Strategies to Save Energy During the Pumping Process

OVERVIEW
In a drinking water system, pumping transfers water from a source (e.g., river, treatment plant) to a destination (e.g., treatment plant, storage reservoir). Most water pumping systems have a combination of “static head” (the distance in height between the source and destination of the water being moved) and “friction head” (the friction loss on the water being moved in pipes, valves, and other equipment in the system) (Leiby and Burke 2011).

Eighty percent of the energy used in water treatment and distribution is used to pump water (which weighs 8.34 pounds per gallon). Given that large amounts of energy are used by pumps for lifting and moving water, and because energy costs often are the second highest cost of a water utility operating budget, the proper selection of pumps, motors, and controls is critical to ensure an efficient system and to control costs (EPRI 2002).

PUMPING
Proper pump selection is critical for efficient pump system operations. To ensure that the

QUICK FACTS
- Energy is the second highest utility expense, after labor
- Money can be saved during the pumping process by
  - Proper pump selection and operation
  - Variable Frequency Drives
  - Efficient pump motors
  - In-line turbines
  - Hydraulic Modeling
  - Appropriate distribution system piping

FACT SHEET
pump will be efficient, it is important to know the rates of flow and pressure in the pumping system. There are many combinations of pumps and components, and the challenge is to identify the most cost-effective and energy-efficient mix to match the design of the pumping system (DOE 2006).

When evaluating pumping systems for ways to improve efficiency and reduce costs, water utilities should identify indicators of inefficient pump system operations. These indicators include pumps with high maintenance requirements, oversized pumps that operate in a throttled position, badly worn pumps, and noisy pumps or valves (DOE 2006).

Inefficient pump systems have “choke points” or areas that may result in pressure drops (e.g., sharp bends and partially closed valves). To improve performance, pipes leading to the pump inlet should be straight and have a minimum number of bends. Leaks in pipes also contribute to inefficiency, as they lower system pressure, resulting in a need to increase pumping (DOE 2006).

Installation of variable frequency drives (VFDs) is one of the easiest energy improvements a water utility can implement. VFDs should be considered when a pump is oversized or when a throttling valve is used in pump operations. VFDs or variable-speed drives (VSDs) are electronic controllers that adjust the rotational speed of the electric motor (such as a pump motor) by controlling the frequency of the electric power supplied to the motor. The use of VFDs is estimated to reduce energy use by as much as 50% because VFDs match the motor speed to the specific energy demands needed (Energy Commission N.d.). Therefore, energy is conserved because the drive operates at lower speeds when needed.

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- Pumps with high maintenance requirements
- Pumps operating in a throttled position
- Badly worn pumps
- Noisy pumps or valves

Optimizing pumps can provide significant energy savings by reducing energy wasted from operating oversized pumps and using excess throttling or bypass valves to control flow (Leiby and Burke 2011). If pumps are oversized or operating outside of the optimal “best efficiency point” range, water utilities can use a number of approaches to improve overall efficiency and thus reduce energy consumption, including:

- Replacing impellers (high-speed wheels) with smaller-diameter impellers, reducing energy use;
- Controlling the pump speed by adding a variable-frequency drive, improving efficiency; and
- Establishing a schedule for regular and preventive maintenance on pumps, preserving performance and extending the pump life (DOE 2006).

### MOTORS

As part of pump system improvement, water utilities should evaluate the pump motor. Motors control pump speed and are directly tied to the efficiency of the pumping system. If motors are operated for long periods (more than 50% of the time), then motor efficiency increases (DOE 2006). They are most efficient when running 75% of the time (DOE 2008).

Water utilities should develop a plan to upgrade existing motors with premium efficiency models, as those motors can provide up to 10% more efficiency compared to standard models.

### IN-LINE TURBINES

In regions where water utilities have significant elevation changes over their distribution areas, some utilities may pump water into the distribution system at a higher than desired line pressure, and install pressure-reducing valves at lower elevations. This type of water system design will waste some of the energy through the pressure-reducing valves. Rather than waste this energy, utilities can install in-line turbines to generate electricity from the excess pressure (Leiby and Burke 2011).
HYDRAULIC MODELING
As water distribution systems become more complex, it often becomes more challenging for water utilities to operate the system efficiently and to manage energy use. Hydraulic models enable the utility to simulate the behavior of the water system and can help predict the system’s response to changes in conditions. These models are typically used for long-term planning such as for design of new systems and expansion of existing ones (Leiby and Burke 2011).

DISTRIBUTION SYSTEM PIPING
The primary causes of high pumping costs in a water distribution system are head loss and friction loss. In evaluating ways to improve the pumping system, water utilities should determine if there are lengths of pipes that are “choke points” that are causing large amounts of head loss. Correcting pipe size can save up to 20% of pumping energy (Easton Consultants 1995).

Utilities also can reduce pipe costs by selecting the smallest pipe diameter that provides the lowest velocities during peak demand. In addition, the smoothness of the pipe can reduce friction loss and reduce the amount of energy required to move water (DOE 2006).

For existing piping, there are two options to improve efficiency: replacement or rehabilitation through cleaning or installing a new lining (DOE 2006).

REFERENCES


