Energy Tips – Pumping Systems

Suggested Actions

- Check the operating conditions for all control valves in your plant processes.
- Consult vendor catalogs, equipment manufacturers, and DOE's Pumping System Assessment Tool (PSAT) for valve pressure drop data.
- Use PSAT to estimate the energy losses and costs of throttled valves.

Resources

Improving Pumping System Performance: A Sourcebook for Industry, U.S. Department of Energy, 2006

Variable Speed Pumping: A Guide to Successful Applications, Hydraulic Institute, 2004

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. Visit: www.pumps.org
www.pumplearning.org
www.pumpsystemsmatter.org

U.S. Department of Energy—DOE's PSAT can help you assess pumping system efficiency and estimate energy and cost savings. PSAT uses pump performance data from HI standards and motor performance data from the MotorMaster+ database.

Visit the BestPractices Web site at www.eere.energy.gov/industry/bestpractices to access these and many other industrial efficiency resources and information on training.

Energy Savings Opportunities in Control Valves

Pumping system control valve inefficiencies in plant processes offer opportunities for energy savings and reduced maintenance costs. Valves that consume a large fraction of the total pressure drop for the system or are excessively throttled can be opportunities for energy savings. Pressure drops or head losses in liquid pumping systems increase the energy requirements of these systems. Pressure drops are caused by resistance or friction in piping and in bends, elbows, or joints, as well as by throttling across the control valves. The power required to overcome a pressure drop is proportional to both the fluid flow rate (given in gallons per minute [gpm]) and the magnitude of the pressure drop (expressed in feet of head).

For example, for fluid with a specific gravity of 1, a pressure drop of one pound per square inch (psi) is equal to a head loss of 2.308 feet.

Fluid horsepower = flow rate (gpm) x head loss (ft) x fluid specific gravity / 3,960 (where 3,960 is a conversion factor)

The friction loss and pressure drop caused by fluids flowing through valves and fittings depend on the size and type of pipe and fittings used, the roughness of interior surfaces, and the fluid flow rate and viscosity. Typical ranges of head loss coefficients (K values) for various fittings are given in the table. Values can vary by 30% to 50% because of variations in pipe size, type of fluid, and other factors. Fitting head losses vary with the square of the fluid flow rate or flow velocity:

$$H_L = K \text{ x } (v^2/2xg)$$

where

H_L = the fitting head loss, in feet

v = fluid flow velocity, in feet/second

g = the gravitational constant, 32.174 feet/second

K = the fitting head loss coefficient. For valves, K is a function of valve type, size, and the percentage of time that the valve is open.

Table 1. Range of Head-loss Coefficients (K) for Water Flowing Through Various Fittings

Fitting Description	K Value	Fitting Description	K value
Globe valve, fully open	3 – 8	Square-edged inlet (from tank)	0.5
Ball valve, fully open	0.04 – 0.1	Bell-mouth inlet	0.05
Check valve, fully open	2	Discharge into tank	1
Gate valve, fully open	0.03 – 0.2	Standard elbow	0.2 – 0.3
Butterfly valve, fully open	0.5 – 2	Long radius elbow	<0.1 – 0.3

Energy Savings Opportunites

Pumping system controls should be evaluated to determine the most economical control method. High-head-loss valves, such as globe valves, are commonly used for control purposes. Significant losses occur with these types of valves, however, even when they are fully open. If the evaluation shows that a control valve is needed, choose the type that minimizes pressure drop across the valve.

Adjustable speed drives (ASDs) are often recommended for pumping systems that have variable flow rate requirements. When systems are being retrofitted with ASDs, the control valve can be removed from the system to eliminate unnecessary pressure drops. The control valve can be replaced with a spool piece or, when isolation capability is desired, a carefully selected low-loss replacement valve.

Figure 1 illustrates the wide variability in frictional head loss as a function of flow rate across three types of fully open, 12-inch valves. Substantial energy and cost savings can be achieved by installing a low-loss valve, such as a butterfly valve. When installing a smaller pump impeller, trimming an existing impeller, or making other pumping system modifications, consider replacing current valves with more efficient ones.

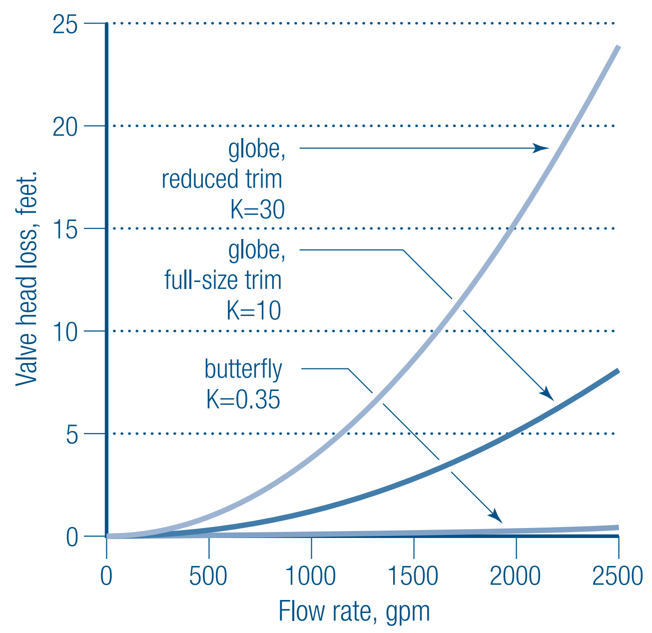

Figure 1.

To calculate control valve losses in terms of head, energy, and cost, see DOE's Pumping System Assessment Tool (PSAT), available online in the Resources section of the ITP BestPractices Web site: *www.eere.energy.gov/industry/bestpractices.*

Reference

"Control Valve Replacement Savings," U.S. Department of Energy Performance Optimization Tip, *Energy Matters,* July 1998; available online at: http:/*/www.nrel.gov/docs/legosti/fy98/23382.pdf*

BestPractices is part of the Industrial Technologies Program (ITP) Technology Delivery strategy, which helps industry save energy and increase competitiveness. Through this strategy, ITP brings together state-of-the-art technologies and energy management best practices to help companies improve energy efficiency, environmental performance, and productivity right now.

BestPractices focuses on key plant energy systems where significant efficiency improvements and savings can be achieved. Energy Savings Assessments are encouraged for the largest energy consuming plants. In addition, the Industrial Assessment Centers help small- and medium-size manufacturers identify opportunities in their operations. Industry gains easy access to near-term and long-term solutions for improving the performance of steam, process heating, compressed air, and motor systems.

FOR ADDITIONAL INFORMATION, PLEASE CONTACT:

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