature drops of up to 34°F (19°C) when compared to the stock intercooler. This reduction was achieved with an increase in flow of 12%.
- **Conclusion:** The Mishimoto direct-fit intercooler is an excellent upgrade for WRX owners who want a well-balanced intercooler in terms of performance and fitment.

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DESIGN OBJECTIVES

The design requirements assigned to this project are as follows:

- Design a performance intercooler that reduces charge-air temperatures when compared to the stock cooler.
- Must be a direct fit with no cutting or permanent modification necessary.
- Intercooler should not show a significant increase in pressure drop when compared to stock.

DESIGN AND FITMENT

We began the R&D process by evaluating the stock intercooler and finding potential room for improvement. The stock intercooler is a relatively dense tube-and-fin design. It mounts above the engine (top-mount intercooler) thus giving little room for a bigger unit. After evaluating the internal construction of the core and its given location in the engine, it was evident that this unit was susceptible to heat-soak. The Mishimoto performance intercooler was designed to increase overall core volume and fin surface area while retaining a direct fitment. As shown in Figures 1 and 2, the Mishimoto intercooler increases core volume by 75%, internal fin surface area by 27%, and external fin surface area by 81% when compared to stock.

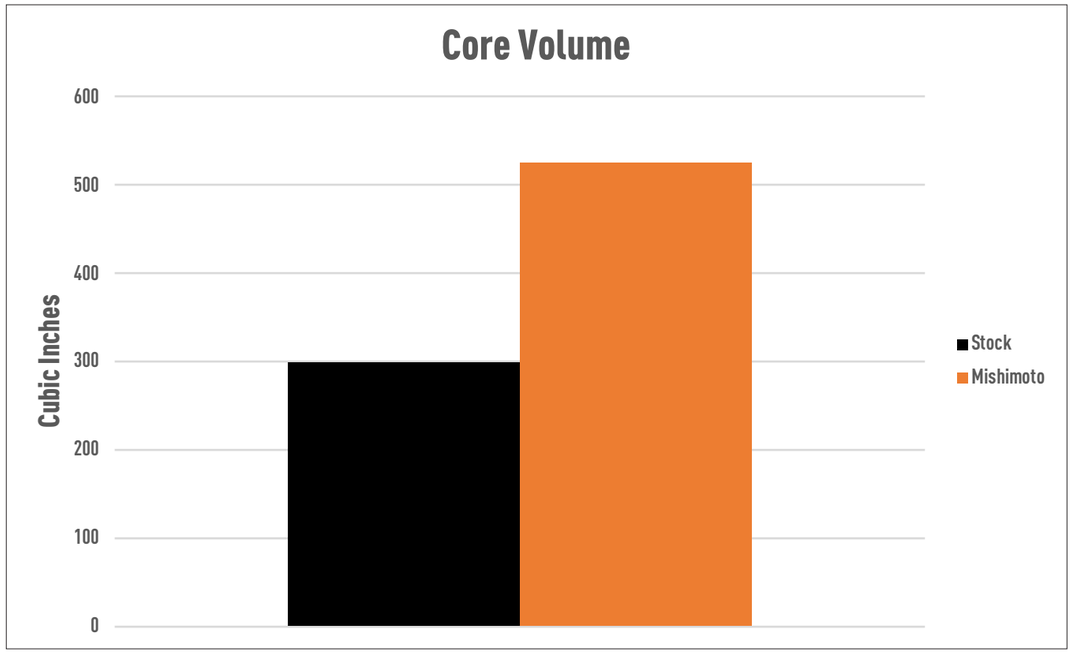

FIGURE 1: *The Mishimoto intercooler core is 75% larger than stock while maintaining a factory fit.*

