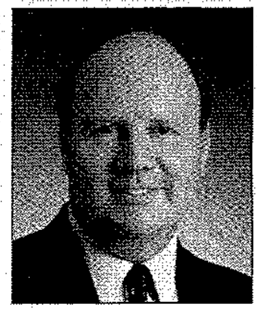
Ross Mackay, Contributing Editor



Increase Pipe Size To Lower Energy Cost

The increased use of computerized pump selection and system design software lets us consider many more details of the system and the manner in which it interacts with the pump, than was previously possible. Such software allows the designer to go far beyond the restriction of a capital cost budget and implement the consideration of lifetime costs of operation.

In selecting the pipe sizes to be used in any system for example, standard practice has been to limit the velocity in the discharge line from the pump to a maximum of 10 ft/sec. With the flexibility permitted by the computerized systems, however, designers can now consider the effect of lowering the velocity even further. This is accomplished by evaluating the larger pipe sizes and the resultant reduction in the cost of power needed to operate the pump over the long term.

Let's Get Practical and review the basic elements of system design, so that we can get a better feel for what we're trying to accomplish.

Flow Rate

In designing any kind of pumping system, the first requirement is to determine the speed at which the task must be performed—in other words, the flow needed through the system. In some systems, the flow rate will be determined by production requirements or by other process considerations, such as the flow rate needed to achieve the necessary temperature transfer in a liquid flowing through a heat exchanger.

The next requirement to be considered is how to overcome all the factors that hinder the movement of the liquid from one point to another in the system. These are primarily Gravity, System Pressure Differential and Friction.

Gravity and Static Head

If we consider Gravity as a force of nature that drives vertically downwards, then in a pumping system, we can oppose it by means of an energy factor we will refer to as the Total Static Head. This is simply the change in elevation through which the liquid must be lifted, and it's measured vertically, regardless of the linear distance between the start and end points in the system. As shown in Figure 1, the Static Head can be measured between the free surface of the liquid in Tank "A", and the highest level of the discharge line.

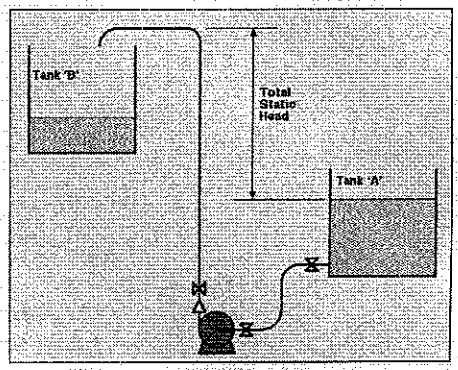


Figure 1. Typical pumping system

In another system, where the pump discharges into Tank "B" at a point below the liquid level in that tank, the Total Static Head in the system is the vertical distance from the free surface of the liquid in Tank "A" to the free surface of the liquid in Tank "B". It should be noted that this also applies even when the suction source is lower than the pump. Regardless of the layout of the system, the Total Static Head is not a variable of the flow rate. Therefore, a graph comparing the two would show up as a straight line.

System Pressure Differential

Another factor that has to be overcome is any differences in pressure that may exist between the suction source and the discharge destination. As this doesn't change with the flow, it is frequently included as part of the Static Head.

Friction Head

Friction is the resistance to flow in the piping system and must be considered for three separate areas individually: the piping, the valves and fittings, and other equipment, such as filters, heat exchangers, etc.

The Friction Losses in piping can most readily be obtained through the Friction Loss Tables available from a variety of sources. Tables are also available to identify the losses through the more common pipe fittings and valve types. However, any such losses in filters, heat exchangers, etc., must be obtained from the original equipment manufacturer, or by measuring the equipment on site. As the flow increases, so too does the Friction Loss—but at a far higher rate.

Total Head

The combination of these values equals the Total Head of the System.

