About pump curves

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. 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 Annex A, 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.**

Head, the QH-curve

The QH-curve shows the head the pump is able to perform at a given flow. Head is measured in meter liquid column [mLC]; normally the unit metre [m] is applied. The advantage of using the unit [m] 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.

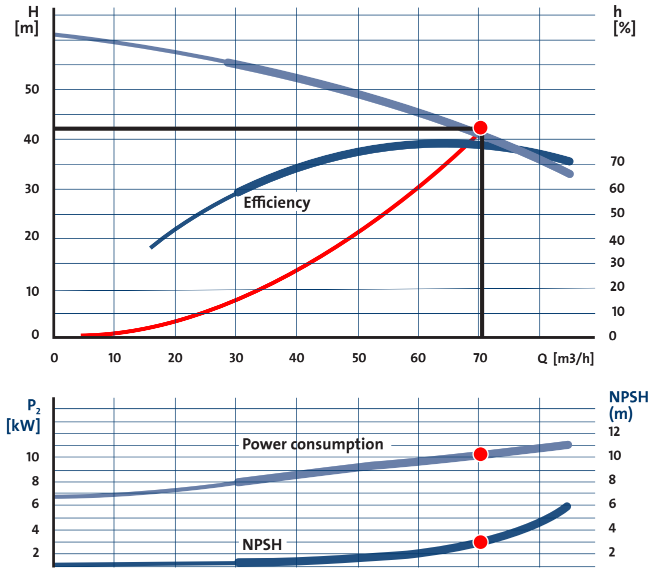

Fig. 1: Typical performance curves for a centrifugal pump. Head, power consumption, efficiency and NPSH are shown as a function of the flow

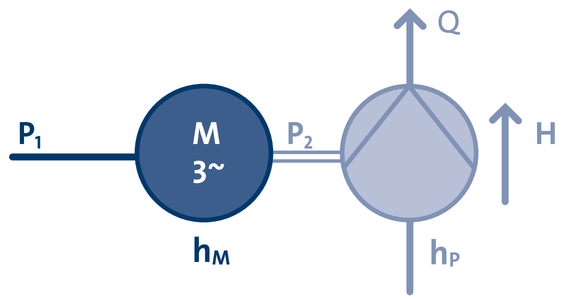

Fig. 2: The curves for power consumption and efficiency will normally only cover the pump part of the unit – i.e., P_2 and ηP

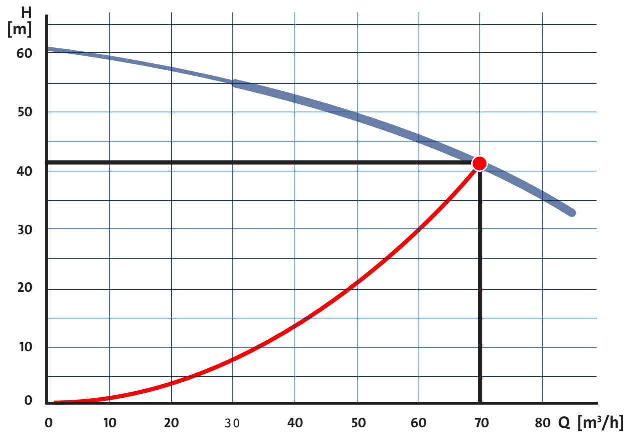

Fig. 3: A typical QH-curve for a centrifugal pump; low flow results in high head and high flow results in low head

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 η^p is the relation between the power the pump delivers to the water (PH) and the power input to the shaft (P_2):

$$\eta_p = \frac{P_H}{P_2} = \frac{\rho \cdot g \cdot Q \cdot H}{P_2 \times 3600}$$

where:

ρ is the density of the liquid in kg/m³,
g is the acceleration of gravity in m/s2,
Q is the flow in m³/h and H is the head in m.

For water at 20°C and with Q measured in m³/h and H in m, the hydraulic power can be calculated as:

$$P_H = 2.72 \cdot Q \cdot H \text{ [W]}$$

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**.**

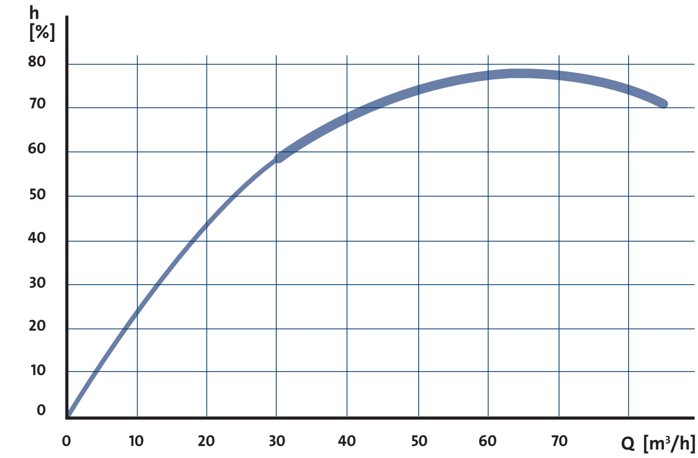

Fig. 4: The efficiency curve of a typical centrifugal pump

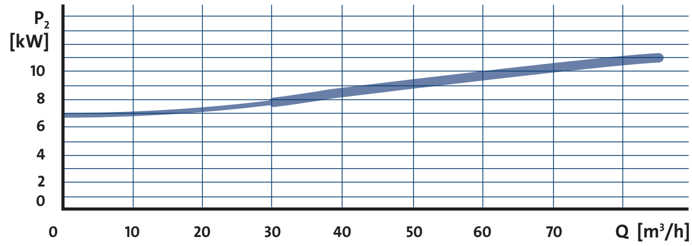

Fig. 5: The power consumption curve of a typical centrifugal pump

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.

$$P_2 = \frac{Q \cdot H \cdot g \cdot \rho}{3600 \times \eta_p}$$

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 [m] and depend on flow; when flow increases, the NPSH-value also increases **(see figure 6).**

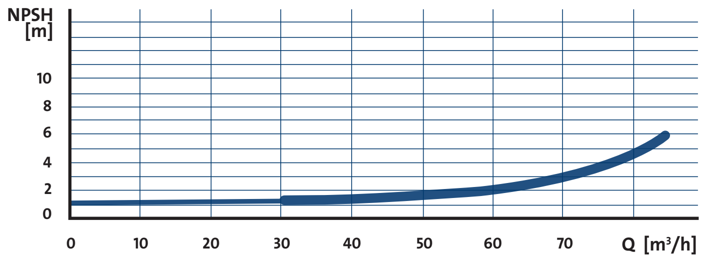

Fig. 6: The NPSH-curve of a typical centrifugal pump