AIR TEMPERATURE TESTING

At the end of the day, what really matters is HOW DOES MY SUPERCHARGER KIT PERFORM WHEN I’M IN BOOST? DOES IT DELIVER THE ADVERTISED HP AND PERFORMANCE? Occasionally, temperature or other test data by an individual may be misleading.

For example: There has been considerable discussions regarding air and water temperatures of supercharger kits. Comparisons are okay if they are accurate. If not, they are just more misinformation circulating on the web.

And, it is not our intent to compare the design and efficiency of any kit or the individual mechanical components that influence air discharge temp. These are the supercharger, inlet tract, intercooler, heat exchanger, pump etc. Optimizing these parts lower the air discharge temps. resulting in greater HP and reduced detonation potential. “Hot air” under-hood inlets increase temps and hurt performance by 30-55HP while adding an external real cool air kit does the opposite. One would have to be living in a village to not be aware of these basics- cooler air MAKES MORE HP.

Instead, we hope to point out the testing procedure and criteria we use at Kenne Bell to accurately compare the charge and coolant temps when dyno testing. Disregard any of the following 12 parameters and accuracy is compromised resulting in bogus comparison data. As you will see, it’s easy to skew the data with even the same car, kit, day, ambient and boost.

If any meaningful or accurate data is to be derived from comparing the air discharge temps of supercharger kits on a vehicle, it must be a controlled test with specific test parameters that ELIMINATE THE VARIABLES.

All the below will, and do, affect temperature when tested on a chassis dyno. One “kit” may wrongly appear superior or inferior on the same vehicle because of the simple temp or boost reading error or failure to note a cool air kit upgrade or open vs closed hood change to one kit and not the other.

Also, dyno testing with an open hood vs a vehicle at road speed are two different temp scenarios.

VARIABLES THAT AFFECT COMPARISON TESTING
1) UNDER-HOOD TEMP (HOOD UP VS DOWN)
2) AMBIENT TEMP.
3) ACTUAL BOOST (1 PSI OF BOOST= 10*-15* SC air discharge temps.)
4) RPM, LENGTH OF RUN + GEAR RATIO
5) STARTING AIR TEMP
6) STARTING INTERCOOLER FLUID TEMP.
7) WATER VS. COOLANT RATIO
8) SUPERCHARGER TEMP.
9) INLET RESTRICTION
10) IDLE-RUN-AFTER RUN
11) WHERE THE ACTUAL CHARGE TEMP MEASUREMENT IS TAKEN
12) IMPROPER CIRCULATION (AIR TO WATER)
13) HEAT EXCHANGERS, INTERCOOLERS & PUMPS
1a) FILTER TEMP- The ONLY measurement to use for “engine in” air temp. calculations. Other temp. readings under, above or around the dyno or car are wrong. The engine draws air from the filter. Nowhere else matters. Keep in mind this temp. alters HP at 1% per 10* of variation. Also, cooler ambient air makes more boost.

1b) UNDER-HOOD TEMPS (HOOD UP VS DOWN)- Why do dyno operators insist on testing with the hood “up?” That isn’t the way the cars are driven. CLOSE THE HOOD- unless you want false air data. Under-hood temps. reach 200* vs 70* or ambient outside air. If the filter (inlet source) is located under the hood, then the dyno run should be conducted the same way. Why is that so difficult to grasp for so many? What are they afraid of? Yes, the hot under-hood air will reduce HP, increase the detonation threshold, lower boost, alter supercharger efficiency and elevate engine and exhaust temps. Not good, but it is what it is - hotter air.

It’s why everyone uses scoops and not mini sized grill cracks to supply the 750-1500 cu.ft. of cool air flow required by the engine. And why the Camaro utilizes an air scoop in the grill. They are looking for cool outside air for their filter box. Close the hood with an “open” under-hood filter and watch your kits power drop 55HP! See “Kenne Bell 30HP Advantage” for comparisons.

Fact: Very little cool air finds it’s way through those little 50 CFM grill openings. Yes, some outside air mixes with all that hot air from the radiator, engine, headers etc. but it is all ingested via the filter into your engine.

