The Folly of Comparing Flow Numbers and Dyno Tests

- Home - About 10 Litre
- CNC Prototype Machining
- Automotive and Marine
- Harley Davidson
- Harley Notes
- Shipping and Policies
- Contact Informantion
- Cylinder Head Mods
- Flow Numbers & Dynos
- Dealer Network

THE FOLLY OF COMPARING FLOW NUMBERS AND DYNO TESTS

Excerpt from Engine Builder Magazine Article "How to Get the Most out of a Dyno" by Ken Weber

There are a number of myths attached to the science of engine testing. One is that a Flow Bench or a Dyno will tell you what you need to do to make more power, and/or will provide you with the skill to make informed changes. Only experience and study will do that. And even then, cut test, and repeat is the only road to improvement. Dynos and flow benches are the single biggest investments you can make in confusion, and they have a nasty habit of showing your best theories to be terribly wrong.

Comparing flow numbers on heads from two different sources can be deceptive. In order to make a meaningful comparison between the flow tests for two different cylinder heads, you must know the conditions of each test. ***It's very important to know what test pressure was used and that it is the same for both tests.*** If a radiused inlet guide is used on the intake port, small differences in its shape will have a pronounced effect on the flow numbers. If one head was tested with a radius, and the other had an intake manifold, comparing the two tests is meaningless. The accuracy of the mechanism used to open the valve will affect the flow numbers too. On the exhaust side, whether or not a pipe was installed on the head can make a large difference in the flow. Changing the size and shape of the pipe will also change the flow.

THE BASICS OF HORSEPOWER AND DYNO TESTING

One of the more common misconceptions about a dynamometer is that it measures horsepower. WRONG - it only measures TORQUE and RPM…horsepower must be calculated. In its simplest form, an engine dyno would only have a torque arm, a scale to measure the load exerted by the arm, and a tachometer to measure rpm.

Think of Horsepower in terms of cranking a bucket of water up a well. Torque is the effort needed to turn the crank handle. If you pull on the crank, but don't move the bucket, you have generated torque, but no work and no horsepower. Horsepower is the result of lifting the weight of the bucket (***Force or Torque***) to the top of the well (***Distance***), and the ***Time*** it takes to do it.

If you raise the same weight bucket the same distance but do it in half the time (same torque, twice the rpm), you have generated twice the horsepower. If you double the weight of the bucket, but take the same time to get it to the top (twice the torque, same rpm), you have also generated twice the horsepower. Torque ***AND*** rpm are necessary to develop horsepower.

CORRECTION FACTORS AND SAE STANDARDS

When we test an engine, environmental differences have a significant impact on the actual power that the engine develops. On a daily basis, the barometric pressure, temperature, and relative humidity all change, and when they change, they have an effect on the power that an engine develops. Those of you that live at higher elevations or have taken trips into the Rockies, have experienced the loss of power that your bike, car or truck experiences at these altitudes. In Denver, an engine typically makes about 75% to 78% of the power that it would make on a similar day in Miami. So when we test an engine up here, how do we know if it's competitive, and how to we relate a test done last week to one done today under different weather conditions? Well, we could take it to Miami and test it, or we could wait until the conditions are the same as they were during the last test, or, we could just apply a correction factor to all of the test results, giving another set of numbers that, in theory would be what that test would show if it were done under a standard set of conditions.

The SAE (Society of Automotive Engineers) has standards that are used by automobile manufactures to rate their engines. Although these standards change from time to time, it serves to give some credibility to the advertised horsepower you see in those television commercials all the time. In the after-market, most horsepower and torque numbers are corrected to conditions of 29.92 inches of mercury barometric pressure, 60 degrees temperature, and dry air. In theory, a test done at 30.12 inches of mercury, 90 degrees, and 30% relative humidity, can be corrected to standard conditions and compared to one done in another part of world at 23.50 inches of mercury, 75 degrees, and 15% relative humidity. As long as both tests were done with accurately calibrated instruments, and with the same procedures, they should be within a couple of percent of each other.

In reality, if a shop is not concerned about comparisons to what goes on in other parts of the country, they can establish their own standard atmosphere, and use that to generate their correction factor. This is done regularly in NASCAR shops. Eliminating the basis of comparison to the rest of the world would certainly eliminate the emotion and ego factors seen in a lot of dyno results. "You have to be able to handle the truth". **The correction factor is probably the most miss-used and intentionally abused element effecting horsepower figures, because it is so easily slewed to "enhance" the results. Poor or non-existent calibration of the equipment is probably the next biggest source of bad data.**

THE TEST

Atmospheric conditions should be monitored closely: barometer, air temperature, and wet & dry bulb temperatures for vapor pressure (humidity), as they directly relate to the correction factor used.

The engine should be properly broken in and tuned to optimize the combination you are going to record. Then re-tuned for the next combination, and so on. Each test should be done at the same acceleration rate, if that mode is used, because you cannot compare data from tests done at, say, a 300 rpm/second acceleration rate to those done at a 100 rpm/second acceleration rate. On a chassis dyno, tire pressure is critical. Small variations in oil and coolant temperature will also influence power output.

WHY DOESN'T IT MAKE AS MUCH POWER AS…?

The difference in test cells - each installation's ability to control its own environment, the difference in operator technique, and indeed, the difference in brands of dynos, all influence the results of a dyno test.

Chassis dynos are particularly difficult in this area, because there are dynos that use the rollers plus an eddy-current brake, like some models of Superflow and Mustang, and dynos that use only an inertia wheel like Dyno Jet. Add to this the difference in roller diameters and the weight of the rollers, the relative size/weight of the rollers to the size/weight of the vehicle, and the result can be a substantial difference in power readings for the same vehicle. A chassis dyno, with an eddy current controller to load the roller, can achieve the same acceleration rate on each test, or the test can be done fully loaded with no acceleration. This is not possible on a straight inertia dyno. The horsepower figures could be entirely different depending on the method of the test. On an inertia type dyno, you can gain or lose significant horsepower by changing the wheels and tires. This is because every component in the drive-line has inertia including the wheels and tires, and when you change any of them, you change the amount of horsepower required to accelerate the whole mass. Unless you are doing fully loaded testing, there is no easy way to account for the differences.

Once you consider the mechanical differences of each brand of dyno, the configuration of the dyno cell, and even the operator himself, then you have to consider the software packages. How many samples/ second the software generates has an impact on the accuracy of the data it records. More samples, more accuracy.

For these reasons, unless you know all of the conditions that an engine was tested under, comparing figures for one engine at one location, to a different engine tested at a different location must be done with a degree of skepticism. It's also one reason it's not uncommon for a given engine to wax the butt of another that supposedly makes substantially more power. If comparisons are made on the ***same*** dyno, under carefully controlled conditions, then you have the basis for a good comparison.

In summary, the real value of flow bench and dynamometer testing is to evaluate **changes to engine or chassis components** to determine the best possible combination of those components to satisfy the intended use. It is also used for quality control to verify that an engine or chassis measures up to the desired standard of other engines of known specifications, such as is done in NASCAR shops. It streamlines this process by eliminating variables seen in road or track testing, and by closely controlling the other variables The process of developing a performance package requires many changes, many dyno runs, and a lot of time, effort, and expense, to achieve the goals of the project. The mistake is not doing enough testing, as opposed to too much. All too often, the customer has a shop make one run on his engine, and tries to make a meaningful comparison with some other engine he heard about. He is trying to race dynos, without understanding that not everyone is playing the game by the same rules.

Enter content here
Enter content here
Enter content here

10 Litre Performance 11915 E 119th Place Northglenn, CO 80233 303 280 9950