Water for Profit

READING PUMP PERFORMANCE CURVES

Pump performance curves are important for the design and operation of irrigation pumping stations. The performance curve provides information on the pump's ability to produce pressure (head) and flow rate (capacity) along with information on pump efficiency and brake horsepower requirements.

Introduction

Loss of pumping efficiency and capacity are common with increasing suction head or flow rate requirements. Developing an understanding of the engine performance curve will help ensure proper loading of the engine and fuel economy.

Pump performance curve

A typical pump performance curve is shown in Figure 1. Curves for different impeller trim sizes are shown in this figure.
The total dynamic head is read from the left hand vertical axis. The pump capacity is read from the horizontal axis and pump efficiency isohyets are shown within the chart. Brake horsepower requirements are shown below the head-discharge curve. Brake horsepower is the actual amount of work performed on pumping the water at a given head and capacity plus the additional amount of work required due to pump inefficiency.

Pressure and flow rate relationships

The head-capacity curve shows the relationship between the total dynamic head and the capacity for a given pump. Each pump can only produce a certain flow (capacity) at a given head pressure, and vice versa. For example, Figure 1 shows that this particular pump, with a 233 mm (9-3/16 inch) impeller trim (marked as curve A), can produce a total dynamic head of 20 m while pumping 18.75 L/s. Similarly, if 26 L/s of capacity was required, this pump would supply this capacity at no more than 15.4 m of total head pressure.

Meeting head pressure requirements

Most pumping plants have head pressure requirements in excess of the capability of a single bowl or stage of a pump. Pressure increases are accomplished by combining stages of a given pump in a series. Additional stages of the pump are added together until the total dynamic head requirements of the pumping system are met.

Total dynamic head includes head requirements due to pumping lift, elevation changes, friction losses, and system operating pressure. So, if 76 metres of total dynamic head is required with a desired pumping rate of 25.2 L/s, then five stages of this pump would be required.

Adding stages increases pressure, it does not increase capacity. If capacity were to be changed significantly, the selection of a different pump would be required.

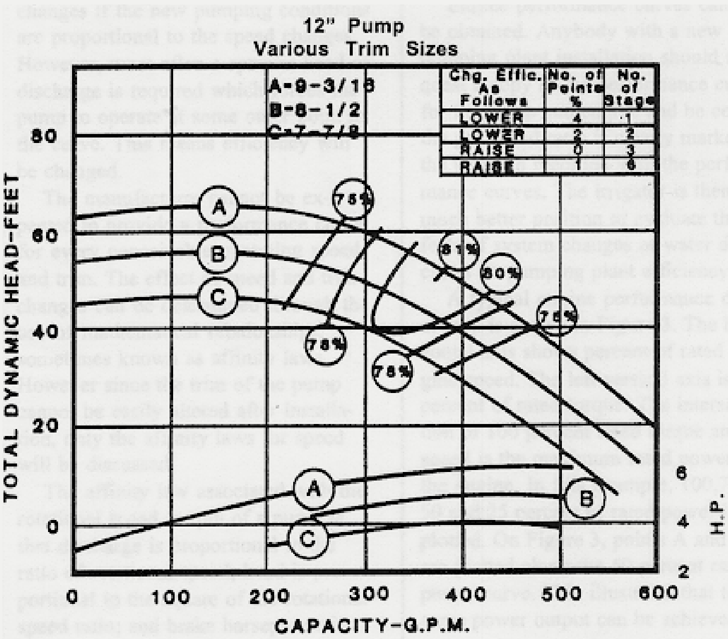

Figure 1: Example performance curve for a pump with various trims

Pumps are generally selected so that the operating point on the performance curve is to the right of the peak efficiency point. Any declines in groundwater and normal wear processes would then tend to push the pump towards higher efficiency, resulting in better performance over a greater period of time than if the original selection was to the left of maximum efficiency.

Pump efficiency

The pump performance curve also provides information on pump efficiency. The efficiency curves intersect with the head-capacity curve and are labelled with percentages. Each pump will have its own maximum efficiency point. Figure 1 shows this pump's maximum efficiency is 81 per cent for operating conditions of approximately 24.5 L/s with an impeller trim A. When operating at 19.4 L/s and 18.3 m of head, efficiency is approximately 78 per cent. When operating at 15.2 m of total head and 25.8 L/s, efficiency is approximately 80.5 per cent.

The pump performance curve may also feature an efficiency adjustment chart to account for changes in efficiency that occur as the number of stages change. Pump efficiency improves with additional stages since the friction losses that occur are shared. In this particular case (figure 1), if only a single stage pump is used then the pump efficiency read from the chart should be reduced by four per cent. Similarly, when three stages are used, the readings can be taken directly from the chart and when six stages are used, chart readings should be increased by one per cent.

Brake horsepower

The pump performance curve provides information on the brake horsepower required to operate a pump at a given point on the performance curve. The brake horsepower curves run across the bottom of the pump performance curve (figure 1). Like the head capacity curve, there is a brake horsepower curve for each different impeller trim. In this case, a pump with an impeller trim operating at 15.2 m of head and 25.8 L/s would require approximately 6.2 horse-power. Adding pump stages increases horsepower by an equal amount.

Impeller trims

Pump performance curves generally show performance for various impeller diameters or trims. Manufacturers will put several different trim curves on a pump performance curve to make pump specification easier, although this sometimes makes the pump performance curve more difficult to read.

Operating speed

Occasionally manufacturers will provide pump performance curves that will show the effect of changing operating speed or rpm. Figure 2 shows the same 12-inch pump with trim A operating at 1770, 1470 and 1170 rpm. The curve lines marked A in Figure 1 and 2 are identical. The general effect of reducing speed is a reduction in both capacity and head. Pump efficiency may be unaffected with head and capacity changes if the new pumping conditions are proportional to the speed changes. However, it is more common that the specific head or discharge required forces the pump to operate at some other point on the curve, affecting efficiency.

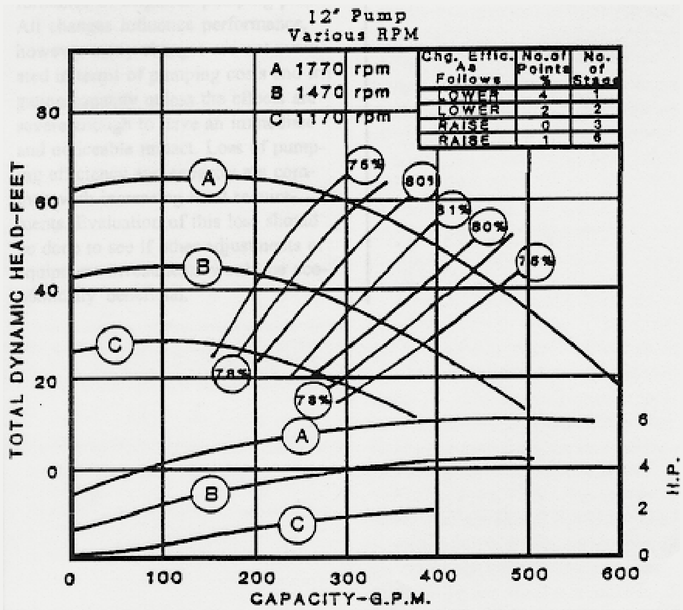

Figure 2: Example performance curve for a pump with various speeds

For more details contact Growcom on 07 3620 3844.

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