DP&L

Customized Efficiency Rebates

Case Study: Pump System Optimization Saves Energy at Paper Mill

Summary

As part of a companywide energy conservation mandate, a large paper mill undertook a system-wide audit of its energy usage. The mill's energy manager implemented an improvement project on the effluent pumping system. Due to chronic maintenance issues and high energy expenditures, the pumping system was ripe with optimization opportunities.

The project involved the installation of mechanical adjustable speed drives (ASDs) on two pumps in the mill's pumping station. The project allowed the system to operate more effectively and resulted in annual energy savings of 400,000 kWh and electric bill savings of nearly $18,000. In addition power demand dropped from 142 kW to 62 kW. The project also eliminated many problems that led to excessive maintenance costs and resulted in additional annual savings in excess of $10,000. All together, the energy and demand savings would garner a $24,000* rebate from DP&L out of a total project cost of $90,000.

*Based on a rebate value of $0.05 per kWh and $50 per kW. These rebate values are preliminary and are subject to change.

How It Would Work—Cost Savings Calculations

A. Energy reduction (first year)	400,000 kWh
B. Demand reduction	80 kW
C. Energy savings (A x $0.045)	$18,000
D. Maintenance savings	$10,000
E. Total annual savings (C + D)	**$28,000**
F. Project cost	$90,000
G. Energy reduction rebate (A x $0.05)	$20,000
H. Demand reduction rebate (B x $50.00)	$4,000
I. Total DP&L rebate (G + H)	$24,000
J. Total project cost (F - I)	**$66,000**
K. Simple payback (J / E)	**28 months**

Project Overview

The effluent pumping system at the mill is vital to the production process because it treats the wastewater created by the paper manufacturing process. The system uses three 100-hp centrifugal pumps. Prior to the project, two of the pumps operated in parallel to pump all of the wastewater from the main pump station sump to a clarifier. The third pump was used as a backup. The mill's treatment process requires a minimum flow rate of 4,800 gallons per minute to be reliable.

The efficiency study revealed that when both pumps operated at full load, their combined capacity was 7,000 gallons per minute (gpm) while the excess 2,200 gpm was being re-circulated back to the sump. The size of the pumps and the system's control scheme caused the excess pumping. The primary system control was a level control in which a throttling valve and a bypass valve worked in tandem to maintain a minimum level in the sump. As the level in the sump rose, the throttling valve opened and the bypass valve closed. Conversely, as the level in the sump fell, the discharge valve closed and the bypass valve opened.

Controlling the pumps this way required starting them at full load from a dead start. This created flow surges and water pipe hammer that led to stress in the system's piping. In addition, starting the pumps from a dead start caused a long duration of locked rotor currents, which overheated the pump motors.

The analysis found that cavities and excessive vibration were present in the piping because the pumps operated at full capacity. Although the pumps were moving 2,200 gpm in excess of the process requirements, the total volume moved was still too small given the pump operating speed. This disparity led to further process-piping fatigue and shortened equipment life.

Solution

The project centered on installing mechanical ASDs, replacing worn impellers on both pumps, and upgrading the pump instrumentation.

The ASDs would replace the throttle and bypass valve operation and would match the system's output to the mill's requirements.

Several factors made the selected mechanical ASDs more suitable for the mill's environment and needs than electronic variable speed drives (VSDs).

One factor that made this ASD model attractive was its easy installation. The ASD installation simply required moving the pumps back on their bases and installing spacers between the motors and the pumps. No inverter-duty motors, extensive rewiring, or reconfiguration of the pump stations was necessary.

Second, ruggedness and a lack of sensitive electronic parts made these mechanical ASDs less prone to maintenance problems. Because the mill's system is a medium-voltage application, these ASDs were less costly than comparable VSDs.

Finally these ASDs are mechanical so there are no direct connections between the motors and pumps. This substantially reduces vibration and allows soft-start capabilities.

Results

The implementation of the project has improved the operation of the effluent pumping system and resulted in significant energy savings.

The newly configured system no longer depends on bypass and throttling valves. The ASDs can vary the pump speed to match the pump output capacity with the mill's required process flow rate. The new configuration allows the mill to baseload only one of the pumps while operating the other one at partial load. Because they are uncoupled from the pump motors, the ASDs allow the pumps to start gradually, which eliminates water surges and pipe hammer. This in turn, lessens the stress on the system's piping and internal components, reduces maintenance costs, and prolongs equipment life.

The system's flow rate has declined by 31 percent, or 2,200 gpm from 7,000 gpm. Power demand has declined from 142 kW to 62 kW. The reduction in the system's flow rate and power demand are due to:

- the installation of the ASDs,
- the rebuilt pumps,
- and the operation of one pump at partial load versus two pumps at full load.

The mill saves $18,000 in annual energy costs and $10,000 in maintenance costs. The $24,000 custom rebate from DP&L combined with operations and maintenance savings would result in a short 28 month payback period.

Source: Department of Energy

For More Information

For more information, please contact DP&L at EnergyEfficiency@dplinc.com.