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.

### 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: \((1690/1000 \text{ft.}) \times 10,000 \text{ ft.} = \$16,900\)
- 8 inch pipe: \((425/1000 \text{ ft.}) \times 10,000 \text{ ft.} = \$4,250\)
- 10 inch pipe: \((140/1000 \text{ ft.}) \times 10,000 \text{ ft.} = \$1,400\)

After calculating the energy costs, one should calculate the installation and maintenance 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.

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For additional information on industrial energy efficiency measures, contact the OIT Clearinghouse at (800) 862-2086.
General Equation for Estimating Frictional Pumping Costs

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

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 between 0.015 and 0.0225.

References and Footnotes


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.

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

- Agriculture
- Aluminum
- Chemicals
- Forest Products
- Glass
- Metal Casting
- Mining
- Petroleum
- 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.

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

BestPractices focuses on 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.

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