Water Matters

How to make sense of pump curves

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Have you ever looked at a pump chart and tried to understand what its all about? At first glance they appear to be a confused mess of meaningless lines that pump people insist tells all you need to know about your pump! 'Pump charts' are really a number of graphs put together on one page. And like most things that seem complex, they are not hard to understand when broken down into their components.

The main curves show the flow rate at a particular 'head' (expressed in metres) or pressure (expressed in kPa). Flow rate and head are the two factors that define the job the pump has to do, referred to as its 'duty'. The flow-head curves are defined for either certain impeller sizes at a given speed, or certain speeds for a given impeller size.

Flow v head curves

Figure 1 shows the curves for a particular centrifugal pump at a set speed of 1470 rpm with different impeller sizes, from 274 mm to 342 mm.

This pump is capable of pumping at rates varying from about 40 litres per second to about 140 litres per second at a head varying from around 42 metres to around 10 metres. Any specific point on any of the specific impeller sizes is a duty point. For example, on the curve for 308 mm impeller, one duty point is 100 litres per second at 25 metre head.

Most irrigation pumps don't operate at just one duty point – they operate over a range of duties and need to be selected for this range.

An important observation is the overall shape of the flow-head curve. If it slopes down from the left side to the right side, the pump is described as stable and having a non-overloading power characteristic. If the curve rises from the left to a point then slopes down to the right, the pump is described as having an unstable head and overloading power characteristic. A stable pump won't create overload on the prime mover if the head decreases for some reason (such as broken pipe) whereas an unstable pump might.

Efficiency curves

Curves for efficiency are included on the same chart. They are usually marked with percentages. They show how efficiently the input power (from the engine or motor) is transferred into energy to pump the water at a particular duty point.

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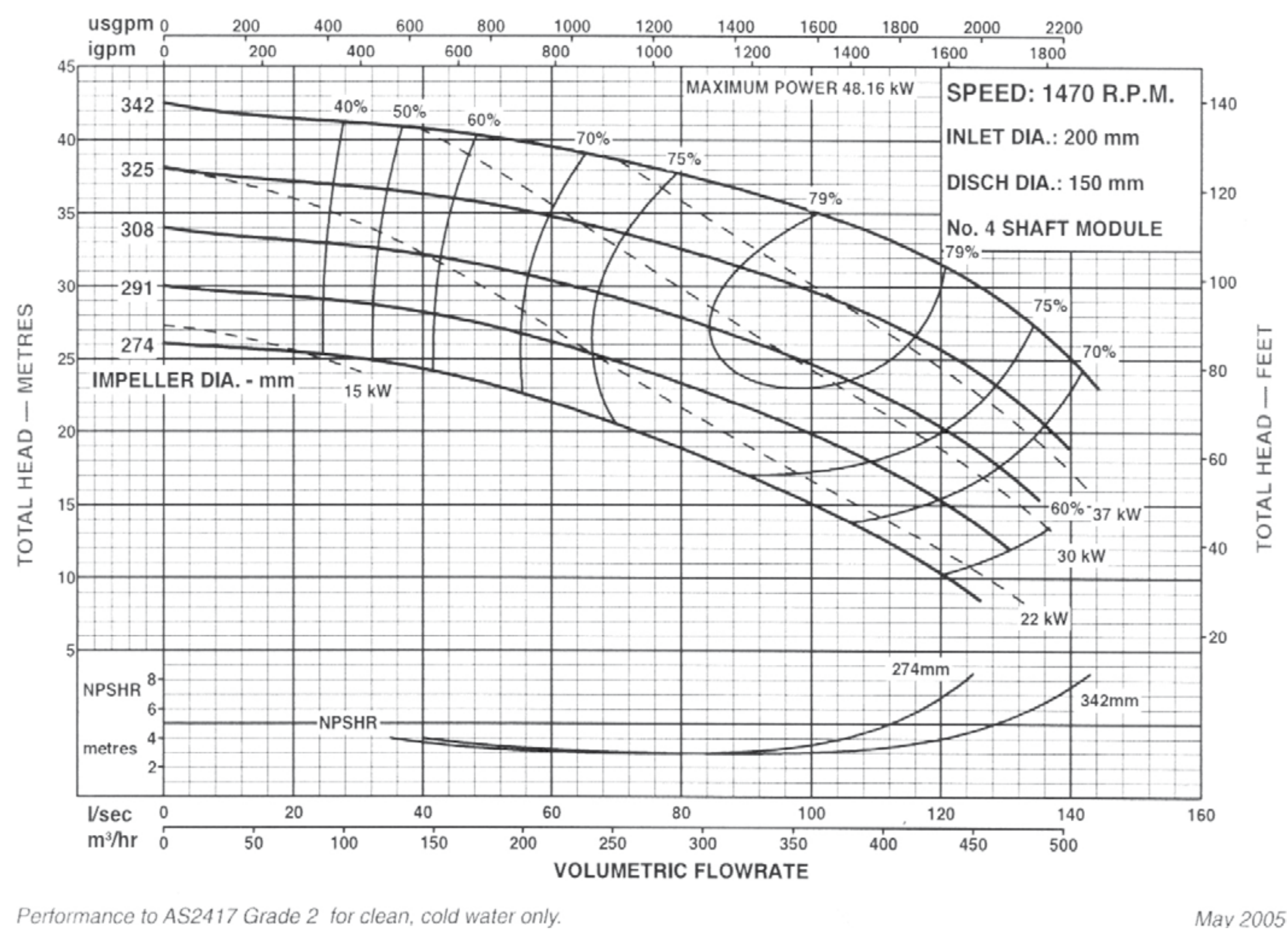
FIGURE 1: Pump curves for a centrifugal pump at set speed of 1470 rpm with various impeller sizes



