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Power Factor Study Reduces Energy Costs at Aluminum Extrusion Plant

Summary

In 1999, Alcoa North American Extrusions (NAE) conducted a power factor study at their facility in Spanish Fork, Utah. The facility was paying approximately $5,000/month in a power factor penalty and Alcoa wanted to reduce this penalty. Alcoa also wanted to improve the efficiency and capacity of the plant's electrical distribution system and the productivity of the equipment it serves. As a result of the power factor study, supplemental capacitance was added to the distribution system and the power factor increased from 70 to 90 percent. The $5,000/month power factor penalty was virtually eliminated. Since the project's total cost was about $55,000, the project paid for itself in less than one year.

Facility Overview

The power factor at Alcoa's North American Extrusions facility in Spanish Fork, Utah, varied from 68 to 70 percent. No capacitors were originally installed in the system to correct the low power factor. A study was performed to determine how much added capacitance was needed to attain a power factor greater than 90 percent.

The NAE Spanish Fork facility has a cast house, two extrusion press lines, and additional fabrication equipment. The facility operates off a single utility feeder operating at 12,470 volts (V). Approximately 2,500 horsepower (hp) of connected load runs at the facility during normal operation. The motors vary from 1 to 250 hp, with the largest motors operating the hydraulic system for the two extrusion presses. The large induction motors can operate either loaded or unloaded during the press cycle; the unloaded condition contributed to the power factor deterioration in the system.

Project Overview

Low power factors waste money directly because of higher electricity bills, and indirectly by reducing the efficiency and capacity of the plant distribution system and the productivity of the equipment it serves. Correcting the system power factor provides four major benefits:

Benefits

- Estimated annual savings of $60,000
- Lowered electric bills
- Increased system capacity without expansion
- More effective motor performance
- Decreased electrical losses

Applications

A poor power factor penalizes the user by robbing the distribution system of useful capacity, causing electrical system losses, and giving rise to electric power billing penalties. Energy-intensive industries can benefit from a power factor study to discover ways to gain the benefits of a higher power factor.

1. Lower electricity bills because of reduced premium and penalty charges
2. Increased system capacity without expansion of the power distribution system
3. Higher, constant voltage levels which result in more effective motor performance
4. Lower line currents, which decrease the electrical losses in the lines and equipment between the power source and the capacitors

Project Implementation

The Spanish Fork power factor study encompassed the distribution system from the 12,470-V primary feeder for the three main distribution transformers to the main breakers of the 480-V motor control centers (MCCs). A computer load flow program was used to analyze the loading conditions, power factor, and voltage profile of the system. During the on-site load monitoring, the voltage levels were found to be very low in some areas of the plant. During the monitoring phase, the equipment measured and recorded significant harmonic content in some of the substations.

The results of the power factor study indicated that approximately 2,000 kvar should be added to the system to improve and maintain the required power factor of greater than 90 percent. Table 1 lists the recommended capacitance for the equipment on each of the three transformers.

Results

The power factor study cost approximately $10,000. The capacitors cost approximately $20,000, with an additional $25,000 for installation. The average facility power factor is now consistently above 90 percent, and the $5,000/month power factor penalty has been nearly eliminated. Without considering improved motor operation, improved lighting effectiveness, and increased system capacity, the project paid for itself in less than one year.

Capacitors installed at Exit Motor Control Center

Table 1. Recommended Capacitance

Transformer No.	Equipment	Recommended Capacitor (kvar)
	Ingot Plant main switchboard	400
	Log saw MCC	37.5
	Cast unit pumps MCC	22.5
	Exhaust blower	17.5
1	Combustion blower	20
	Homogenizer recirculation blowers	17.5 each
	Homogenizer cooling blowers	40 each
	Ingot recirculation water system MCC	67.5
2	5,000-amp disconnect panel	400
	Scalper hydraulic unit	35
	Age oven MCC	35
	250-hp press hydraulic pumps	60 each
	Exit Handling hydraulic unit	22.5
3	Stretcher hydraulic unit	22.5
	Quench water pump	20
	Hot saw	17.5
	Air quench MCC	80
	Finish saw	17.5
	Water quench return pump	17.5

Capacitors installed at Loma Saw Motor Control Center

Recommendations

The Spanish Fork power factor study revealed several ways to increase the power factor:

- Minimize operation of idling or lightly loaded motors
- Avoid operating equipment above its rated voltage
- Replace standard motors as they fail with energy-efficient motors. Even with energy-efficient motors, however, the power factor is significantly affected by variations in the load. A motor must be operated near its rated capacity to realize the benefits of a high power factor
- Install capacitors in the AC circuit to decrease the magnitude of reactive power. The closer that the capacitors are installed to the source of the low power factor, the greater the benefits
- Install capacitors on high-intensity discharge lighting, and select high power factor ballasts

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Project Partner

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Industry of the Future—Aluminum

Through OIT's Industries of the Future initiative, and on behalf of the aluminum industry, the Aluminum Association, Inc., has partnered with the U.S. Department of Energy (DOE) to spur technological innovations that will reduce energy consumption, pollution, and production costs. In March 1996, the industry outlined its vision for maintaining and building its competitive position in the world market in ***Aluminum Industry: Industry/Government Partnerships for the Future****.*

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