MOTOR CHALLENGE
Project Fact Sheet

A Motor Challeng

Benefits

- Reduced annual energy consumption by 225,100 kWh, saving $11,255.
- Improved system reliability – since any two of the three pumps could meet system requirements, one pump can be shut down for maintenance or repair without affecting system operation.
- Lower maintenance requirements are expected since each pump operates close to its best efficiency point.

Applications

The use of a single pump with a recirculation line to serve a wide variation in operating conditions is inherently inefficient. In many cases, the use of parallel pump configurations and/or variable speed drives provides an effective means of matching the available pumping capacity to the system requirements and improving operating reliability. In addition, plants that do not exploit the available head from city water mains or have pumping systems located far from the primary water demand area should consider ways to redesign their systems in order to minimize pumping requirements and lower operating costs.

New Water Booster Pump System Reduces Energy Consumption By 80 Percent And Increases Reliability

Summary

Due to major renovations at their Pontiac Operations Complex, General Motors (GM) needed to relocate the facility's city water booster pumping system. Using a systems approach and careful forethought, a highly efficient pumping system appropriate for current plant requirements was developed.

Because of a sizeable decrease in the workforce and production at this facility, the demand for city water had significantly decreased. Thus, in relocating the pumping system, GM was able to replace the five original 60- to 100-hp pumps with three 15-hp pumps whose speed could be adjusted to meet plant requirements. As a result, GM reduced pumping system energy consumption by 80 percent (225,100 kWh per year), saving an annual $11,255 in pumping costs. With a capital investment of $44,966 in the energy efficiency portion of their new system, GM projects a simple payback of 4.0 years.

GM Pontiac Operations Complex

OFFICE OF INDUSTRIAL TECHNOLOGIES
ENERGY EFFICIENCY AND RENEWABLE ENERGY • U.S. DEPARTMENT OF ENERGY

Plant Overview

GM is the world's largest automobile manufacturer. Their automotive divisions—Chevrolet, Buick, Cadillac, Oldsmobile, Pontiac, and Saturn—account for almost 33 percent of cars and light trucks sold in the United States. GM has about 711,000 employees and generates approximately $164 billion in annual revenue. The GM Pontiac Operations Complex is located in Pontiac, Michigan and manufactures components for a variety of GM automobiles. Although in the late 1970's it employed about 14,000 workers in the assembly of Fieros and G-cars, the work force has declined to its current level of about 3,000 employees.

Project Background

The Pontiac Operations Complex is being significantly renovated to reduce its operating costs and better position it to meet future GM production requirements. This necessitated the demolition of several buildings in the southern part of the complex including the original pump house. The need to relocate the city water booster pumping system also provided an opportunity to replace it with a more energy-efficient system.

Project Team

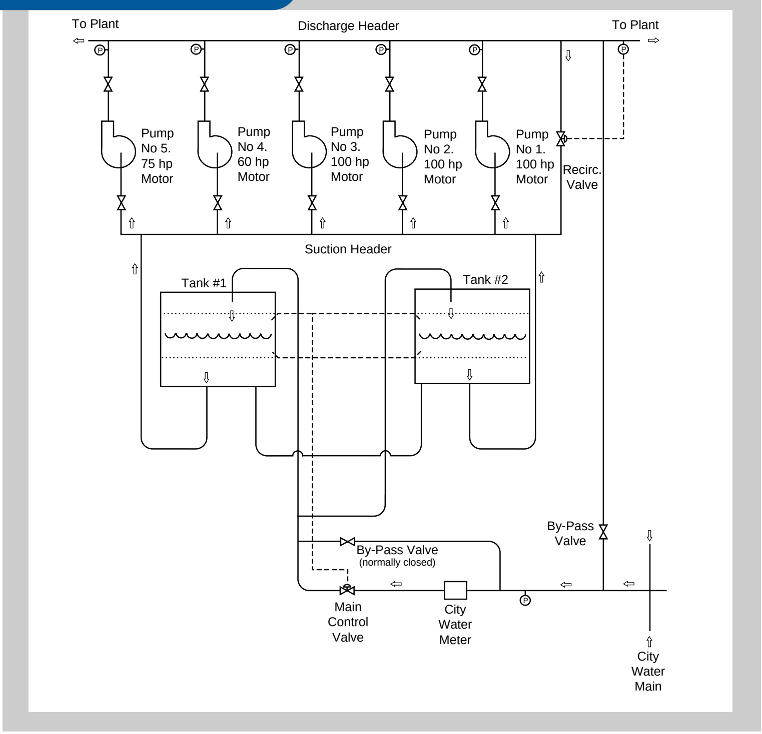
GM teamed up with their electric power provider, Detroit Edison, to evaluate opportunities for cost improvement and to measure pre- and post-modification system performance. Detroit Edison set up power monitoring equipment to determine electricity consumption for the system prior to the system upgrade and again after the project was completed. In addition, U.S. Electrical Motors supplied the motors to drive the three pumps. Two of the pump motors used variable frequency drives (VFDs) while the third was a switched reluctance unit.

The Old System

The city water booster pumping system provides water to the complex for process functions and personnel use. The complex uses about 840,000 ft^3 of water per month. The system was originally designed for well-water service, and used two holding tanks to supply the five pumps that pressurized the water distribution system as shown in the figure. When city water was connected to the complex, the holding tanks were kept and the inflow from the city water main to the tanks was regulated by a liquid level control system in the tanks. This assured a constant water supply to the pumps but basically did not take advantage of the pressure available from the city water main.

