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HP Ratings / Submersible Pump Industry

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HP Ratings as applied in the Submersible Pump Industry can be misleading at times and lead to misinterpretation when evaluation pumps. Comparing pumps based on HP Rating could lead to an erroneous conclusion.

In this article, I'll explain why this occurs. I'll also go into some detail of what factors to consider when you are to compare different models of submersible pumps.

Understand that a Submersible Pump Manufacturer typically will not buy an assembled motor. The stator and rotor for a pump as well as the bearings and mechanical seals are purchased separately and assembled into the motor housing. Therefore, the pump manufacture is also the motor manufacture. Being the motor manufacturer, some latitude is obtained as to how the HP Rating of the pump is established. Since a motor used with a submersible pump operates in an environment with a narrow temperature range, the manufacturer determines how a submersible motor is utilized. Designing a pump where its motor will work below its load limit (non-overloading) is the goal of the Pump Engineer.

Working under its load limit is the key. You never want your pump to do more work than its motor can handle (or overload). This all relates back to controlling the temperature of the motor. Three factors involved in determining a motor's operational limits are the internal operating temperature of the unit, the Class rating of the motor winding, and the rate of heat dissipation. A good pump design will have a motor that will typically operate at least 50 degrees below its temperature rating at the full run out capacity of its impeller. This is accomplished by using a motor large enough to handle the load. Additionally, the motor housing design must be able to quickly dissipate the heat being generated during operation.

Since the pump manufacturer determines the HP Rating on the nameplate of the pump, other factors need to be considered when evaluating a submersible pump. The pump's nameplate Full Load Amperage (FLA) Rating is very important. The FLA Rating is one of the better indications of the amount of work the pump's driver (motor shaft) can do. The type of impeller must also be taken into consideration. For example, in a given situation a Vortex Impeller might be preferred because of its solid-handling capabilities, but it might also require a greater HP rated pump. Finally, pumps cannot be compared without reviewing their performance curves.

How do Pump Manufacturers establish a pump's HP Rating? Based on my observations, I've found three methods used.

The first method uses the pump performance curve (GPM vs. Head) as a basis for establishing its HP Rating. There is not a direct electrical relationship to this HP Rating. Manufacturers use this method for smaller Residential or Commercial grade pumps. This would include Sump Pumps, Sewage Ejectors and 2 HP Grinder Pumps. If you compare most any pump curve within a specific Sump, Sewage, or Grinder category having the same motor speed (RPM) and solids capacity, you'll see the relationship of the pump performance curve to the HP Rating without regard to the electrical current draw of the pump. These pumps, being used intermittently, do not consume large quantities of electrical power. For that reason, the solid-handling capacity, the pump's reliability and the pumps ability to meet the application's design point is of greatest importance.

The second method is more precise and is utilized by manufacturers who supply pumping systems for Industrial use, primarily in the Water and Wastewater Industry. These customers expect to be provided with products where there is a direct relationship between the electrical ratings and hydraulic performance of the unit. These relationships can be seen with the use of published performance data and mathematical formulas.

Finally, and most important, there is usually a direct correlation between the FLA and HP Rating on the pump's nameplate to the Full Load Current Charts as published by the National Electrical Code. This is critical since these are usually larger pumps of a heavier duty nature, which are operated with more sophisticated electrical control systems. When designing an engineered pumping system, the electrical and instrumentation people expect the pump's HP Rating to be in line with the NEC's Chart. This enables them to properly size the power distribution and control system.

The third method is one you need to be most aware of. There are some reputable manufacturers in the Industry who misrepresent some products in their line. Knowledgeable pump people can readily see these discrepancies. For instance, recently, I saw a curve on a 5 HP Grinder Pump, which could only match with our 7.5 HP Model. Upon further review, I noticed that this 5 HP pump had a higher FLA Rating than our 7.5 HP unit. An engineer might reject the 7.5 HP pump if he did not do a thorough evaluation of the two pumps. Another Manufacturer shows 3" solids handling pump with some impressive flows at higher heads. Few can detect that this pump will not pass a 3" solid, but independent testing proved that to be the case. Still, this pump and its curve remain unchanged in that Manufacturer's catalog. These isolated instances demonstrate why you need to evaluate a pump on factors other than HP, since the criteria used to rate some pumps do not fall within the standard acceptable practices of the Industry.

WHAT DO WE LOOK FOR WHEN EVALUATING A SUBMERSIBLE PUMP?

1. You need to evaluate the full run out of the selected impeller diameter. The Industry Standard for minimum Total Dynamic Head (TDH) is 5 to 10 feet. But sometimes a performance curve for a pump stops at a TDH point greater than 10 feet. If a pump is selected, which has a high minimum Head, you need to make sure that your system has sufficient Head, which will protect it from overloading.

2. The larger heavier duty type pumps usually have curves where both the Performance and HP curve are plotted on the same graph. The performances of varying impeller diameters are shown with a solid line whereas the HP limits are shown with a dashed line. At any point, where the solid impeller curve crosses the dashed HP curve, you'll have an overloaded motor. To be safe, always select a pump where there is a sufficient gap between the impeller's operating point and the HP line. The larger the gap, the cooler your motor will operate and a likely longer service life. Ideally, select the HP where the desired impeller in non-overloading through its full run-out.

3. Motor windings are rated by Classes. Each Class has a temperature rating to which the winding's insulation can be exposed. The higher the temperature rating of the winding the greater protection you'll have against overheating a motor. Additionally, the higher rated winding will provide a longer service life when properly applied. Typical ratings are as follow:

- Class A - 221 Degrees F Class B - 266 Degrees F
- Class F - 311 Degrees F Class H - 356 Degrees F

4. Oil Filled motors will dissipate the heat from the motor much quicker than an Air Filled type. There are some arguments that might favor Air Filled, but these are outweighed by the heat dissipating and lubrication properties of an Oil Filled motor.

5. The weight of a pump can be significant. A heavier pump will have thicker castings, which provide for faster heat dissipation. It may also have a higher rated motor. Some manufactures do no list the weight of their pump in their general technical data, but it is worth inquiring into. If you find two pumps to be equal but one weighs 25% more than the other, the pumps may not be as equal as they might appear.

6. All impellers are not the same. Comparing materials, one manufacture may offer Cast Iron while another uses Ductile Iron. One may be a Single Vane style while another uses a Dual Vane. The standard for one manufacture may be a Semi-Open type while another uses an Enclosed impeller. In an application with a high concentration of solids, you may want to consider using a Vortex type. A discussion on impellers is too broad for this paper, but you should be aware that there are advantages and disadvantages to each design.