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MISHIMOTO ENGINEERING REPORT

Testing of the Mishimoto Evolution 7/8/9 Race Intercooler

Test Vehicle
2006 Lancer Evolution IX

Modifications
Intake, turbo-back exhaust, intercooler piping, tune

Objective
To make a race-style intercooler that is a direct fit for the Mitsubishi Evo 7/8/9

Testing conditions
The ambient temperature on the day of testing was approximately 83°F with 35% humidity.

Apparatus
For hardware Mishimoto chose the PLX sensor modules driven by the Kiwi WiFi plus iMFD. This is a wireless system from the sensor modules to an iPad or laptop computer. The software used was the Palmer Performance Scan XL pro, which has full data logging capabilities.

Figure 1: Palmer Performance Scan XL software was used to record testing data.

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Air temperatures were measured using sensors that were mounted to the inlet and outlet of the intercoolers. A sensor was also placed in front of the intercooler to measure the temperature of the air entering the core. This data allowed us to determine the overall efficiency of each unit. Pressure sensors were also mounted to the inlet and outlet of the intercooler to determine overall pressure drop.

Research and Development

To ensure that an effective intercooler was chosen, we sampled and tested different core styles on the Evo IX. The first core that was tested featured a serrated-fin style, which would promote turbulence within the core. The turbulence would, in theory, force the air within the core to mix at a greater rate, thus leading to more overall heat transfer. Our test results showed that while this prediction may hold true in very high-horsepower applications, it was actually less effective than the straight/perforated core. The straight/perforated core did not promote as much turbulence; however it also did not cause as large a pressure drop as the serrated style core. By comparing outlet temperatures, pressure drops, and overall efficiencies, it was clear that the perforated-fin style was the best option.

Experiment

Colder air is denser than hot air and will therefore allow a larger combustion while also reducing the chances of engine knock. As the intake air becomes colder, a tuner is able to load a more aggressive timing map into the vehicle's ECU, which will directly result in more power. An intercooler's primary function is to reduce the intake temperature significantly and with the best possible efficiency. This requires a large amount of heat transfer with the least possible pressure drop. Utilizing a larger core and optimizing the intercooler's fin style achieves this goal.

To test the design effectiveness of the Mishimoto intercooler, we put an Evo IX on a dynamometer and measured parameters such as inlet/outlet air temperatures and pressures, and the temperature of the air entering the intercooler. We were also able to see the power and torque output of the vehicle with each intercooler bolted on. The tune on the vehicle remained constant to give a true "apples to apples" comparison. The Evo was dyno tested with both Mishimoto units (perforated fins and serrated fins) and also the OEM intercooler.

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Again, results showed that the straight/perforated style was more effective than the offset/serrated style. We then proceeded to test the chosen Mishimoto design against the OEM intercooler.

The OEM Evo intercooler performs well for a stock unit, but there is certainly plenty of room for improvement. With all other factors remaining constant, the Mishimoto intercooler showed significant gains compared to the stock unit. The most noticeable change was a sharp decrease in outlet temperatures. After a few pulls, the OEM unit began to heat soak and outlet temperatures began to climb. The peak temperature of the OEM unit was 137.7°F, whereas the highest temperature of the Mishimoto unit was 109.5°F. This 28-degree drop in the Mishimoto unit yielded an additional 8 horsepower on the dyno compared to the stock unit. Additional gains would be expected if the ECU was tuned to compensate for the colder air.