Total Head = Static Head +
System Pressure Differential + Friction Loss

System Curve

When the Total Head (H) is plotted against the Flow Rate (Q), the resultant curve is known as the System Curve. Thus, when a specific Flow Rate is considered for a system, the System Curve will identify the Total Head that must be overcome at that Flow.

The Flow Rate through a system can only be supplied by a pump, and is therefore the capacity required from the pump. Consequently, the intersection of the Pump Performance Curve and the System Curve represents the point at which the pump will operate as shown in Figure 2.

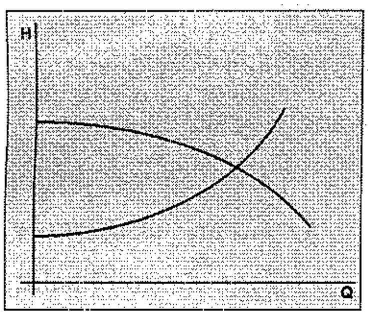


Figure 2. Pump and system curves

The System Curve shown in Figure 2 identifies the system as it has been selected, with specific pipe sizes and a particular arrangement of the fittings and other process equipment.

Power Draw

The power draw for the pump at various operating conditions can be calculated as follows, by identifying the specific gravity of the actual liquid being pumped.

$$HP = \frac{Q \times H \times S.G.}{3960 \times Effy}$$

The HP Curve can then be included in the graph of the Pump Curve and System Curve to show the full range of operational conditions. (See Figure 3.)

It's evident from this formula that the development of the Total Head in the pump absorbs a significant amount of the power. So, *Let's Get Practical.* How much of that Head is contributed by the Friction Losses through the line, and how would it be affected if we were to replace the pipe size selected with a larger diameter pipe?

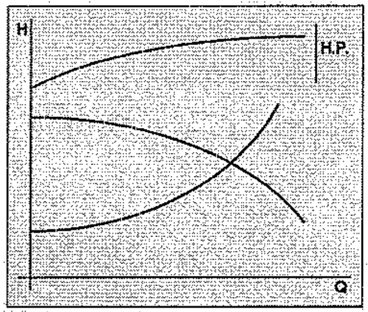


Figure 3. Pump and system HP curves

As shown in Figure 4, this can be calculated in a similar fashion as the previous formula. We can then plot the new System Curve at the same Flow Rate and consider the amount of energy saved by the larger pipe.

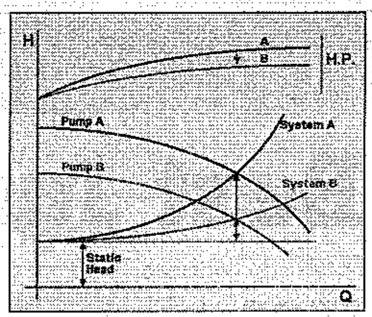


Figure 4. Optional pipe diameters

A diagram from the book on Life Cycle Cost produced by the Hydraulic Institute (HI) and Europump shows a relationship between the pump cost, the system cost and the energy cost of running the pump with various sizes of pipelines, and the resultant changes in the total life cost of the system (see Figure 5).

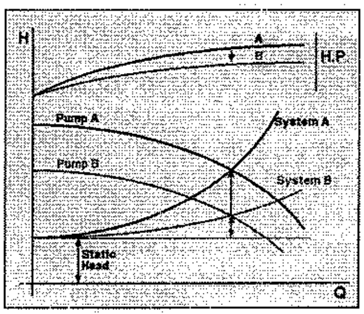


Figure 5. Life cycle system costing ***(graphic courtesy of the Hydraulic Institute (HI) and Europump)***

Let's Continue Being Practical. By drawing a similar graph, we can determine the optimum pipe size for long-term efficiency and economy in all our systems.

Ross Mackay specializes in helping companies increase their pump reliability and reduce operating and maintenance costs through consulting and education. He is the author of the new book "The Practical Pumping Handbook," that's now available at www.practicalpumping.com. He can be reached at 1-800-465-6260.