◁22…PUMP CURVES

This is the pumping efficiency. Like most mechanical devices, it is not possible to achieve 100 per cent efficiency in pumps.

The goal is to select and operate a pump near its peak efficiency. The result is more efficient use of electricity or diesel, and thus reduced operating costs and carbon emissions. Note that the efficiency decreases if the flow rate is too high or too low and if the head is too high or too low.

For our example, at 100 litres per second and 25 metre head, the efficiency is a little more than 79 per cent.

If a particular pump will not allow 65 per cent efficiency or more for your duty, check a different pump – there is a very wide range to choose from.

POWER CURVES

Curves showing the power required to drive the pump are also included on the chart.

These are often placed across the other curves but are sometimes shown separately.

They show the amount of power at the pump shaft and are usually marked in kW.

You can work out the power at any point by estimating the figure from the closest power curve.

For a duty of 100 litres per second and 25 metre head, the power required is very close to 30 kW. *(This is the pump power required. The prime mover needs to be rated significantly higher than this to overcome any drive train losses, unexpected changes of duty, change of power conditions, and wear in both the prime mover and pump.)*

NPSHR

For pumps located above the water source, the charts usually supply another important piece of information called ‘Net Positive Suction Head Required’. It is often presented as a separate curve, sometimes as a table, and occasionally it is written text. In the figure, it is a separate curve at the bottom of the chart.

This is an indication of the pump’s ability to suck water from the supply source. If this is not properly allowed for, the pump will have problems trying to lift the water from the source, and it may also ‘cavitate’ causing damage to the impeller.

(Cavitation occurs when the suction pressure is too low and water partially turns into vapour bubbles at the eye of the impeller. As these bubbles are carried over to the discharge side of the impeller, they are compressed back into a liquid by the high discharge pressure. This action occurs violently and may remove bits of material from the impeller. This will cause premature failure of the pump. It often sounds like gravel or marbles in the pump.)

The theoretical maximum vertical height any pump can lift water is about 10 metres at sea level, less at higher altitudes. The NPSHR is the amount of this 10 metres used by the pump just getting the water into it.

This, plus an allowance for the friction loss in your suction pipe, is subtracted from 10 metres (at sea level). The vertical suction lift should not exceed this figure.

For our example, at 100 litres per second and 25 metre head, the NPSHR is about 3.5 metres. If the friction loss of the suction pipe is 1.0 metres, the total suction loss is 4.5 metrers. This means the vertical suction lift should not exceed 10 minus 4.5 = 5.5 metres.

Turbine pumps are usually fully submerged, including the pump inlet, which means there is no suction lift. But care needs to be taken to ensure the inlet is immersed sufficiently to avoid vortexing and sucking air.