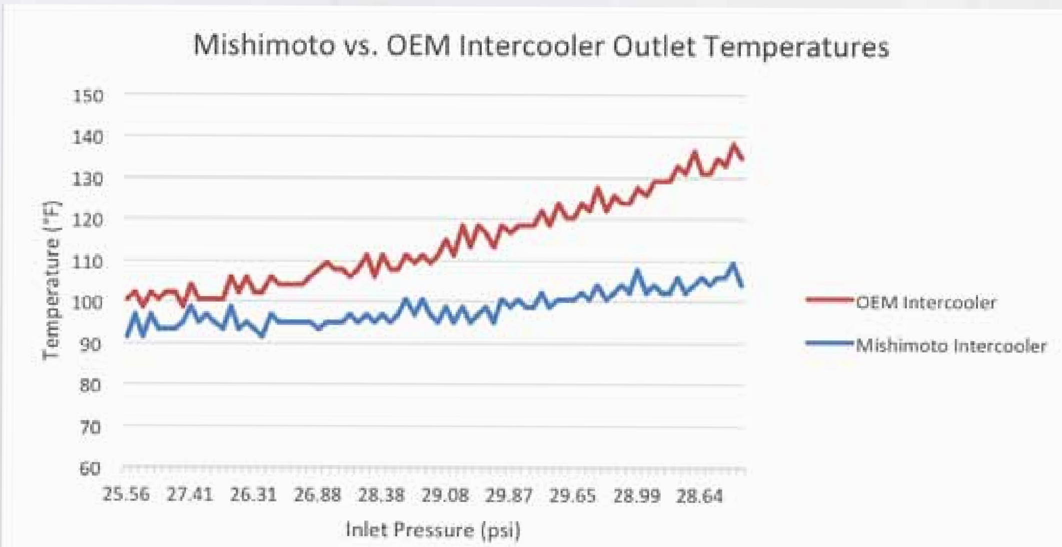

Figure 2: The OEM intercooler showed an average temperature of 113.6 degrees. The Mishimoto unit showed an average temperature of 99.4 degrees. This colder intake air allows for a more aggressive tune which will result greater power.

By placing an air temperature sensor in front of the intercooler, we were able to calculate the efficiency of each unit throughout every dyno pull. The efficiency of an intercooler is its ability to cool the intake air as close to the ambient air as possible. On average, the OEM unit showed an efficiency of about 79%, whereas the Mishimoto unit showed an efficiency of 86%. As seen in the graph below, the greater efficiency of the Mishimoto intercooler becomes more apparent as boost pressures increase.

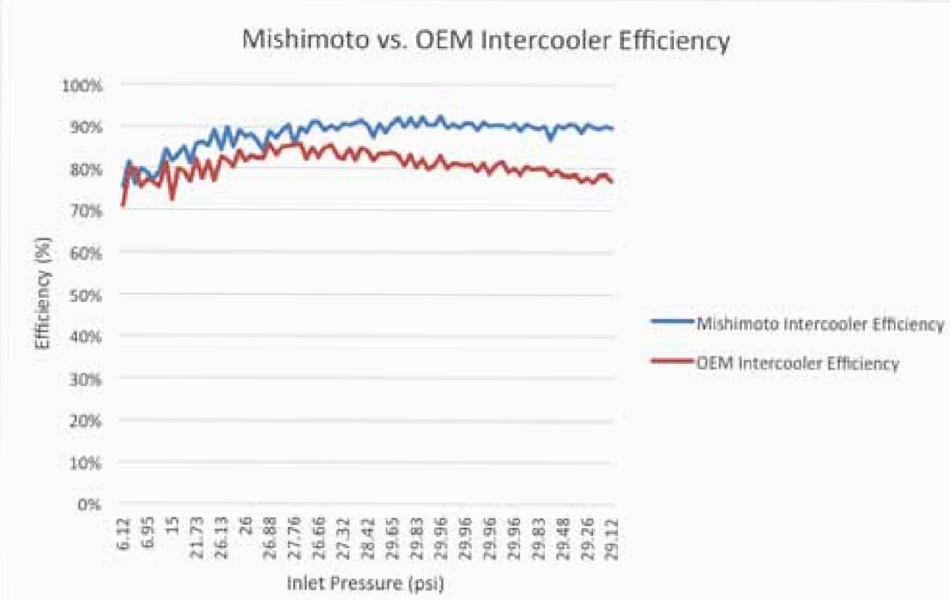

Figure 3: As inlet pressure increases, the efficiency of the Mishimoto intercooler increases dramatically compared to the OEM unit. A higher efficiency means the unit has greater heat transfer properties and will allow colder air to enter the motor. In general, colder air allows the engine to make more power.

The final parameter we measured was pressure drop. Pressure drop is undesirable as it forces the turbo to work harder and will also create more heat at the intercooler inlet. Our results showed that on average, the Mishimoto intercooler created only 0.4 psi more pressure drop than the OEM unit. The graph below shows the pressure drop of each intercooler throughout a dyno pull.

