Reduce Pumping Costs through Optimum Pipe Sizing

Tip Sheet

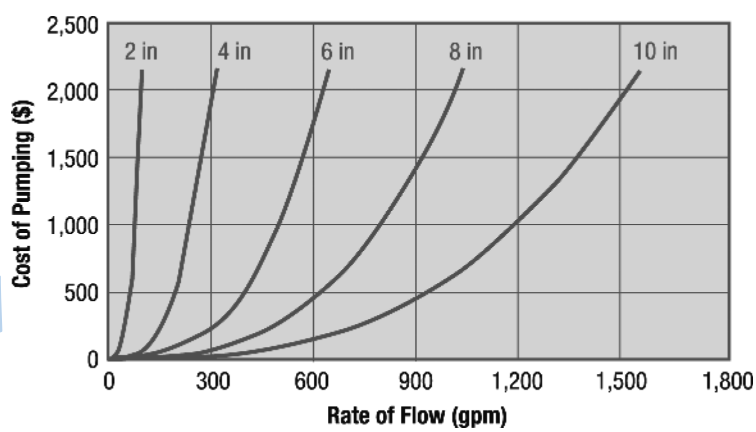
Suggested Actions

- Compute annual and life-cycle cost for systems before making an engineering design decision.
- In systems dominated by friction head, evaluate pumping costs for at least two pipe sizes and try to accommodate pipe size with the lowest life-cycle cost.
- Look for ways to reduce friction factor. If your application permits, epoxy-coated steel or plastic pipes can reduce friction factor by more than 40%, proportionately reducing your pumping costs.

Every industrial facility has a piping network that carries water or other fluids. According to the U.S. Department of Energy (DOE), 16% of a typical facility's electricity costs are for its pumping systems.

The power consumed to overcome the static head in a pumping system varies linearly with flow, and very little can be done to reduce the static component of the system requirement. However, there are several energy-and money-saving opportunities to reduce the power required to overcome the friction component.

The frictional power required depends on flow rate, pipe size (diameter), overall pipe length, pipe characteristics (surface roughness, material, etc.), and properties of the fluid being pumped. Figure 1 shows the annual water pumping cost (frictional power only) for 1,000 feet of pipe length for different pipe sizes and flow rates.



Based on 1,000 ft. for clean iron and steel pipes (schedule 40) for pumping 70°F water. Electricity rate—0.05 $/kWh and 8,760 operating hours annually. Combined pump and motor efficiency—70%.

Figure 1: annual water pumping cost for 1,000 feet of pipe of different sizes

Example

A pumping facility has 10,000 feet of piping to carry 600 gallons per minute (gpm) of water continuously to storage tanks. Determine the annual pumping costs associated with different pipe sizes.

From Figure 1, for 600 gpm:

6-inch pipe: ($1,690/1,000 feet) x 10,000 feet =$16,900
8-inch pipe: ($425/1,000 feet) x 10,000 feet =$4,250
10-inch pipe: ($140/1,000 feet) x 10,000 feet =$1,400

After the energy costs are calculated, the installation and maintenance costs should be calculated for each pipe size. Although the up-front cost of a larger pipe may be higher, it may still provide the most cost-effective solution because it will greatly reduce the initial pump and operating costs.

General Equation for Estimating Frictional Portion of Pumping Costs

$$\text{Cost (\$)} = \frac{1}{1706}\,(\text{Friction factor})\,\frac{(\text{Flow in gpm})^3\,(\text{Pipe length in feet})}{(\text{Pipe inner diameter in inches})^5}\;\frac{(\text{\# of hours})(\text{\$/kWh})}{(\text{Combined pump and motor efficiency as a percent})}$$

Where the friction factor, based on the pipe roughness, pipe diameter, and the Reynolds number, can be obtained from engineering handbooks. For most applications, the value of this friction factor will be 0.015 to 0.0225.

References

United States Industrial Motor Systems Market Opportunities Assessment, Xenergy Inc., prepared for DOE,December 1998.

Piping Handbook, Mohinder K. Nayyar, McGraw-Hill Publications, New York,1998.

Engineering Data Book, Hydraulic Institute, Second Edition, New Jersey, 1990. **www.Pumps.org**

Pump Systems Improvement Modeling Tool (PSIM) Software, available at **www.PumpSystemsMatter.org**

RESOURCES

Hydraulic Institute (HI). Hydraulic Institute, the largest association of pump producers in North America, serves member companies and pump users worldwide by developing comprehensive industry standards, expanding knowledge by providing education and training, and serving as a forum for the exchange of industry information. In addition to the ANSI/HI pump standards, HI has a variety of resources for pump users and specifiers, including Pump LCC and VSP guidebooks, "7 Ways To Save Energy" training program and more. To download FREE executive summaries of HI's "Pump Life Cycle Costs", "Variable Speed Pumping", and an index to ANSI/HI Standards, visit **www.Pumps.org** and **www.PumpLearning.org**.

Pump Systems Matter™ (PSM). Developed by the Hydraulic Institute, PSM is an educational initiative created to assist North American pump users gain a more competitive business advantage through strategic, broad-based energy management and pump system performance optimization. PSM's mission is to provide end-users, engineering consultants and pump suppliers with tools and collaborative opportunities to integrate pump system performance optimization and efficient energy management practices into normal business operations.

PSM is seeking the active support and involvement of energy efficiency organizations, utilities, pump users, consulting engineering firms, government agencies, and other associations. For more information on PSM, to become a sponsor, or to download PSM's *FREE Pump System Improvement Modeling Tool*™ (PSIM), an educational tool designed to show pump systems engineers how modeling tools can reduce cost and conserve energy, visit **www.PumpSystemsMatter.org**.

U.S. Department of Energy (DOE). DOE's Industrial Technologies Program (ITP), through partnerships with industry, government, and non-governmental organizations, develops and delivers advanced energy efficiency, renewable energy, and pollution prevention technologies for industrial applications. ITP has launched the **Save Energy Now** initiative to help the nation's manufacturing facilities continue to thrive during a time of diminished energy supplies and rising costs. As a part of this initiative, ITP is sending DOE Energy Experts to the nation's most energy-intensive manufacturing facilities to conduct 200 Energy Savings Assessments. See www.eere.energy.gov/industry for additional information on DOE's energy efficiency activities.

BestPractices emphasizes opportunities for savings in plant systems such as motor, steam, compressed air, and process heating systems. BestPractices is a part of the Industrial Technologies Program, and offers a variety of resources addressing ways to reduce energy and maintenance costs in industrial process systems. This includes training workshops, software tools, a series of sourcebooks, case studies, tip sheets, and other materials, including several which focus on opportunities in pumping systems. For example, the Pumping System Assessment Tool (PSAT) aids in the assessment of pumping system efficiency and estimating energy and cost savings.

For more information, please contact: EERE Information Center; 1-877-EERE-INF (1-877-337-3463); **www.eere.energy.gov/industry/bestpractices.**