So which Rolling Roads Dynamometer is the best?

The fact is that we have the opportunity to choose which type Rolling Roads Dynamometer we go to in order to tune. Most often this decision is largely a function of who is tuning the vehicle. None the less there is an option: (1) Inertial Rolling Road or (2) Eddy Current Rolling Road.
When people start talking about which is better and which is more accurate there inevitably ends up being a very simple set of unfounded statements that are made, either way.

So let's keep this really simple, stick to planet Earth's physical laws and look at both.
First though we need to look at a very simple rules.

- To measure the energy output from anything you have to expend it.
- To measure the total energy potential you have to expend exactly equal to what is generated.
- The coefficient of friction changes slightly dependent on the rate and magnitude of change in velocity, and change in temperature, but this is getting too complicated so let's just say **Crr** (Coefficient of rolling resistance) remains constant for a wheel.
- Friction = Force x Coefficient of Friction (Cf)
- For a rolling wheel: Friction = $\frac{\text{Force x Cf}}{\text{Radius}}$
- Power is work done (energy expended). Torque is the force applied to rotate or twist an object about an axis. How quickly we can rotate this object, in time, is proportional to the amount of energy being expended……or the power being generated.
- Horse Power = $\frac{\text{Rpm x Torque}}{5252}$
- The constant of 5252 is very old and goes back to the days when the horse did the work. Derived from how quickly the horse could move a specific weight a specific distance in a specific time…….hence the unit of one Horse Power.
- As TORQUE increases the FORCE applied also increases, hence the LOSSES due to friction INCREASE.
- The SMALLER the wheel the more TORQUE is generated at the contact patch.
- The MORE TORQUE that is generated means the MORE deformation we get on the contact patch and consequently the more friction loss we get.
- The FUNDAMENTAL PRINCIPLE OF ANY ROLLING ROADS DYNAMOMETER is based expressly on the Horse Power formula. The Dynamometer manufacturer knows with very reasonable accuracy over a wide range of speeds, loads and other variables within the dyno what CORRECTIONS need to be applied to the simplistic Horse Power Formula…….at the WHEEL.

So very simply:
More Torque = More Power at the same speed; More Torque means more load = more friction.
Bigger Wheels = less torque at the contact patch, Smaller Wheels = more torque at the contact patch.
All else being equal; The RATE of ACCELERATION with a given LOAD is proportional to the Power Expended.
The more wheels under power (4WD) the more power that is lost.
The more power you make, the more you loose in order to measure it on the chassis dyno.

Read that again so it sinks in. Remember this is a simplification and is subject to various other factors and a lot more math.

Now that this makes some sense: **It is impossible to calculate the power applied by the crankshaft simply by measuring the power consumed at the wheel.** The best that can be done here is to use statistically derived "corrections" which range anywhere from 10% to +25% in some cases.

Inertial Dynamometer:

Again, keeping it simple, Mass multiplied by acceleration is equal to force.
The Mass is the Roller, which has an inertia that has to be overcome, and has to be accelerated in order measure change in velocity. So once the rate of acceleration is measured and the mass is known so the inertial forces are calculated. The Mass is accelerated due to the Torque applied, and the rate at which that Torque is applied is proportional to the amount of POWER that was expended into the Roller. The energy is transferred to the Roller as Momentum which is dissipated on over-run.
Measuring the rate of loss of momentum due to reduction of velocity or the Roller ignores the friction losses, heat rejection and a host of other sources of lost energy that were present only when the Roller was being accelerated.
Again: It is impossible to calculate the power applied by the crankshaft simply by measuring the power consumed at the wheel and applying some hair brained coast down correction.

Eddy Current Dynamometer:

The fact is that the wheel still turns a Roller and this Roller has its own inertia. So effectively the Eddy Current Dyno is a combination Inertial and Eddy Current system. Because the system is not relying on the mass of the Roller to expend all the input energy the Roller is smaller in diameter and weighs less. However the mass and all it's kinetics factor into the final calculation of power, just as in the purely Inertial Dyno.
All the Eddy Current system does is behave like a BRAKE that has a very high level of control without inducing velocity / load / friction variables. This is electrical theory, but simply, the Eddy Current Brake opposes the electrical energy generated internally as a result of being coupled directly to the Roller. The applied energy is consumed by opposing the generated forces with electrical energy from an external source. The opposing forces over time are measured in electrical units transformed to units of torque and displayed as required; torque or power or both. Because the system utilizes electrical energy to oppose the Roller, the total system dissipates a significant amount of heat.

