DJAM Pump Specialists Technical Knowledge Series

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Horsepower

Where did Horsepower come from? Inventor James Watt first coined the term horsepower in 1780. Accounts vary as to how he came up with it, but the generally accepted version involves trying to develop a method of calculating the amount of work performed by a draft horse operating a pump to remove water from a coal mine. Watt had modified a steam engine to improve its performance and he sought a way to quantify its power by relating it to that of a draft horse. Since horses were the primary power source of that period, the term horsepower was applied to his work. Through observation and measurement, Watt determined the horse's ability to generate a torque (twisting force) about a capstan that operated the mine pump. He calculated that the horse could move 33,000 pounds times 1 foot per 1 minute. He called that 1 horsepower.

One of the most basic formulas in pumping applications is Hydraulic Horsepower. Hydraulic Horsepower can be used in both sizing equipment and estimating operating requirements for a project.

HYDRAULIC HORSEPOWER = Q (usgpm) x P (psi) / 1714 **or**
Q (m3/d) x P (kPa) / 64423

When we get into Brake Horsepower or the power required to drive our pumping system, there are many variants that can make up what you require to include in your HP calculation. Perhaps the simplest is positive displacement water pumps or reciprocating plunger pumps.

BRAKE HORSEPOWER = Q (usgpm) x P (psi) / (1714 x (Eff.)) **or**
Q (m3/d) x P (kPa) / (64423 x (Eff.))

Basically, Brake HP is the same formula as Hydraulic HP, with the adding of Efficiency to the calculation. It is common industry standard when pumping water to use an efficiency factor of 90%. This 90% includes a combination of both volumetric efficiency (typically 95% for water) and mechanical efficiency (95%). The mechanical efficiency can vary depending on what you are using to drive your equipment, for example, an electric motor with a v-belt drive would be the better than a natural gas engine with a gearbox.

Staying with positive displacement pumps, other factors that could affect the HP calculation are high suction pressures, compressible fluids, slip, temperature, viscosity and a factor called the C/D factor. With most pump companies these days having an online sizing program, it is important to realize that most of the on-line calculators only use the most basic information and they usually keep the more technical calculators in their engineering departments.

Once we move over to roto-dynamic pumps (typically centrifugal pumps), when we are doing our HP calculation, it is similar to the Brake HP calculation for positive displacement pumps, but our Eff (efficiency) factor is far more specific to each individual pump than it is with PD pumps. All centrifugal pumps have a range of performance that is called the Best Efficiency Point (BEP), or a point where the pump is operating at peak performance. As a guideline, you do not find many centrifugal pumps with an BEP greater than 80%. With centrifugal pumps, if you are not operating within the best efficiency point, your efficiency can drop to 60% or even lower.

With centrifugal pumps, another difference is that instead of using Pressure for our HP Calculation we use Head and typically we use the differential Head. What differential Head you are pumping against will determine what your flow rate is going to be, which determines your efficiency, which completes your HP calculation. Other factors that can affect your HP calculation is specific gravity and viscosity. Viscosity can have an extraordinary and often negative effect on centrifugal pump performance. An increase in viscosity will dramatically reduce a pump's efficiency in conjunction with marked reductions in head and flow. The net result is an increase in the brake horsepower required for the driver.

As discussed above, most centrifugal pump companies will have basic pump sizing available either on their websites, or on Pump-Flo. Sizing pumps on-line can be tricky trying to find the right pump for your application taking into account efficiency, BEP, future flow and pressure requirements.

Lesson 1 - Horsepower

When we get into further Lessons, we will discuss in more detail how to properly read a centrifugal curve and the basics to sizing a centrifugal pump.

Check out my website for more Pump Technical Information.

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