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.

Resources

Improving Pumping System Performance: A Sourcebook for Industry, DOE and Hydraulic Institute.

Hydraulic Institute—HI is a non-profit industry association for pump and pump system manufacturers; it provides product standards and a forum for the exchange of industry information for management decision-making. In addition to the ANSI/HI pump standards, HI has a variety of energy-related resources for pump users and specifiers, including training, guidebooks, and more. For more information, visit www.pumps.org, www.pumplearning.org, and www.pumpsystemsmatter.org.

U.S. Department of Energy—DOE's Pumping System Assessment Tool (PSAT) can help you assess pumping system efficiency and estimate energy and cost savings. PSAT uses pump performance data from Hydraulic Institute standards and motor performance data from the MotorMaster+ database.

Visit the BestPractices Web site at www.eere.energy.gov/bestpractices for more information on PSAT and for upcoming training in improving pumping system performance and in becoming a qualified pumping system specialist.

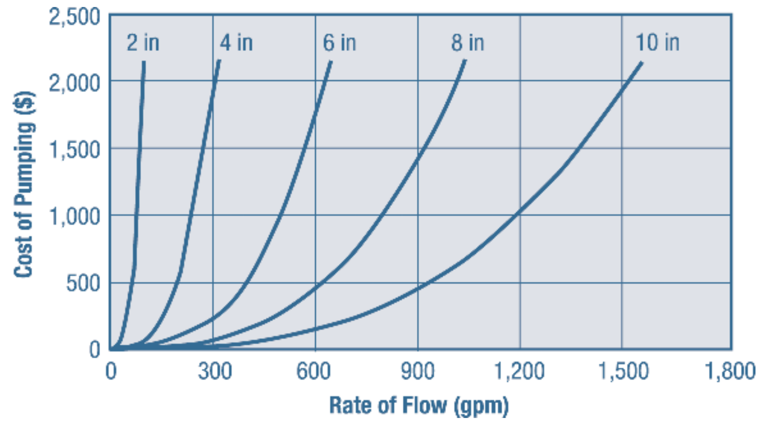
Reduce Pumping Costs through Optimum Pipe Sizing

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.

Figure 1. Annual water pumping cost for 1,000 feet of pipe of different sizes



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%.

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 maintenence 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.

About DOE's Industrial Technologies Program

The Industrial Technologies Program, through partnerships with industry, government, and non-governmental organizations, develops and delivers advanced energy efficiency, renewable energy, and pollution prevention technologies for industrial applications. The Industrial Technologies Program is part of the U.S. Department of Energy's Office of Energy Efficiency and Renewable Energy.

The Industrial Technologies Program encourages industry-wide efforts to boost resource productivity through a strategy called Industries of the Future (IOF). IOF focuses on the following eight energy and resource intensive industries:

- Aluminum
- Forest Products
- Metal Casting
- Petroleum
- Chemicals
- Glass
- Mining
- Steel

The Industrial Technologies Program and its BestPractices activities offer a wide variety of resources to industrial partners that cover motor, steam, compressed air, and process heating systems. For example, BestPractices software can help you decide whether to replace or rewind motors (MotorMaster+), assess the efficiency of pumping systems (PSAT), compressed air systems (AirMaster+), steam systems (Steam Scoping Tool), or determine optimal insulation thickness for pipes and pressure vessels (3E Plus). Training is available to help you or your staff learn how to use these software programs and learn more about industrial systems. Workshops are held around the country on topics such as "Capturing the Value of Steam Efficiency," "Fundamentals and Advanced Management of Compressed Air Systems," and "Motor System Management." Available technical publications range from case studies and tip sheets to sourcebooks and market assessments. The Energy Matters newsletter, for example, provides timely articles and information on comprehensive energy systems for industry. You can access these resources and more by visiting the BestPractices Web site at **www.eere.energy.gov/ industry/bestpractices** or by contacting the EERE Information Center at **877-337-3463** or via email at **www.eere.energy.gov/informationcenter/.**

BestPractices is part of the Industrial Technologies Program Industries of the Future strategy, which helps the country's most energy-intensive industries improve their competitiveness. BestPractices brings together emerging technologies and best energy-management practices to help companies begin improving energy efficiency, environmental performance, and productivity right now.

BestPractices emphasizes plant systems, where significant efficiency improvements and savings can be achieved. Industry gains easy access to near-term and long-term solutions for improving the performance of motor, steam, compressed air, and process heating systems. In addition, the Industrial Assessment Centers provide comprehensive industrial energy evaluations to small- and medium-size manufacturers.

FOR ADDITIONAL INFORMATION, PLEASE CONTACT:

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A Strong Energy Portfolio for a Strong America

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