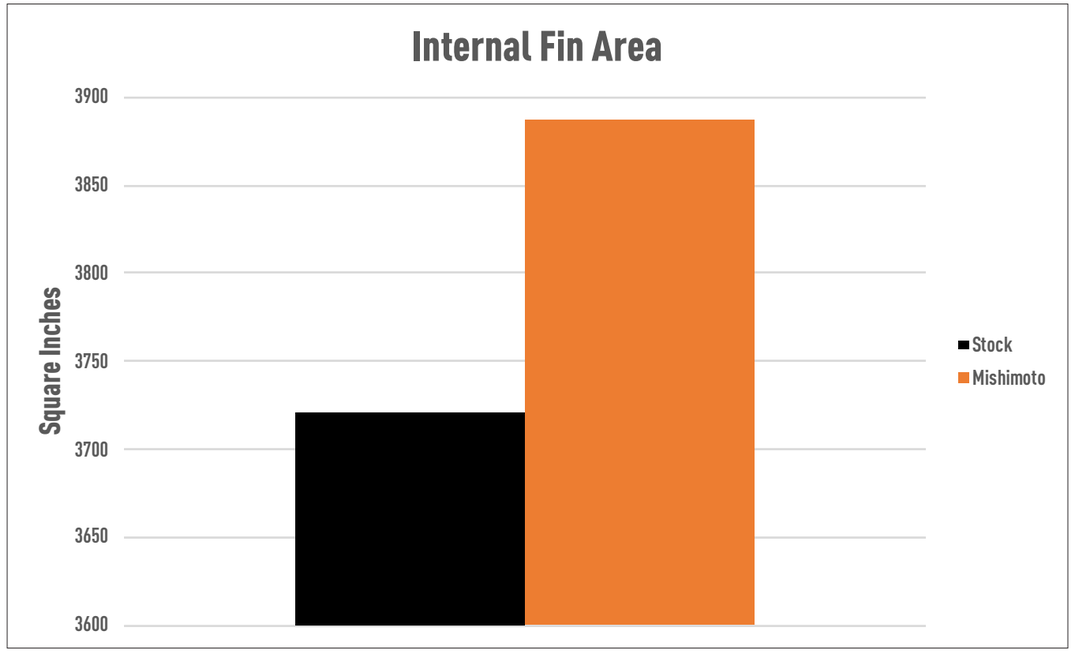

FIGURE 2: *By reducing fin height and pitch, the surface area was increased by 27% compared to the stock core.*

The WRX is used for many purposes: daily driving, autocross, and rally cross. We wanted to offer an intercooler that would be the best under all conditions. To achieve that, two cores would be specced and tested. We conducted our test in our R&D facility and sent a sample to a private party for additional testing. All the cores were bar-and-plate construction. The reason for bar-and-plate is increased strength to live up to the extreme demands of these vehicles.

More information on the R&D process for the intercooler can be found on the Mishimoto Engineering Blog.

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PERFORMANCE TESTING

A 2015 Subaru WRX was used for testing. This vehicle had an exhaust and an intake. The ambient temperature on the day of testing was approximately 72°F (22.2°C) with 29% humidity. To test the performance increases of the intercooler and heat-soak, a DynaPack™ dynamometer was used to apply a constant and repeatable load on the WRX.

FIGURE 3: *A Dynapack™ dynamometer was used for vehicle testing.*

To test the performance gains as well as heat-soak of the Mishimoto intercooler, the WRX was loaded onto the Dynapack, and baseline pulls were made of the completely stock car. These single pulls, while generating heat, did not demonstrate how an intercooler can heat-soak over time. A new test was performed to heat-soak the intercooler. With the car on the dyno, three consecutive dyno pulls were performed in 4th gear with a no wait between each run. This allowed the intercooler to heat-soak. This more closely simulated real work conditions of back-to-back pulls with no wait in-between.

Our third-party tester performed similar tests and put the car on E85 along with a Stage 2 tune. All tests were compared to the stock intercooler to ensure the best possible intercooler was developed.
A flow bench test was performed to ensure the core was flowing better than stock despite having more internal surface area. A 12% increase in flow was achieved over the stock core. CFD analysis was also performed on the core to ensure that the air was reaching all the internal passages. It is very apparent that the Mishimoto core flowed better than the stock core.

From testing, it was clear that the Mishimoto intercooler outperformed the stock intercooler in terms of temperature drop and resistance to heat-soak. The flow bench also showed an improvement over the stock core. This coupled with the increased cooling shows the Mishimoto intercooler is an upgrade over the stock intercooler. Outlet temperatures were much more consistent and very close to the ambient temperature. The results for temperature drops and pressure drops from testing on a stock tune can be seen in Figures 4–7 below.