Finally, under-hood shrouds and seals do virtually nothing. Once eliminated, this common but huge test misstep (we’ve seen up to 55 HP and 100* with hood “up” vs. “down”) the rest is common sense testing and the air and water data will support meaningful accurate results. All Kenne Bell kits mount the filter outside the engine bay where temps are cooler and consistent at any vehicle position or speed. The dyno fan will simulate vehicle high speed and under-hood air flow.

So, no exceptions. Locate the ambient temp sensor at the filter whether it be under-hood (hood down) or behind the front bumper. Begin test at the same temp or data is junk.

2) AMBIENT TEMP- Cool outside the engine bay air is what also cools the fluid in the heat exchanger. Cooler air= cooler water= cooler supercharger air into the intercooler= cooler air charge to engine= more boost= higher HP. So, ambient air temp should be the same as it influences all the other components. 20* higher ambient raises intercooler air and water temps. It does matter.

3) ACTUAL BOOST- Boost makes HP, but it produces heat. There’s no free ride. Twin Screw positive displacement, and centrifugal superchargers generate approximately 10* of charge temp per PSI. Starting run design temps are approx. 10* per PSI + Inlet temp. Example: 90* ambient + 90* (9 PSI) = min air charge temp 180* before intercooler. Roots style are higher. Be sure “actual” boost is the same. Don’t just assume all 9 PSI kits develop exactly the same boost. The intercooler system (air to water or air to air) is typically 50-75% efficient depending on numerous kit design variables. To accurately compare kits, boost cannot vary.

4) RPM, LENGTH OF RUN & GEAR RATIO- The higher the RPM, read end or trans. gears the longer the dyno run and the greater the final temp. Everything heats up with time until there is stabilization. Use the same vehicle to insure accuracy.

5) STARTING INTERCOOLER WATER TEMP- If the intercooler water (it cools the air) is 20* hotter at the “start” of the run, the “finish” will be hotter. Start temps must be identical for accurate comparisons. Intercooler “start” water and air temps can vary from ambient 70* to 200*
depending on idle time. Now, at what temp do you “start” the run? Get the picture?

6) STARTING INLET AIR TEMP- Same here. Obviously, a hotter filter at the beginning of a run results in higher supercharger discharge temps. A 30-50* variance is common. Start test at same filter air temp. or the tests are useless. NOTE: Under-hood filters are difficult to test because engine bay temps increase (heat soak) with time when idling from ambient to 200*.

Open the hood and let cooler dyno room external air blow in and the test are skewed.

7) WATER VS. COOLANT- Since no liquid cools better than water, 100% water is best. 50/50 is not as efficient in cooling. 90/10 is better. Try placing ice cubes in a pot of coolant. Ice 32* and coolant 50* between the ice cubes. Engine coolant “resists” lower temperatures and freezing. Run the same mix when testing if your goal is an accurate comparison.

8) SUPERCHARGER TEMP (HEAT SOAKING)- Obviously, heat soaked components can heat the air passing through them. For example: We use a thermal laser gun to quickly measure supercharger case temp. If the supercharger is covered (never on our design priority list) with a manifold, intercooler or plastic engine cover, it obviously runs hotter. Then there’s the heat transfer from the engine. However, for test comparisons, the temps. of the supercharger and other metal or plastic pieces in a particular kit “are what they are.” Also consider the type of supercharger and the pressure ratio. Centrifugals run cooler at idle because they are not compressing air (boost) like the positive displacement superchargers. No heat of compression- no boost. Less boost at low and mid range- less heat. Boost IS heat. The twin screw can run higher pressure ratios of 2.1 (15 psi) vs 1.4 (6 psi) so, of course the “idle” temps are higher. Again, you look at the higher efficiency and boost of a 15-30 psi Twin Screw and the benefits. Higher IAT’s are unavoidable.

9) INLET RESTRICTION- NEVER compare 2 kits with inlet tracts ( filter, meter, tubing, throttle body etc.) that vary in restriction/efficiency. If one inlet is larger and enjoys less restriction to air flow to the supercharger, then the supercharger is not required to work as hard. Like sucking coke through a straw vs. a straw half pinched off. The upside of a larger inlet tract is the supercharger uses less HP to suck in the air and subsequently runs cooler AND develops more boost. Supercharging efficiency, boost and inlet temps will all be better but DIFFERENT.

