Energy Savings Opportunities in Control Valves

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.

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 oportunities 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 Table 1. 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:

$$H_L = K \times (v^2/2xg)$$

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 that the valve is open.

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

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

Fitting Description	K Value	Fitting Description	K Value
Goo valve, fully open	3 – 8	Square-edged inlet (from tank)	0.5
Pal 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

Tip Sheet

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.

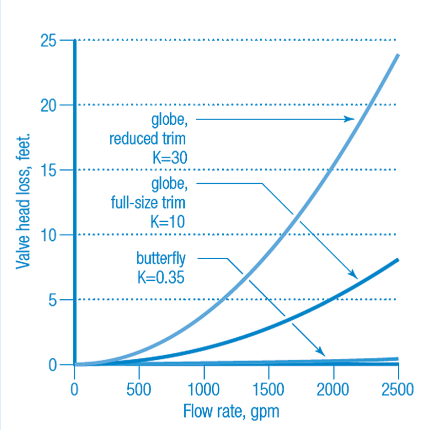

Figure 1.

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.

References

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

Improving Pumping Systems 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). 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.

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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.