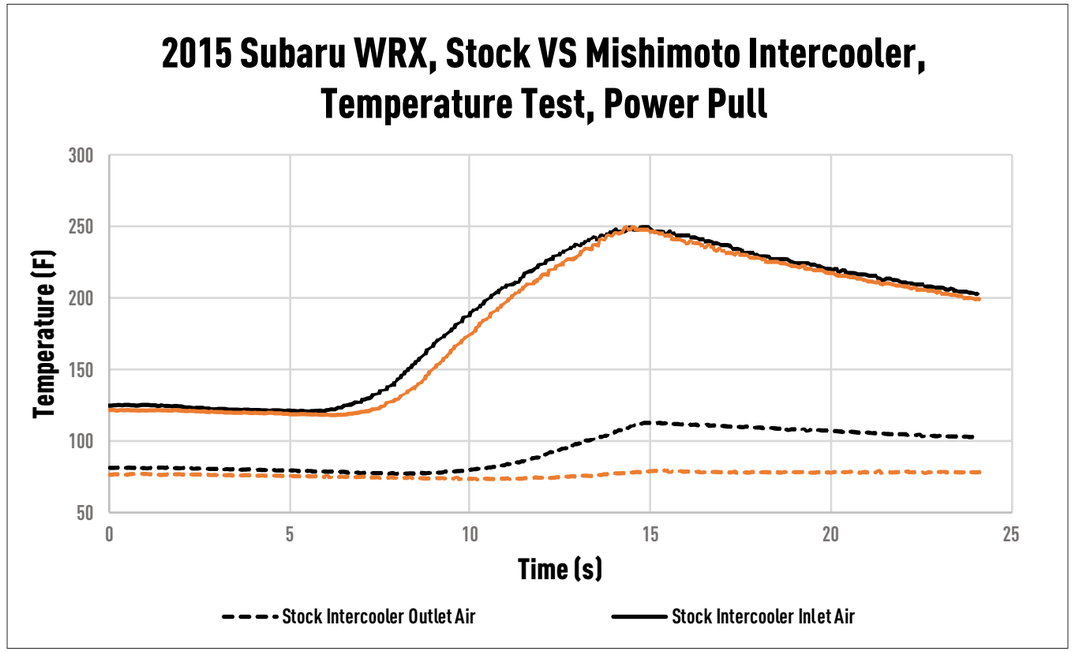

FIGURE 4: *This is the chosen Mishimoto Intercooler vs the Stock Intercooler. Notice how the stock outlet rises during the dyno pull while the Mishimoto intercooler stays much flatter.*

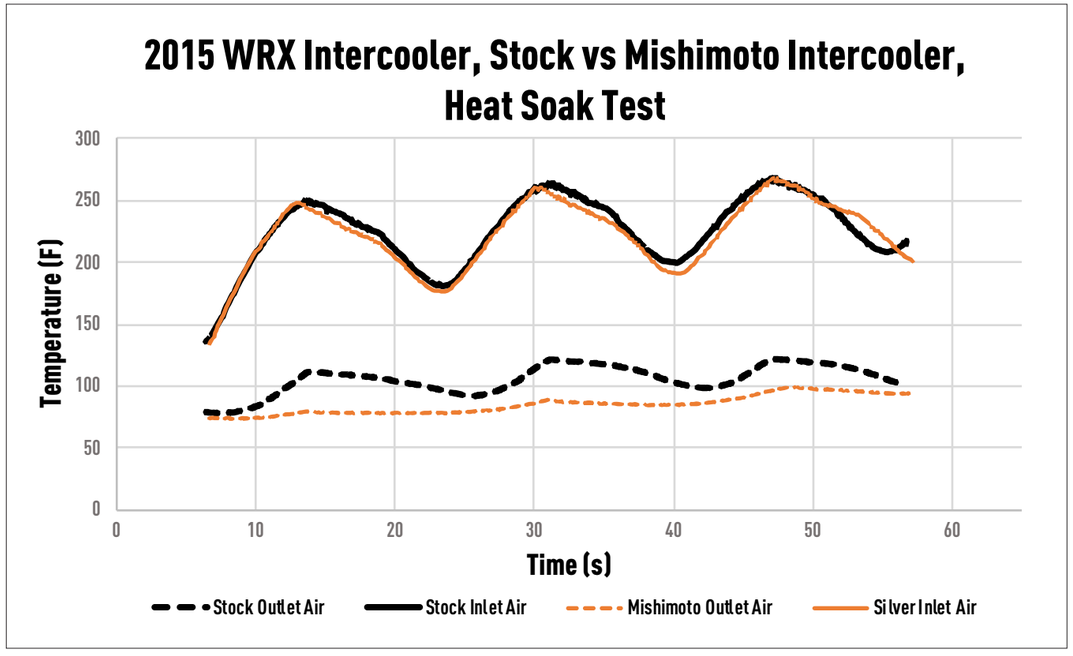

FIGURE 5: *Mishimoto Intercooler Heat-Soak Test, notice how the stock intercooler temperatures are higher and rise faster than the Mishimoto core.*