10) IDLE/RUN-AFTER RUN- Idle temp. will be highest before a run. Let it cool to the test temp. and make the run in the same gear, car, boost, trans. and RPM. Check the data at the same peak RPM as everything heats up after getting off the throttle.

11) WHERE THE ACTUAL CHARGE TEMP MEASUREMENTS IS TAKEN- This is probably the most important part of the measurement process. Equally important is the sensor being used is properly calibrated. Different air temp sensors can be calibrated differently and if the person testing is not aware of this, all data will be useless. Transfer functions are different for some push in type sensors vs screw in type and vs shielded/unshielded sensors. The most accurate and fastest response air temperature sensors are the unshielded type. Never compare shielded sensors against unshielded.

Given that the a) sensor types are the same (unshielded) and b) the transfer functions are correct, then c) placement of the sensor is critical. Let’s make sure we are not using a sensor that is located upstream of the supercharger on one system and then downstream on the other. Believe it or not this mistake has been made before. Whenever temperature readings are only a few degrees above ambient under boost, always suspect the sensor is either a) located upstream (before) the supercharger as is the case in many applications if a new sensor has not been relocated from the factory location to the discharge
side of the intercooler, or b) sensor is incorrectly calibrated or c) sensor is of the shielded type. Ever wonder why there are sensor “relocation kits?” was it the wrong location? Big problem when the Camaro and other Ford kits were introduced.

12) IMPROPER CIRCULATION (AIR TO WATER)- Always compare systems that have proper water circulation. A common error when seeing high discharge air temps is not to insure there is adequate flow in the system. In any new installation it is very easy to have air pockets that hinder/stop circulation of the liquid (cooling media). Even the best designed system can produce high charge temperatures if proper purging of the intercooler system has not been performed. Blockage of airflow to the heat exchanger from debris, bumper cover, etc. can also have a drastic effect. There has to be sufficient airflow across the heat exchanger to drop the charge temperature.

13) HEAT EXCHANGERS, INTERCOOLERS & PUMPS- At Kenne Bell we test numerous configurations and sizes, including our competitions heat exchangers, intercoolers and pumps.

HEAT EXCHANGERS
We double or stack heat exchangers and check various frontal locations for air flow velocity (in and out), cooling and heat soaking.
Example: A larger surface area HE mounted in front of a radiator may seem like a great idea but it has distinct shortcomings.

1) RESTRICTION- Who can deny that it is a big restriction to the radiators air flow and ENGINE COOLING. The engine WILL run HOTTER!
2) TEMP- Do you really believe 70* ambient blowing through a 130* of HE water will cool a radiator better than the 70* air? Oops!

INTERCOOLERS
Thinner intercoolers flow more air and enjoy less boost loss because the core is less resistant to laminar air flow. Thicker cores flow less air, kill more boost but do a better job of cooling. HOWEVER, THE LOWER BOOST WILL REDUCE HP by 15-20 HP/ psi loss. Yes, the supercharger boost and speed can be increased.

PUMPS
Unfortunately, the supercharger will now consume more engine HP to blow the additional through the thicker more restrictive core. Excess water flow/ speed through the HE doesn’t allow sufficient time for the water to remain in the core and cool. Insufficient flow/speed keeps the water in the HE too long resulting in excess heating.

CONCLUSION
When we develop this package, temps and flow (air and water) are measured both “in” and “out” of the HE, IC, radiator and pumps in addition to the all important filter temp.

That’s how Kenne Bell develops and tests product. Again, it’s all about the overall design at WOT and the HP the supercharger kit produces in boost. No one can deny they make plenty of HP with room to grow.

What we often think is the same is the same but it’s different.
If analyzing supercharger kits by the same or competing manufacturers, it is important to refer to the above 13 test variables and make the necessary adjustments to guarantee boost temperatures, run length, inlet, restriction, temps measurement location is identical- and the hood is CLOSED, like you drive the car.

There’s a saying on the Kenne Bell dyno that an OEM engineer left us- “One of the real dangers in running a test is you are bound to get data”.

We hope the information is helpful.