Measuring Horsepower
on the King Racing Puma Top Fuel Dragbike

***NCTE** is a market leading non contact torque sensor specialist based at Unterhaching, Munich in Germany. www.ncte.com*
***King Racing** are the most successful Championship winning Top Fuel Dragbike Team in Europe and currently manages the Gulf Oil International - Grand Prix Originals operation in FIM European Competition. www.kingracing.com*

Torque measurement in a dragbike

After conducting research into the possibilities for measuring torque and power on a nitromethane powered engine team principal Ian King approached NCTE at the Autosport International Show in Birmingham, England in 2010 and later met with their key personnel at his company Puma Engineering where a project to develop a torque sensor set up for his estimated 1500 HP Top Fuel Dragbike was agreed.

Up until that point it has been practically impossible to measure torque and HP on a Nitro powered machine of this type. Certainly the possibility for onboard measurement was out of the question. The high power outputs and the required load characteristics when using nitromethane as primary fuel were severe barriers to success. Theoretical methods using mathematical formulae had been used, but were widely inaccurate due to the need to factor in indeterminate loss factors such as wind resistance, tyre, clutch and gearbox slippage etc. Varying estimates for a typical supercharged four cylinder Puma Engine type machine were claimed between 1000 and 1500 HP based on these mathematical methods.

Solution with NCTE technology

NCTE technology is primarily based on non contact methods where two spaced sensing elements measure the twist in a magnetized portion of a rotating shaft.

While it is more common to measure on the outside of a (driven) shaft, our desire to measure torque and HP at the rear wheel rather than at the crankshaft meant that measuring from the inside of the output shaft would be the best approach. The gearbox output shaft that holds the front sprocket was chosen for the sensor location. This shaft in turn drives the rear wheel through a steel drive chain and sprocket assembly.

The sensor probe ‚secondary sensor' is approx 10 mm in outer diameter and protrudes some 100 mm into the output shaft. This output shaft ‚primary sensor' receives a magnetizing process and it is the change in this magnetic field due to twist in the shaft which is recorded by the secondary sensor. The secondary sensor signal is converted into a 0-5 Volt signal by the control module for translation.

The choice of material and the heat treatment of the shaft are critical with respect to the characteristics of the recorded curve. As negative torque should be considered in such data measurement any hysteresis characteristics can affect the accuracy of the curve and so certain iron alloys are more suited for the application. Alloys suitable for both gearbox shaft use and torque sensing are readily available although not typically used by manufacturers of gearboxes used in typical Dragbike applications.

After shaft manufacture and heat treatment the entire system is put on a test bench in order to calibrate it.

The use of measuring inside dragbike

With the assistance of Racepak specialist Vincent Pels of Zodiac International we added a Horsepower and Torque channel to our favoured V300 SD data recorder system.

This unit is the most common recorder found on Dragbike machines. In its base configuration, the V300 monitors six parameters (Engine RPM, Driveshaft RPM, Accel G, Lateral G, Battery Volts and a 12-volt event), but it can be expanded to monitor up to 67 channels of data to meet the needs of most users. The V300SD can sample data as quickly as 1000 times per second.

Uploading recorded data to the computer is done via a SD memory card, which provides hours of recording time and the ability to store many runs prior to uploading the data. The V300SD also has multiple methods of displaying monitored data in real time. When linked by serial cable to a PC you can view all recorded functions in either graph format or on 8 virtual gauges while the vehicle is running. Any monitored function can also be displayed in real time on a dash-board, in our case the IQ3 from the same manufacturer. On the right are two screenshots from the Racepak data recorder, both images reflecting the same time span with the cursor line set at 0.25 seconds.

The green line shows the engine rpm. One can see it idling at approx 3000rpm and increasing to 8600rpm within 0.15 sec after the hit of the throttle. The cursor line is set at 0.25 seconds into the run; the blue line shows driveshaft rpm which is directly related to rear wheel speed. Tyre spin is visible at around 0.30 seconds. This particular run was aborted after some 5 seconds.

Since we record both time and torque just a calculation was needed to create a true horsepower graph. In an ideal dragrace run the throttle is kept fully open all the way through the run but due to wind conditions it was not the case in this particular run.

We have recorded more ‚perfect' runs with higher torque and HP peaks but this particular run was chosen to illustrate this article as it is ideal for showing the relationship between throttle powwsition and torque output.

Peak torque was registered at some 0.23 sec in the run and was measured at just over 1075 Nm. Maximum horsepower registered at 0.25 seconds is 1314 HP at the gearbox output shaft so effectively RWHP. Crank measurement would, of course, be higher. For dragrace tuning purposes it is typical to tune for maximum power and take power out at various points of the track where needed, i.e. where the tyre loses traction.

There are many combinations and ways to take power out, but the most controlled way (within the rules) is by retarding ignition, commonly by use of a preset timer based system.

The torque sensor allows us to very accurately observe the effect on the power output of any ignition retard curve we have programmed.

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