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Eaton vs. Autorotor in a supercharger slugfest

By Richard Holdener
PHOTOGRAPHY BY THE AUTHOR

What is a supercharger issue without a good blower battle royale? I live for things like supercharger comparisons, but they are not without their difficulties. Case in point: the positive displacement supercharger slugfest presented here pitting the like-displacement 3150 twin-screw Autorotor versus the Roots-style M90 Eaton. From a readers standpoint, I’m sure all you care about is how much power they make. In truth, that is the real criteria for a supercharger as we all bolt them on in search of improved performance.

The problem lies in how to accurately test them. It is difficult enough to get a normally aspirated motor to cooperate and produce repeatable results on a dyno, let alone a supercharged monstrosity. There are any number of variables such as timing, air/fuel ratio and even the various temperatures (air, water and oil) that can alter the results. All of these things must be accounted for in order to produce reliable results. The variables are especially important when you are looking for minor variations in power production. As it turned out, our differences were significant, but we still data-logged every possible variable to ensure accuracy.

With variables accounted for, we decided that the best method of comparison was to run each of the two blowers on the 4.6 2-valve test motor using various blower pulley ratios. The test vehicle was a 2000 Saleen S281 equipped with a 4.6 2-valve GT motor. Unfortunately the motor was attached to an automatic trans, which limited how low we could begin our tests, but the self-shifter performed perfectly during the testing. The 4.6 had been augmented with a Bassani X-pipe (sans cats) and a cat-back exhaust. The Bassani was installed prior to any testing to ensure we had plenty of exhaust flow for the supercharged motors. The 4.6 had also been treated to a Saleen supercharger kit featuring the positive displacement Eaton M90. You will remember that Saleen decided to use the twin-screw supercharger design for its top-of-the-line S281-E for all-out power. These tests may well illustrate why the Saleen boys made that switch. The Eaton supercharger kit from Saleen also included an air-to-water intercooler, but our testing showed that the reduction in charge temperature was not quite what we would hope for—more on that later.

Obviously the Saleen kit for the 4.6 was designed to run with the Eaton M90 supercharger. You can’t just remove the Eaton and bolt the Autorotor in its place. In order to facilitate the testing, the folks over at Kenne Bell fabricated an adapter plate to allow the 3150 Autorotor to bolt in place of the Eaton. The two superchargers would then share the same mass air meter, throttle body and intercooler, making the comparison test as even as possible.

Rather than just run the S281 with the Eaton and then again with the Autorotor, we wanted to demonstrate both the stock and maximum potential of each blower. After all, who installs a supercharger and runs it at just 6 psi? We all get addicted to that wonderful boost and like every junkie we then crave more. Well, by testing the superchargers at various boost (and power) levels, we could demonstrate the upgrade potential of each blower.

To test the two superchargers, we first ran the Eaton M90 on the 4.6 with the 2.75-inch blower pulley (combined with a standard 6.5-inch crank pulley) that came on the Saleen supercharger kit. We then dropped down in pulley size until we finally reached the limit of the supercharger. The smallest pulley run on either supercharger measured 1.975-inches, producing a lower speed of nearly 20,000 rpm.

Here is some theory before we get to the results. Though enthusiasts tend to lump the positive displacement superchargers into one group, there is a significant difference between the twin-screw Autorotor and the Roots-type Eaton. Unlike the traditional Roots-type (Eaton), the twin-screw Autorotor is (to a minor
Naturally our blowers battle royale took place on the DynoJet where any good supercharger slugfest should happen.

Think we weren't serious about data-logging? Check out all this equipment used by Kenne Bell to ensure the test results were 100 percent accurate and repeatable.

Fist up was the Roots-type Eaton M90. It is shown here equipped with the smallest 1.975 blower pulley.

Here is the difference between the largest 2.75-inch and smallest 1.975-inch blower pulleys. The blower speed reached nearly 20,000 rpm with the 1.975 pulley, well beyond the efficient range specified by Eaton for the M90.

Kenne Bell had a whole slew of blower pulleys available to match the speed of the Eaton supercharger.

In an effort to free up some of the inlet restriction, we installed a larger 90mm MAF. The power gain was minimal with the inlet change.

The supercharger kit for the 4.6 came from SALEEN with an air-to-water intercooler. Check out the core tucked down in the intake manifold.