To supply water to the remote locations of the plant, the booster pumps generated a nominal discharge pressure of 110 psig. This pressure was required to overcome the head loss of the complex's distribution system and to provide the required 50-psig water supply pressure to the plant. The pumps operated in conjunction with a recirculation valve that controlled the pressure on the discharge header. If the system demand was light and the discharge header pressure increased, the recirculation valve opened to divert flow back to the pump suction header. Conversely, if the system demand increased, the recirculation valve closed, sending flow to the distribution system and causing the pressure to increase. During the final few years of service, as the water demand decreased, only a single 100-hp pump was used and even it was oversized for the present demand. The pump operated continuously 24 hours a day, 8,760 hours a year, even during plant shutdowns.

Original Booster Pump System



Project Implementation

Since the relocation of the booster pump station was mandated by the demolition of the original facility in the southern part of the complex, GM used a systems approach in designing the new facility. It was determined that significant energy savings could be realized by more closely matching the installed pumping capacity to the actual demand for water. In addition, it was realized that eliminating the storage tank concept and tying the pumping system directly to the city water would enable the system to utilize the available city water main pressure. Locating the new facility closer to the primary water demand area significantly decreased the pipe friction head loss. Finally, instead of utilizing a recirculating flow line to modulate the flow to the plant, it was decided to vary the motor speed to match the pumping requirements to the flow demand.

The New System

The new city water booster pumping system was located approximately a half mile closer to the current primary water demand location. Satisfactory operation was obtained with a discharge pressure of 80 psig—a 30 psi reduction from the 110 psig discharge head set point of the old pump system. In addition, city water was directly connected to the pump inlet, thus reducing the head that the pumps have to generate. These two energy-conserving steps coupled with the reduction in demand for water by the plant complex over the years enabled the original 60- to 100-hp pumps to be abandoned and replaced by three new 15-hp pumps. Two of these pumps were driven by induction motors controlled by VFDs while the third was a switched reluctance unit. The pump speed modulation provided additional operating cost savings through improved flow control. By matching flow energy to the system requirements, the energy lost in pumping against a partially closed recirculation line was eliminated.

New Water Booster Pumping System

The use of three smaller pumps in parallel provided another performance improvement over the single large pump. While most of the pumping requirements could be met by one pump, during periods of high demand the control system would automatically switch on a second pump to maintain the 80-psig discharge head. Since the pumps are the same model, this transition could be achieved smoothly. If two pumps were operating and the flow requirement decreased, one pump would de-energize while the other continued to supply the system needs. The control system was programmed so that during any 24-hour period, a single pump operated as the lead pump with the other two as backups in case additional pumping capacity was required or in case the lead pump failed. Every 24 hours, a different pump was designated as the lead unit. In this manner, all three pumps saw approximately the same amount of running time. Having two pumps act as backup for an operating pump provided additional operating flexibility and system reliability that was not available in the original pumphouse where only one 100-hp pump was in operation.

Results

To validate the performance improvement of the new system, the electrical input power and water flows to the previous system were measured. After the new system was installed, the electrical power and water flows were again measured. When extrapolated to an annual basis, the energy consumed by the system was reduced from 280,400 kWh to 55,300 kWh—an 80 percent decrease. This represented an annual decrease in energy costs of $11,255. When compared to the additional system cost of about $45,000 that can be allocated to energy efficiency measures, the new system is expected to achieve a payback of four years.

In addition to significantly lower energy usage, the inherent redundancy in the new system increased reliability. The parallel pump configuration allowed one pump to be isolated from the system for maintenance or repairs while the others served the complex.

Energy and Cost Savings

Project Implementation Costs	$44,966
Annual Energy Costs Saving	$11,225
Simple Payback (years)	4.0
Annual Energy Savings (MWh)	225

Total Annual Emissions Reductions

CO_2	394,150 lbs
Carbon Equivalent	107,496 lbs
SO_x	2,147 lbs
NO_x	1,589 lbs
PM-10	59 lbs
VOC	7 lbs
CO	60 lbs

Lessons Learned

The parallel configuration of multiple pumps combined with the use of motor speed adjustment to match system requirements to plant needs provides an efficient, flexible, and reliable pumping system. By replacing one large pump with three smaller pumps that more closely meet the present flow and pressure requirements, engineers were able to select pumps that often operated close to their best efficiency point. This pump system also served as a pilot demonstration project comparing the performance of the two motors that had VFDs against the third motor, which was an experimental switched reluctance unit. No difference in operating efficiency could be discerned between the two VFD units and the switched reluctance unit. This is not unexpected since any existing differences would be small and therefore not detectable due to system variations that can be expected in any large production facility.

Other Applications

VFDs can be applied to many pumping systems. Their relatively high operating efficiencies and ability to match flow energy to system requirements can result in substantial cost savings, both in terms of lower energy consumption and reduced system wear.

MOTOR CHALLENGE

Motor Challenge, administered by the Office of Industrial Technologies, is a voluntary partnership program with U.S. industry to promote the use of energy-efficient electric motor systems. Thousands of industrial partners have joined Motor Challenge and are improving their competitiveness and efficiency, and, in turn, the Nation's.

Motor Challenge assists the OIT Industries of the Future by identifying near-term gains in energy efficiency these industries can achieve by adopting existing technologies.

Project Partners

General Motors Corporation
Pontiac, MI

Detroit Edison Company
Detroit, MI

U.S. Electrical Motors
St. Louis, MO

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