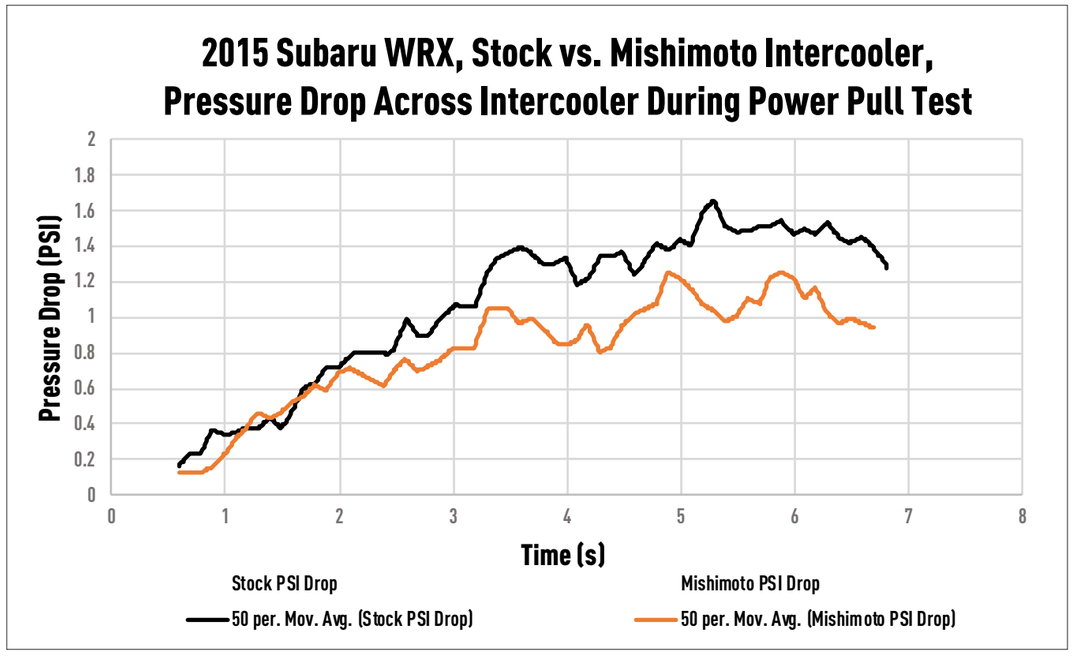

FIGURE 6: *Stock intercooler pressure drop across the core. At the end of the run the stock core is at a 1.5 psi drop, and the Mishimoto core is at about a 1.2 psi drop.*

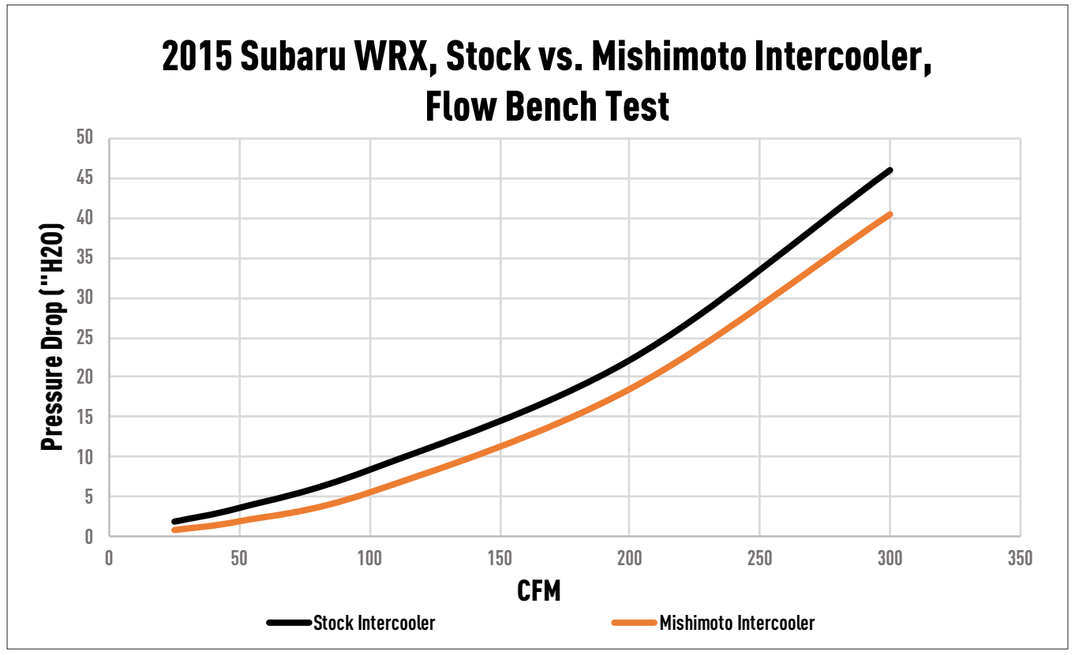

FIGURE 7: *Flow bench test. At 200 CFM the stock core has a pressure drop of 22 H2O while the Mishimoto has a lower pressure drop of 18.5 H2O. The Mishimoto core is lower across the entire range of testing.*

This configuration showed temperature drops of up to 34°F (19°C) compared to the stock intercooler, while showing a greater resistance to heat-soak throughout the entire testing process. This was achieved with an increase in flow of 12% and an overall psi drop of 1.2 psi, which is lower than stock.

An intercooler's primary function is to keep charge-air temperatures low. If the air temperature entering the engine begins to climb, the ECU will reduce power to preserve engine longevity. This can greatly impact the available power during heavy load events. A performance intercooler will aid in preventing this loss of power on a completely stock tune. If an aftermarket tune is being loaded onto the vehicle, additional gains can be expected because the tuner is able to compensate for the reduction in engine air temperature as well as the increased volume.

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