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BASIC PRINCIPLES AND PUMP TYPES

ABOUT PUMP CURVES

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The performance of a centrifugal pump is shown by a set of performance curves. The performance curves for a centrifugal pump are shown in **figure 1**. Head, power consumption, efficiency and NPSH are shown as a function of the flow.

Normally, pump curves in data booklets only cover the pump part. Because of this, power consumption, the P2-value, listed in data booklets, only covers power going into the pump (see **figure 1**). The same goes for the efficiency value, which only covers the pump part (η = ηP). In some pump types with integrated motor and perhaps also an integrated frequency converter, e.g., canned motor pumps, the power consumption curve and the η-curve cover both the motor and the pump.

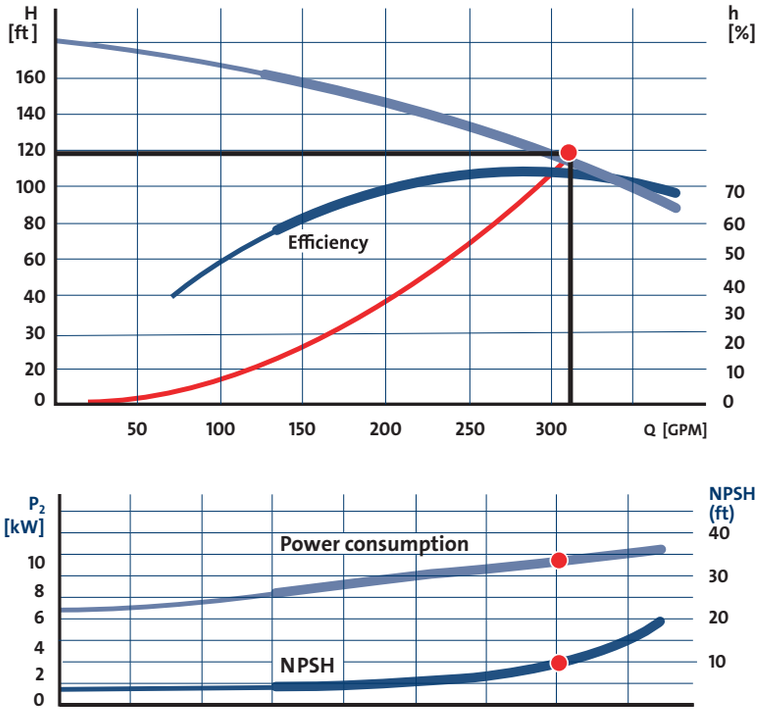

Fig. 1: Typical performance curves for a centrifugal pump. Head, power consumption, efficiency and NPSH are shown as a function of the flow.

In this case it is the P1-value that has to be taken into account. In general, pump curves are designed according to ISO 9906:2012 Grade 3, which specifies the tolerances of the curves:

Q +/- 9%,

H +/-7%,

P +9%

η-7%.

What follows is a **brief presentation of the different pump performance curves.**

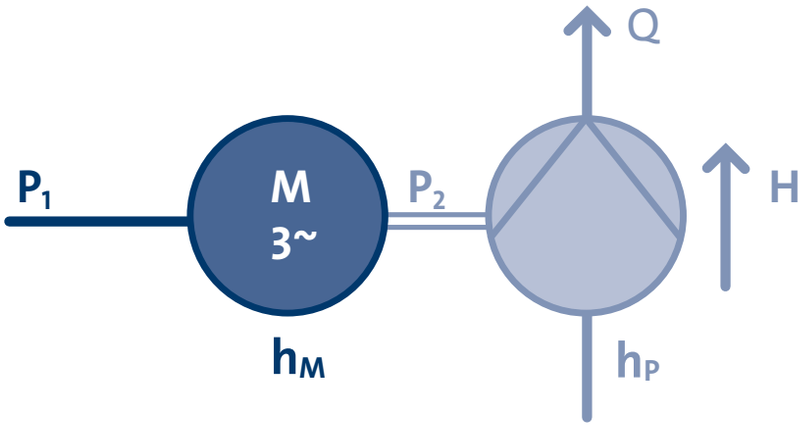

Fig. 2: The curves for power consumption and efficiency will normally only cover the pump part of the unit – i.e., P_2 and ηP

Head, the QH-curve

The QH-curve shows the head the pump is able to perform at a given flow. Head is measured in feet liquid column [ftLC]; normally the unit metre [ft] is applied. The advantage of using the unit [ft] as the unit of measurement for a pump's head is that the QH-curve is not affected by the type of liquid the pump has to handle.

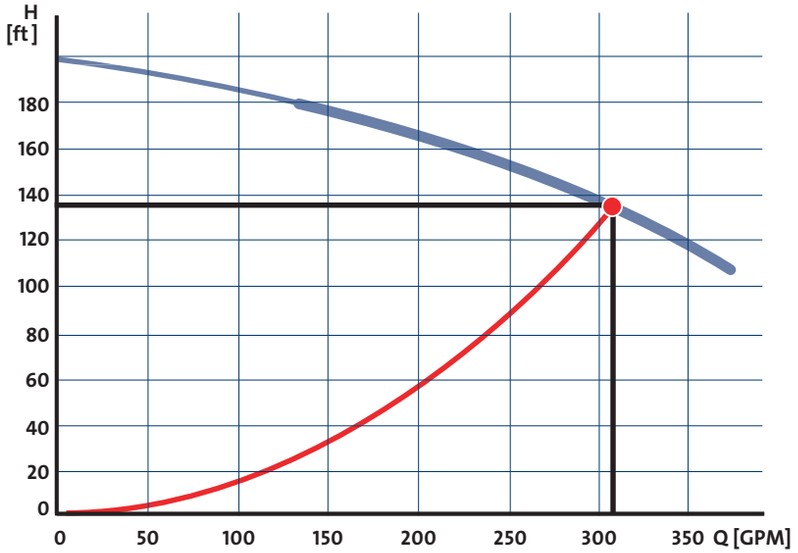

Fig. 3: A typical QH-curve for a centrifugal pump; low flow results in high head and high flow results in low head

