Correction Factors

The calculation of horsepower or the accuracy of our dynamometer is not dependent on the location or conditions during the measurement. The performance of the internal combustion engine is, however, sensitive to atmospheric conditions, especially air density and air temperature. To compare power measurements taken at different times or places, it is necessary to compensate for differing atmospheric conditions.

Correction Factors are used to compensate engine horsepower measurements for differences in operating conditions during engine testing. The typical correction factor (CF) is calculated based on the absolute barometric pressure, air temperature and water content of the air used for combustion by the engine under test. It attempts to predict the horsepower that would be developed if the engine were tested at sea level under standard pressure and temperature conditions.

Absolute barometric pressure is a measure of how hard the air molecules are being pushed closer to one another. The unit of measurement is typically inches of mercury (inches Hg). The more pressure, the more molecules there are in a liter of air and the more air the engine gobbles up during the intake stroke. Absolute barometric pressure is equal to Relative barometric pressure only at sea level. Relative barometric pressure is reported at airports and by weather barometers.

air and less air is swallowed during the intake stroke.

Dynojet's WinPEP (Performance Evaluation Program for Windows 95) software uses the SAE's latest correction formula (June 1990). This formula assumes a mechanical efficiency of 85% and is much more accurate than earlier formulas at extreme conditions. The formula used is:

$$CF= 1.18 \times (29.22/Bdo) \times (\sqrt{To+460} / 537) - 0.18$$

Where:

To = *Intake air temperature in degrees F*

Bdo = *Dry ambient absolute barometric pressure*

Hardware and Software

The dynamometer electronics acquire data necessary for power, torque, and correction factor calculations. This includes air temperature, absolute barometric pressure, drum timing, and engine rpm.

During a run, the data is stored in the dyno electronics memory.

After a dyno run is finished, data from the PC card, calibration data and user notes are saved to a file on the computer's hard disk. Each run file is saved in a directory structure composed of "Make", "Model" and "Name" which organizes the data for quick and easy retrieval. When the user selects a run, the data is loaded from the hard disk into computer memory. Data

A good approximation for converting relative barometric pressure to absolute barometric pressure is:

$$AbsHg = RelHg - (Elev/1000)$$

Where:

AbsHg	=	*Absolute barometric pressure*
RelHg	=	*Relative barometric pressure*
Elev	=	*test location elevation in feet above sea level*

Water content is calculated from the ambient wet and dry bulb temperatures. Dry bulb temperature is normal room temperature. Wet bulb temperature is always less than or equal to dry bulb temperature. As air is blown over the wet bulb thermometer the water evaporates and cools the thermometer. The dryer the air, the cooler the wet thermometer indicates. If the ambient air is saturated (humidity = 100%), very little water evaporates and the wet bulb temperature is equal to the dry bulb temperature. These measurements are then converted to partial pressure in inches of mercury and used in the correction formula. Water vapor displaces oxygen and reduces the amount of combustion air ingested during the intake stroke.

Air temperature is the temperature of the air entering the intake system of the engine under test. In some cases this is ambient air temperature, but in other cases the intake air is significantly heated by the engine and is different than ambient air. Heat tends to spread air molecules apart. So as temperature increases, there are less molecules in a liter of

Acceleration is simply the difference in velocity at the surface of the drum from one revolution to the next. The force applied to the drum is calculated from acceleration using Newton's 2nd law, (F)orce = (M)ass x (A)cceleration.

Power is coupled to the drum by friction developed between the driving tire of the vehicle and the knurled steel surface on the drum of the dynamometer.

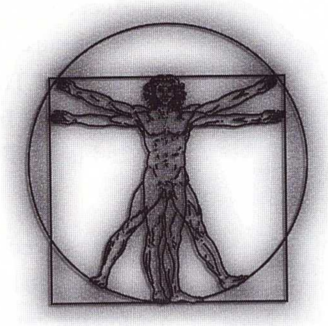
Torque

When an object rotates around a point, its speed of rotation depends on both an applied force and the moment arm. The moment arm is the distance from the point of rotation to where the force is being applied. Torque is the product of the force and the moment arm. For example, if a rope, wrapped around a drum of 1 foot radius, is pulled with 550 pounds of force, the resulting force is 550 foot-pounds.

The Torque on the dyno's drum can be calculated by multiplying the force applied by the drum's radius. However, engine torque is not equal to drum torque because the gearing through the drive train changes the moment arm. The change in the moment arm is proportional to the ratio of engine speed to drum speed. Therefore, tachometer readings are necessary to calculate and display engine torque.

Chapter 9

Theory of Operation



Dynojet's inertia dynamometer is a measuring device for recording and displaying power and torque of an engine. Its method of measurement is a direct implementation of the definitions of power and torque. Correction factors assist in the comparison of these measurements under various test condition, making computer hardware and software necessary to obtain, interpret, and display the data.

Power

Power in mechanical terms is the ability to accomplish a specified amount of work in a given amount of time. By definition, one horsepower is equal to applying a 550 pound force through a distance of 1 foot in one second. In real terms, it would take 1 HP to raise a 550 pound weight up 1 foot in 1 second. So to measure horsepower, we need to know force (in pounds) and velocity (in feet per second).

Dynojet's inertia dynamometer measures power according to the terms just described. It measures velocity by measuring the time it takes to rotate a heavy steel drum one turn. The dyno measures force at the surface of the drum by indirectly measuring its acceleration.

from up to twelve runs can be placed in memory at once. This information can be used for either viewing horsepower graphs or racing vehicles.

The drum data is used to calculate and display power while viewing graphs. Data can either be viewed as measured ("uncorrected") or as corrected according to standard atmospheric conditions.

The drum data can also be used for determining speed and distance traveled in a simulated race. When not correcting to standard atmospheric conditions, the vehicle speed is equal to the drum speed and distance traveled equivalent to the number of drum revolutions times drum circumference. The relations are no longer equal when correcting to standard conditions. Both speed and distance are then predicted from the corrected acceleration of the drum.

Conclusion

By accelerating a massive drum, measurement of power and torque is straight forward and accurate. The use of correction factors allows comparison of those measurements under various test conditions. The use of modern computers provides an economical yet logical method of obtaining and viewing the information. Dynojet's inertia dynamometer is fast becoming the industry standard because of its accuracy, repeatability and design simplicity.