Energy Tips

Steam

Motors

Compressed Air

Suggested Actions

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

For additional information on industrial energy efficiency measures, contact the OIT Clearinghouse at (800) 862-2086.

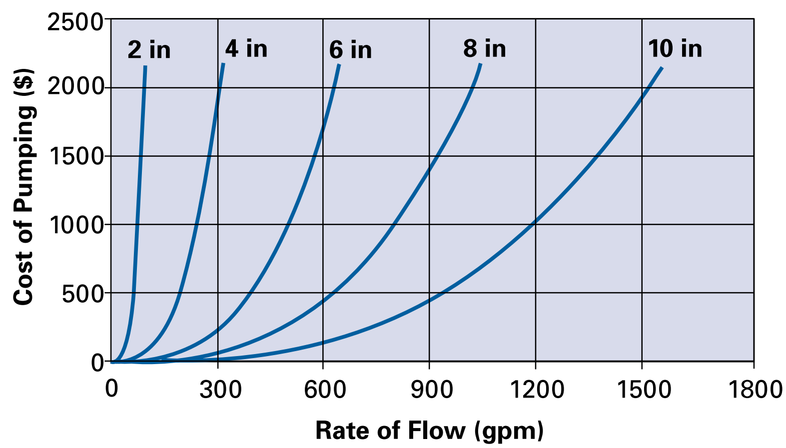
Reduce Pumping Costs through Optimum Pipe Sizing

All industrial facilities have a network of piping that carries water or other liquids. According to the U.S. Department of Energy study[1], 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. On the other hand, several energy and money-saving opportunities exist to reduce the power required to overcome the friction component of the pumping system.

The frictional power required is dependent on rate of flow, pipe size (diameter), overall length of the pipe, pipe characteristics (surface roughness, material, etc.) and properties of the liquid being pumped. The figure below shows the annual water pumping cost (frictional power only) for 1000 ft. of pipe length for different pipe sizes and rates of flow.

Annual Water Pumping Cost for 1000 Feet of Pipe of Different Sizes



Based on 1000 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 ft. of piping to carry 600 gpm of water continuously to storage tanks. Determine the annual pumping costs associated with different pipe sizes.

From the figure above, for 600 gpm:	6 inch pipe:	($1690/1000ft.) x 10,000 ft. =	$16,900
	8 inch pipe:	($425/1000 ft.) x 10,000 ft. =	$4,250
	10 inch pipe:	($140/1000 ft.) x 10,000 ft. =	$1,400

After calculating the energy costs, one should calculate the installation and maintenence costs for the different pipe sizes. Although the up-front cost of a larger pipe size may be higher, it may still provide the most cost-effective solution due to the large reduction in the initial pump and operating costs.

General Equation for Estimating Frictional Pumping Costs

$$\text{Cost (\$)} = \frac{1}{1705}\,\text{(Friction Factor)}\,\frac{\text{(Flow in gpm)}^3\,\text{(Pipe length in ft.)}}{\text{(Pipe inner diameter in inches)}^5}\;\frac{\text{(\# of hours)(\$/kWh)}}{\text{(Combined pump and motor efficiency as a percent)}}$$

Where the *Friction Factor*, based on the pipe roughness, pipe diameter, and the Reynolds number, can be obtained from engineering handbooks.[2,3] For most applications, the value of this friction factor will be between 0.015 and 0.0225.

References and Footnotes

1. Xenergy Inc., *United States Industrial Motor Systems Market Opportunities Assessment,* prepared for the U.S. Department of Energy, December 1998.

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

3. Hydraulic Institute, *Engineering Data Book*, Second Edition, New Jersey, 1990.

4. *Improving Pumping System Performance: A Sourcebook for Industry*, Motor Challenge and Hydraulic Institute, January 1999.

5. *Pumping System Optimization*, Training workshop offered by the U.S. Department of Energy. Call (800) 862-2086 for more information.

About DOE's Office of Industrial Technologies

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

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- Agriculture
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- Steel

OIT and its BestPractices program 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), 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.oit.doe.gov/bestpractices** or by contacting the OIT Clearinghouse at **800-862-2086** or via email at **clearinghouse@ee.doe.gov.**

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