So let's try to answer the question of which is best or more accurate.

We need to define best and accurate……
Let's describe best as being applicable to a wider variety of applications.
Let's describe accurate as being repeatable with very low average deviation from the mean.

Best:
The Inertial Dyno is an ignorant piece of steel that has a sophisticated set of sensors and electronics coupled to a computer that does all the calculation. Its power measuring potential is directly proportional to the Mass of the Roller. Because the significant mass has significant momentum, the ability to control the rate of acceleration of the mass becomes very difficult and using mechanical braking systems to control the acceleration rate (so we can hold load long enough to derive accurate measurements in the steady state) compounds this difficulty. Added to this the heat rejected at the brake is a function of the load applied and the load opposing, so the operating system needs to be extremely accurate and the braking materials need to have quite unique characteristics in order to maintain consistency. That said the systems are up to task if the Operator is up to task. Because the braking system is a purely mechanical system that rejects energy in heat the ability to hold stable load and allow the Roller to "ramp up" is poor.

- If you are trying to hold load at a specific rpm and manifold pressure or throttle position site then you need an Eddy Current Dyno in order to be consistent.
- If you just want to stamp on the throttle and see the peak power expended, then once within the capability of the Inertial Dyno's Roller Mass and the Eddy Current potential……..either one!
- If you want to see the Total Power Potential with a vehicle that produces close to the dyno's rated capacity then the Eddy Current is the choice as you can effectively "stall" the system.

- If the engine is turbo charged and suffers from lag (giant turbo or big rear ends) then Eddy Current, as you can hold load and allow the turbo charger to "catch up".
- If the car has poor traction then use the Inertial Dyno. Bigger Roller, bigger contact patch more grip.

Accurate:
This one is fairly straight forward, but also very misconceived.
Like we said a big ignorant piece of steel or a small fundamental piece of electrical theory?
You choose, because all else being equal they will both produce damned near the same numbers each time they are tested.
Remember that as temperatures go up in the Transmission and the Engine oils the Cf drops and consequently the resultant power goes up. Repeatability requires all the variables to be held constant regardless of Dyno type.
Will the both types show the same numbers, well it is quite apparently not so. They are deriving their "numbers" from two completely different methods of power consumption. Agreed the unit of measure is the same, so which is the CORRECT one?
Unfortunately no one is going to be able to answer that question unless the following is done:

1. Dynamometer test the Engine alone.
2. Dynamometer test the Transmission and Drive Train alone for power losses.
3. Minus # 2 from # 1.
4. **See which type Dynamometer derives the closest to # 3**.

**The test conditions need to be IDENTICAL with no correction factors applied, post run, in the software.

So taking the definitions for "Best" and "Accurate".

BEST = wider variety of applications = **Eddy Current Brake**.

Accurate = repeatable with low error = **Any one of them.**

Finally: where the problems mostly lie?

- **You are measuring power and torque at the wheel via the drive train. The variables between the crank shaft and the contact patch on the tire make comparison extremely subjective.**
- **Application of SAE Correction Factors on Forced Induction Engines in absolute non sense** (explained in another article).
- **Cheating the calculation when using SAE Correction Factors on Forced Induction Engines by placing the inlet air temperature probe in hot spots** (the right place according to some Operators).
- **The Dynamometer Operator not being fully conversant with the Dynamometer Manufacturer's run-type options and control functions.**
- **Trying to convince the vehicle owner or yourself that power can be accurately back-calculated to the crank shaft.**
- **Forget the number, if traction is not the issue, the vehicle with more POWER usually wins.**
- **The Chassis Dynamometer is a practical TUNING AID and nothing more.**

Hope this was helpful. CARVtech PC does not imply or make any recommendation or suggestion outside the grounds of what we believe to be a sound discussion with practical experience. In stating these opinions we do not advocate which type Dynamometer you use; that decision is all up to you.

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