The Eaton was installed and run with the four different size blower pulleys.

Next up was the Autorotor 3150. Actually, the gang at Kenne Bell tested a number of different size Autorotors on the 4.8, but our test centered on the 1.5-liter 3150.

As indicated by this test, the Roots blower offered acceptable airflow and inlet temperatures below 10 psi, but performance suffered beyond that point. According to data supplied by Autorotor, a comparison between the Eaton M90 and Autorotor 3150 shows that the 3150 provides a higher flow rating, a lower charge temperature and requires significantly less power to drive the blower. The numbers supplied by the Autorotor test are not insignificant. How does 100+ extra cfm, an 83 degree reduction in inlet air temperature, and...
Specifications: Eaton M90 (Roots Supercharger)

<table>
<thead>
<tr>
<th>Blower Pulley</th>
<th>Max Boost Pressure</th>
<th>Inlet Air Temp</th>
<th>Air into Intercooler</th>
<th>Air out of Intercooler</th>
<th>Rotor Speed</th>
<th>Peak HP</th>
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<td>76</td>
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Specifications: 3150 Autorotor (Twin Screw Supercharger)

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<th>Inlet Air Temp</th>
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<th>Air out of Intercooler</th>
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<td>74</td>
<td>260</td>
<td>173</td>
<td>19,746</td>
<td>388</td>
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</tbody>
</table>

With the air inlet and mounting brackets in place, the 3150 was ready to rock.

Mounting the stock throttle body (used with the Eaton) in place required an adapter plate.

Like the Eaton tested previously, the Autorotor relied on the stock mass air meter and inlet tube with all four blower pulley sizes.

HorsePower Graph: Autorotor vs. Eaton (2.75-inch Blower Pulley)

This graph illustrates the difference in power produced by the two superchargers using the same 2.75-inch blower pulley. Both the 3150 Autorotor and M90 Eaton are positive displacement superchargers, displace nearly identical 1.5 liters and are used in kit form on 4.6 V8s. What better measure of performance than to run the two blowers at the same rotor speed? Spinning the two blowers at the same speed clearly demonstrated the superiority of the twin-screw design. Running an identical blower speed, the Autorotor produced 47 more peak horsepower than the Eaton.

Pulley changes were made easier with this special tool.

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Going from the largest to the smallest blower pulley required a blower (accessory) belt change.

The DynoJet displayed all the power numbers for each of the blower pulley sizes.

(Above and below) Check out the difference in lobe design between the roots-style Eaton M90 and the twin-screw Autorotor.

 Autorotor vs. Eaton (2.75-inch Blower Pulley)

The torque graph tells a similar story. Note that the torque outputs were similar at lower engine speeds, but the flow rate of the Eaton seemed to sign off as the revs increased. Further indication of the superior efficiency was the fact that the Autorotor produced more boost pressure and a lower charge temperature.

 Autorotor vs. Eaton (1.975-inch Blower Pulley)

Just like our loyal MM&FF readers, we were not satisfied with stock boost or horsepower levels. We wanted to see what happened once we cranked up the boost by installing a much smaller supercharger pulley. Actually, we ran both blowers with pulleys ranging from 2.75-inches down to 1.975-inches in .2-inch steps. This graph illustrates what happened when we installed the 1.975 pulley on both superchargers. The Eaton had long since run out of flow potential, topping out at 317 hp. The Autorotor produced a whopping 388 hp using the same pulley ratio, for a gain of 72 horsepower. Measured out at 6000 rpm, the difference between the two superchargers was nearly 100 horsepower! While the Eaton was indeed done in terms of power out, we installed a larger throttle body and MAF to feed the Autorotor and managed to up the power even more to 419 horsepower. The throttle body and larger MAF had no effect on the Eaton.
Kenne Bell plans to market their own intercooled supercharger kit for the 4.6 Mustang using one of its Laminova air-to-water intercoolers. If this test is any indication, there is room for improvement in the intercooler on the Eaton-based Saleen kit.

After running the 3150 with all four pulley sizes, we tried improving the inlet tract by installing a larger throttle body and mass air meter. Unlike the tests run on the Eaton, the Autorotor responded to the changes with a dramatic power improvement.

The standard 80mm mass air meter was swapped in favor of a larger 90mm unit.