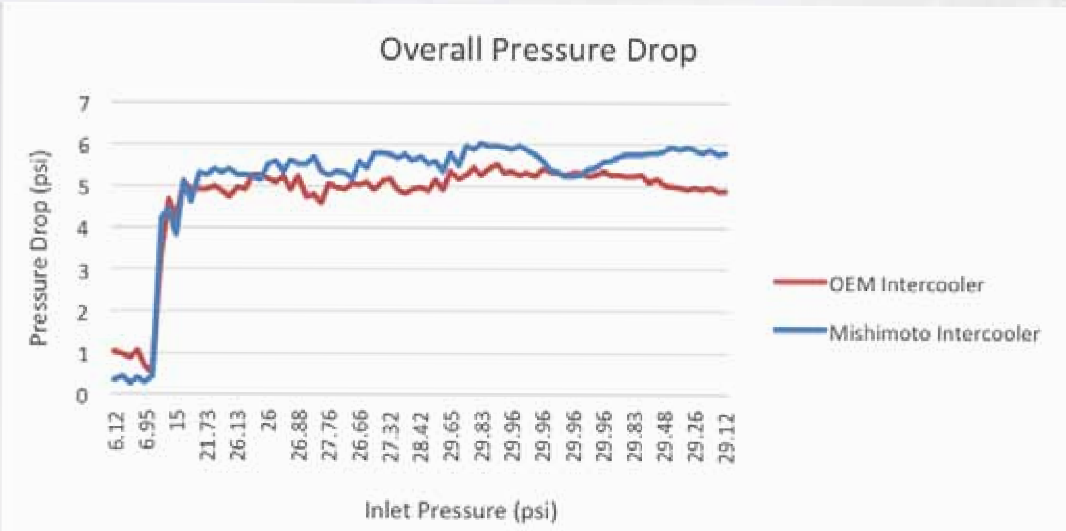

Figure 4: The Mishimoto intercooler shows little increase in pressure drop compared to the stock unit.

Bolting the Mishimoto intercooler directly onto an already-modified Evo IX resulted in an additional 8 hp max and up to 10 hp at lower rpm without adjusting the tune. This horsepower increase would likely be comparable on a completely stock Evo and would definitely be larger if the vehicle was tuned for the Mishimoto intercooler. The dyno graph below shows the power curve of the Evo with the OEM and Mishimoto intercoolers.

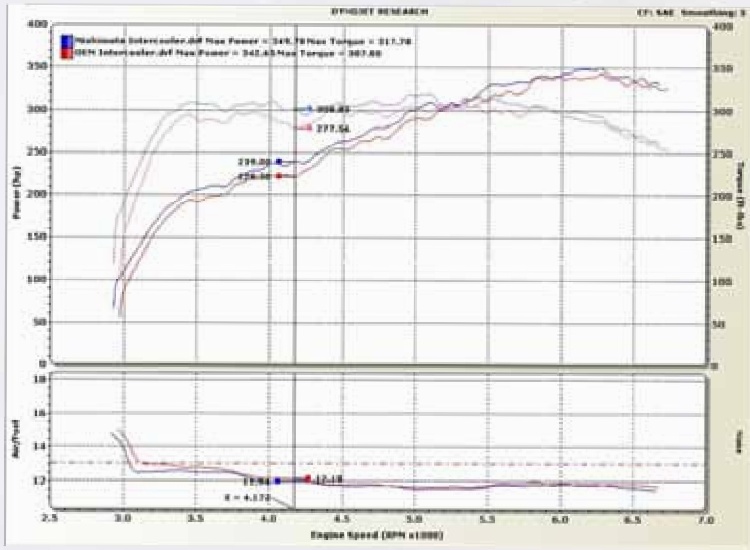

Figure 5: Dyno graph comparing OEM intercooler and Mishimoto intercooler power curves. The Mishimoto unit easily supported 350 whp and is capable of yielding much more power with a proper tune and supporting modifications.

Summary

The Mishimoto intercooler showed impressive performance gains, especially when compared with the stock unit. The outlet temperatures of the Mishimoto unit dropped as much as 28°F over the OEM unit with a pressure drop of less than 1 psi compared to stock. The overall efficiency of the Mishimoto intercooler averaged 86% and far outperformed the stock unit once the inlet pressures rose. The Mishimoto intercooler is a direct bolt-on replacement, with no cutting or modifications required. For vehicles running between 300 whp and 500 whp, the Mishimoto Evo 7/8/9 intercooler is an excellent choice.

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