Efficiency, the η-curve

Efficiency is the relation between power supplied and the amount of power actually utilised. In the world of pumps, the efficiency ηP is the relation between the power the pump delivers to the water (PH) and the power input to the shaft (P2):

$$\eta_p = \frac{P_H}{P_2} = \frac{SG * 8.33 * Q * H}{P_2}$$

where:

SG is the specific gravity of the liquid and is unitless,

8.33 is the weight of 1 gallon of water in lbs,

Q is the flow in gpm and H is the head in ft.

For water at 68°F and with Q measured in gpm and H in ft, the hydraulic power can be calculated as:

$$P_H = 1 * 8.33 * Q * H \text{ [ft lbf/min]}$$

As it appears from the efficiency curve, efficiency depends on the pump's duty point. This makes it important to select a pump that fits the flow requirements and ensures that the pump is working in the most efficient flow area.

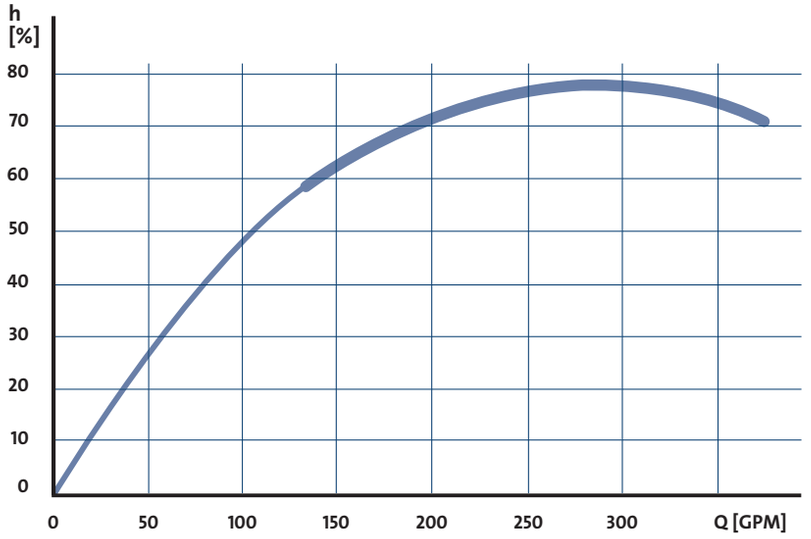

Fig. 4: The efficiency curve of a typical centrifugal pump

Power consumption, the P2-curve

The relation between a pump's power consumption and flow is shown in **figure 5**. The P2-curve of most centrifugal pumps is similar to the one in **figure 5**, where the P2 value increases when flow increases.

$$P_2 = \frac{SG * 8.33 * Q * H}{32980 \times \eta_p}$$

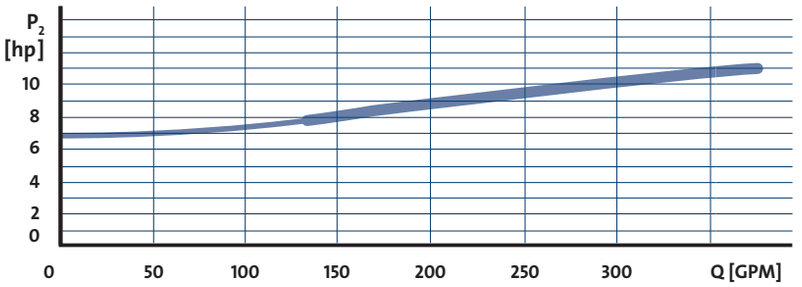

Fig. 5: The power consumption curve of a typical centrifugal pump

NPSH-curve (Net Positive Suction Head)

The NPSH-value of a pump is the minimum absolute pressure that must be present at the suction side of the pump to avoid cavitation. NPSH-values are measured in [ft] and depend on flow; when flow increases, the NPSH-value also increases (**see figure 6**).

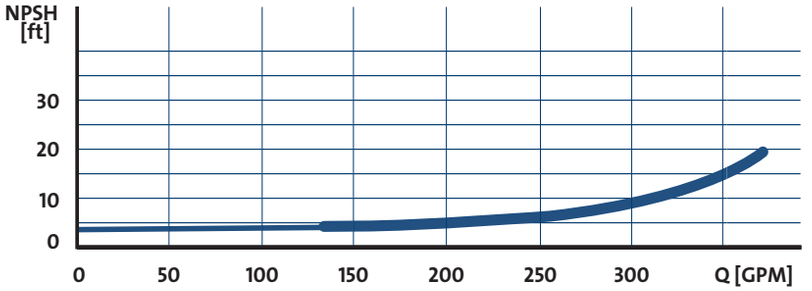

Fig. 6: The NPSH-curve of a typical centrifugal pump

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