A larger cone filter replaced the factory air box. The results were worth the effort, as the Autorotor supercharged 4.6 topped the 400-hp mark with a peak reading of 418 hp (up from 388 hp).

Autorotor vs. Eaton (1.975-inch Blower Pulley)

Once again, the torque graph illustrates that the Eaton simply could not supply the airflow demands of the motors. We knew this even before running this final test, as the motor only picked up 4 horsepower when we reduced the blower pulley size from 2.2-inches down to the 1.975 used for this test. About the only thing the smaller blower pulley on the Eaton did was to dramatically increase the inlet air temperature (before the intercooler) from 265° (with the 2.2-inch blower pulley) to a sizzling 303°. Even with nearly 3 more psi of boost, the discharge temperature produced by the Autorotor was only 260°, or 43° less than the Eaton.

Autorotor vs. Eaton (7.7 psi vs. 7.7 psi)

This test was run for those individuals out there wondering why we didn't simply compare the two superchargers at the same boost level. In order to limit the boost production of the Autorotor, we had to dramatically slow down the rotor speed by installing a 3.125-inch blower pulley. This obviously skewed the test in favor of the Eaton by punishing the twin screw for being overly efficient. Even still, matching the peak boost numbers of the two blowers, the Autorotor still came out on top by 26 horsepower. Note that slowing down the twin screw resulted in a slight loss (compared to the Eaton) down low. This is due to the reduction in blower speed and not a difference between the response rate of the two superchargers.
**Autorotor vs Eaton**

Boost vs Pulley Size

At any given pulley ratio, the Autorotor out-boosted the Eaton by a sizable margin. Even with the increased boost pressure and power output, the charge temperature was still lower on the Autorotor compared to the Eaton.

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perature and 23 less drive horsepower sound at 14,000 rpm and 11.8 psi? The numbers sound almost too good to be true, but our test results show that these numbers were indeed accurate.

Before beginning the test, the 4.6 was outfitted with all manner of data-logging equipment. The data-logged included the air fuel ratio, ambient air, engine speed, boost pressure before and after the intercooler, inlet air before and after the intercooler, water temperature through the intercooler core, mass air volume, timing curve and inlet vacuum before the supercharger. The engine looked like a cardiac patient with hordes of wires running out of every possible orifice. In addition to the data-logging parameters a scan tool was used to stream the oil and water temps to ensure accuracy between runs.

We also monitored the knock sensor to make sure no timing was removed during any of the runs. In anticipation of the high-boost runs, the fuel tank was filled with 100-octane race unleaded fuel to eliminate any possibility of detonation. Naturally, back-up runs were recorded to verify the power numbers generated by each pulley size. The back-up runs help eliminate anomalies that can occur during testing. Knowing the intensity of the blowers这群，every effort was made to ensure accurate, repeatable data.

Since it was already installed on the motor, the first test was the Eaton M90 equipped with the 2.75-inch blower pulley. It should also be noted that the 4.6 was equipped with a Boost-a-Pump, 42 psi injectors and a custom chip necessary for the larger injectors. The idea behind the fuel system upgrades was to ensure a stable air/fuel ratio at each boost level.

The M90 blower kit from Saleen produced a peak of 7.7 psi and 287 hp at the wheels. Remember that this car was equipped with an automatic, so the power level reflects the greater power absorbed by the slush box. The air-fuel ratio hovered right near 12.5:1 and the blower produced a peak inlet temperature reading of 185°F. The air-to-water intercooler only managed to reduce that temperature by 23°F, not much considering the complexity of the system. At the peak boost level, the drop across the intercooler core was less than 1 psi, though we were disappointed by the modest temperature drop.

After a back-up run duplicated the numbers, Brent from Kenne Bell (the owner of the S281) performed the pulley swap, ditching the 2.75-inch pulley in favor of the smaller 2.40-inch unit. The 2.40-inch pulley increased the maximum blower (rotor) speed from 14,180 rpm to 16,249 rpm. Naturally the boost pressure increased with the reduction in pulley size, jumping from a peak of 7.7 psi with the 2.75 pulley to 9.3 psi with the 2.4 pulley. The peak power was now up to 308 hp and the inlet air temperature right along with it. The M90 raised the charge temperature from 81°F to 235°F, with the intercooler dropping it to 185°F before entering the motor. Note that an increase of 1.6 psi resulted in an increase in inlet temperature by 50°F. This significant temperature increase indicates that the Eaton was really struggling to supply the 4.6 motor, not to mention running out of its intended efficiency range.

