Boost Capacity and Efficiency, While Minimizing Upgrade Costs in Water Treatment Plants

Medium Voltage VFDs Provide an Ideal Solution for Many Facilities

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Introduction

The Clean Water Act (CWA) of 1972 provided impetus and funding for a major overhaul of our Water and Waste Water Treatment Plants (W/WWTP). Over time, population growth has resulted in many of these facilities being stretched to the limit of their capabilities. Plants are limited by capacity and often by electric service when trying to fill their expanded needs.

This paper addresses means to increase efficiency and capacity, as well as a novel approach to minimize upgrade costs for future electric service expansion in some facilities.

First, a case study of a recent project that increased both efficiency and capacity, then a phased approach to cost effective capacity increase in plants powered from 2400V.

A Cost Effective Means of Saving Energy and Increasing Capacity

The Municipal Authority of Westmoreland County (MAWC) provides water to 125,000 customers in a 5 county region near Pittsburgh, PA. A recent upgrade to MAWC's George R. Sweeney Water Treatment Plant improved both efficiency and capacity.

The Sweeney plant opened in 1996. The plant used centrifugal pumps operating at full speed with flow controlled by throttling valves. This was the lowest installed cost alternative, commonly implemented at the time.

The cost of electric power is now a major component of a facility's expense. Throttling control valves to achieve flow control is extremely inefficient when compared with controlling the speed of the pump with a Variable Frequency Drive (VFD). Figure 1 shows a comparison of the energy consumption with throttling vs. VFD speed control.

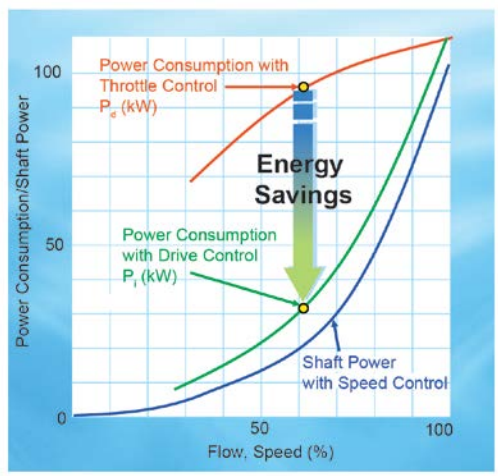


Figure 1: Energy Savings with Speed Control

MAWC researched alternatives and chose to remove the throttling control valve and invest in the energy saving capability of a Variable Frequency Drive (VFD). The application at Sweeney was a 4160V, 700HP pump.

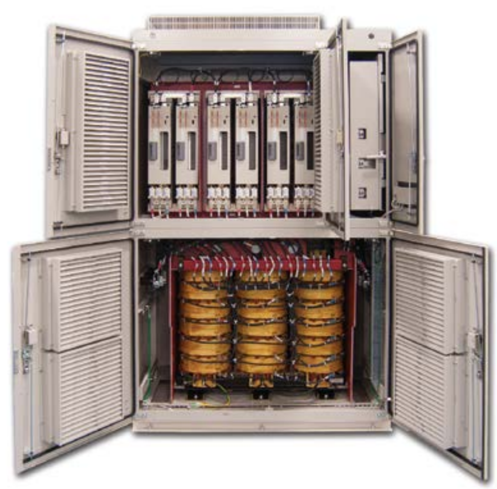
Outside of energy savings, what other considerations are part of a VFD installation? The impact of the VFD on the plant power system and on the motor must be considered. Medium Voltage (MV) VFDs as discussed here deserve careful attention.

On the input power side: harmonic currents caused by the VFD can have negative effects. A 20HP Low Voltage (LV) (230-600V) drive may produce enough distortion to annoy an adjacent instrument, easily corrected. On the other hand, a 700HP, 4160V MV VFD may have a serious impact on peripheral equipment (and neighboring facilities). It is important to meet the criteria of IEEE 519, a measure of allowable input distortion.

On the output side: the VFD synthesizes a more-or-less sinusoidal waveform ("more or less" varies with the VFD technology) often requiring filtering to protect the motor. Retrofitting an MV VFD in an existing facility requires a careful review of the application.

MAWC called on the expertise of DRV, Incorporated, a Pennsylvania and Ohio Yaskawa distributor, Authorized Service Provider and drive system integrator who had served MAWC well on other projects. DRV suggested, and MAWC purchased, the Yaskawa MV1000 Medium Voltage VFD as the optimum solution for a number of reasons:

- Input harmonics: the Yaskawa MV1000 Smart Harmonics™ Technology results in input harmonic distortion of <2.3%, well below the IEEE 519 limit, without input filtering.
- Output waveform: the 9 level output (17 level line-to-line) of the MV1000 is a high quality sinusoid needing no filtering, even on existing motors.
- Reliability: the Yaskawa MV drive population in the Americas has a field proven Mean Time Between Failures (MTBF) of >300,000 hours, by far the best in the industry



Jack Ashton, Operations and Production Manager of MAWC, commenting on the installation, said: "Yaskawa and DRV were chosen due to the simplicity of the MV1000 VFDs and our experience with DRV Incorporated. DRV came out and assisted us in getting the drives running over night into the weekend so that we were able to maintain water service to a highly populated district. MAWC will continue to specify Yaskawa drives and DRV in future projects."

He reported that initial analysis of the George R. Sweeney Yaskawa MV1000 installation will show energy savings of ~$174,000 per year. The cost of the Yaskawa MV1000 and its installation will be paid back in <2 years.

The capacity increase is significant as well: removing the throttling valve reduced restriction and increased the pump output capability by 200,000 GPD.

A Special Consideration for Facilities Powered from 2400V

The case study above was for a facility powered from a 4160V supply. Many Water/Waste Water Treatment Plants are powered from 2400V, particularly in the northeast US and Canada.

In the mid to long term, these facilities will likely need increased capacity, with the resultant need for increased electric power. The easiest and most cost effective way to provide the required power is to increase the input voltage from 2400V to 4160V.

In the short term, a facility may need the addition of an MV drive for a new process or for the efficiency gains discussed above.

If an MV VFD is needed today for operation from 2400V, and three years from now the facility is upgraded to 4160V, what happens to the old drive?

- Discard it (with many years of service still left) and replace with a 4160V VFD? Expensive solution, considerable wasted capital in the original purchase, and two times the installation expense.
- Add a step down transformer and continue operating this section at 2400V? Additional cost for transformer, additional space requirement and additional operating cost by virtue of the losses in the new transformer.
- Eliminate the drive entirely? Loose the efficiency gains of adjustable speed control as well as optimum process control.

There is a best solution: The Yaskawa MV1000 Medium Voltage VFD.

- Order an MV1000 4160V MV VFD with fused input disconnect.
- Specify that the standard input transformer is to be connected for 2400V primary.
- Yaskawa will provide the proper input fusing for the 2400V input.
- If the motor is being replaced, order a 4160V motor.
- If the existing motor will be retained, it can probably be reconnected for 4160V. If not, have it rewound for 4160V.
- Install the Drive, commission, and put the system to work.

In the future, when the facility is upgraded to 4160V:

- Reconnect the MV1000 transformer primary for 4160V.
- Replace the input fuses with the proper current rating for the 4160V input.
- Put the system to work **(that's all there is to do)**.

Capacity increase and energy saving can be achieved in the short term, with virtually no additional cost to the MV VFD package when the plant is upgraded to 4160V. An ideal solution in many facilities.