That the Eaton was well past its efficiency range was hammered home with the next two pulley sizes. Dropping down to a 2.2-inch blower pulley resulted in only 6 additional horsepower although the peak boost jumped from 9.3 psi to 10.4 psi. The charge temperature was up to 265°F, though the intercooler dropped this to 205°F. The 1.975 pulley increased the boost pressure to 12.6 psi, though the boost curve was tapering and not increasing with engine speed. This is a sure sign that the supercharger simply can’t keep up with the demands of the motor. The inlet temp was up to a dangerous 303°F, but the power was only up by 4 hp to 318. The intercooler pulled a hair over 70°F, dropping the charge temperature to a still-high 233°F. The blower speed was up to a whopping 19,746 rpm, a far cry from the 12,500 max recommended by Eaton. The Eaton M90 managed to produce 318 hp and could only supply 11.8 psi at 6000 rpm. Obviously we had reached the limit of the M90 and it was time to bolt on the Autorotor.

Using the fabricated mounting plate, the 3150 Autorotor was installed in place of the M90. The stock throttle body, mass air meter and inlet tube were installed on Autorotor along with the 2.75-inch blower pulley. The necessary data-logging probes and thermocouples were installed on the new blower and we were ready for the first test.

Apparently the tests run by Autorotor were pretty accurate, as the 3150 motored off into the sunset compared to the Eaton M90. Using the same 2.75 pulley, the Autorotor produced a peak of 10 psi and 331 hp. The 1.5-liter Autorotor 3150 outperformed the 1.5-liter Eaton M90 by 57 horsepower with the same blower pulley.

Just as significant was the fact that the inlet air pressure was only 5° hotter with 2.3 psi more boost. At the same boost level, the Autorotor was easily 60°F cooler. Imagine that—remove the Eaton M90 and install an Autorotor and gain 57 horsepower.

While the gains posted with the 2.75 pulley were significant, we were just getting started. Adding the smaller 2.40-inch blower pulley upped boost to a peak of 11.9 psi (versus just 9.3 for the Eaton) and power all the way to 347 hp. The charge temperature was now up to 201°F entering the intercooler and just 148° exiting the core. This 201°F (pre-intercooled) charge...
temperature compared nicely with the 235° temperature posted by the Eaton (again at a much lower boost pressure). Installing the 2.20-inch pulley increased the peak power up to 357 hp at 13.7 psi. The charge temperature was up to 226° before being chilled down to 157° by the intercooler. The Autorotor was still out-boosting and out-powering the Eaton with 40° less charge temperature.

The final test with the Autorotor was run with the 1.975 pulley. Where the Eaton M90 produced 318 hp, the Autorotor thumped out an impressive 388 hp at 15.7 psi. As before, the boost pressure continued to rise with engine speed, indicating that the 3150 had even more to offer. Even at the elevated boost pressure, the Autorotor produced significantly lower charge temperatures than the Eaton. The inlet temperature was only 260° at 15.7 psi, a damn site better than the 303° temps registered by the Eaton at only 11.8 psi.

I think it is safe to say that these tests prove without a shadow of a doubt that the Autorotor 3150 offers significantly more performance than the Eaton M90. Still think that all positive displacement super-chargers are the same?

Since we were so close to 400 hp at the wheels, we wondered what it might take to reach the magic number. We also wondered if the 3150 had the beans to produce 400 hp at the wheels on the automatic-equipped 4.6 GT motor. Though we knew more boost was available from the Autorotor, we noticed during testing that the vacuum readings registered before the blower were getting significant (more than 4 inches). This represented a sizable airflow restriction, so we modified the inlet to improve the airflow by installing a larger throttle body and mass air meter.

Since an adapter plate was necessary to mount the stock (round) throttle body to the oval opening on the blower inlet, we simply removed the adapter plate and installed an oval Cobra throttle body. We also took the liberty of installing a 90mm mass air meter (and new chip) to compensate for the new meter. The airflow changes increased the peak power to 419 hp. Interestingly enough, the boost pressure jumped up to over 18 psi with the changes in airflow. It should be noted that these same changes made no power when tested on the Eaton.

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