Users Return to Proven Technology for Variable Speed Pumping

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The merits of adjustable speed operation for centrifugal pumps have been recognized for most of a century. By far the most common driver for a centrifugal pump in an industrial or municipal setting is an AC induction motor, favored for its rugged simple construction and long service life. However, these motors have a significant drawback: They operate at only one speed, and the choice of that speed is limited to specific choices, dictated by the line frequency (60 Hz in North America) and winding configuration of the motor (number of "pole pairs"). Pump designers must choose a speed which most closely achieves the performance they desire (flow rate and pressure) and design the pump to match or approximate the required output.

Four Dynamatic 450 hp 514 rpm vertical eddy current drives.

However, many applications call for the ability to match performance to an unregulated variable demand. These pumps must be designed to achieve the maximum expected demand but operate at conditions often requiring far less flow or pressure.

Over the decades, a variety of ideas has been devised for controlling the speed of the pump with a motor designed for only one speed. In the 1950s to 1970s, eddy current drives (a.k.a. magnetic drives, eddy current clutches) were a widely preferred solution for variable speed operation. These devices used the mechanical power of the constant speed motor and transmitted torque to the load at a controlled value, thus controlling the speed of the pump, or regulating it as the load varied.

Beginning in the 1970s, a new technology began to emerge: variable frequency drives. Advancement in power electronics technology made available a wide and evolving variety of semi-conductor switching devices with ever increasing voltage, current, and switching speed capabilities. Circuit designers and their marketing colleagues devised VFDs which promised variable speed operation of AC induction motors with better efficiency, simpler installation, less maintenance, and lower cost than the venerable eddy current drive. Encouraged by a plethora of manufacturers entering the market, users began to shift their choices and select a VFD solution in lieu of the eddy current drive.

As more and more VFDs were implemented, it began to appear that VFDs were not the "easy solution" they were promised to be. Installation problems began to emerge, including:

- Harmonic powerline interference
- Demand for harmonic studies prior to implementation
- Harmonic motor heating and increased losses
- Motor bearing damage

- Early failure of power electronics
- Sensitivity to heat, much of which generated by the unit's own losses
- Need for space to house the large cabinets
- Need to air condition space in a majority of applications
- Sensitivity to power quality problems
- Reliability problems (leading to the invention of the "bypass starter")
- Early obsolescence making repair parts unavailable
- Standby generator interference
- Reflected voltages on long motor leads

Manufacturers and Engineers have been able to devise solutions for many of these issues, but these solutions come with added cost, space requirements, and energy losses. For example:

- A large municipal user recently posted bids for a harmonic filter system to mitigate VFD harmonics at a water reclamation plant for an estimated cost of $387,000.
- A Texas consulting engineer recently commented that air conditioning failure was the single most common cause of an outage on variable frequency drives.

As a result of these issues with VFDs many users are now returning to the use of eddy current drives for their variable speed pumping applications. Here are some examples from operations that have returned to this proven technology.

Dynamatic Controls

87th Street Pumping Station

Beginning in 2015, the City of Kansas City, MO needed to add variable speed drives and replace pumps in a large wastewater pumping station. Having had some disappointing results with VFDs in recent years, the city elected to specify four 450 hp 514 rpm vertical eddy current drives at the 87th Street Pump Station. The project was publicly bid and the order for the drives and controls went to Dynamatic, a long-lived proponent and manufacturer of eddy current technology. This equipment replaced constant speed motors and pumps whose only means of flow control had been throttled valves.

Blue River WWTP

In 2018, Dynamatic and their local representative, Mid America Pump (a.k.a Letts Van Kirk) supplied 350 hp eddy current drives to retrofit three existing constant speed motors at the Blue River Treatment Facility. The influent pump array consisted of seven identical pumps, four of which are controlled with existing VFDs. The other three were rarely used, because their operation at full constant speed resulted in frequent cycling as the pump over ran the demand flow.

Mid America provided the structural engineering review to assure the motor foundation could support the added weight of the eddy current drive. The motors were sent to a local repair facility for inspection and refurbishment under a blanket agreement with that facility. Mid America also supplied the installation labor for the units after the motors were sent, one by one, to Dynamatic to be fitted with their new ECDs.

A major consideration for choosing ECDs over VFDs in this application was the lack of available space to house any more VFDs.

Round Grove Pump Station

In 2019, at the direction of KCMO, AECOM specified two 1000 hp 720 rpm eddy current drives and induction motors for the new main pumps at the Round Grove Pump Station, replacing equipment that had been damaged when the station was flooded. Dynamatic received the order from the General Contractor and supplied the motors, ECDs, and exciter/controllers for these pumps.

N.E.I.D. (North East Industrial District) Pumping Station

Adjacent to the Blue River Plant is the N.E.I.D. Pump Station. Pumps there were equipped with 500 hp motors and VFDs. In 2020, in a similar fashion to the Blue River project, Mid America and Dynamatic retrofitted three units with suitably sized eddy current drives, while reusing the existing motors. This retrofit is especially notable because in this instance, *the ECDs are replacing VFDs*. As of this writing, two more VFDs are budgeted to be replaced by ECDs in 2024.

Industrial or municipal plants that need adjustable speed operation for centrifugal pumps need to consider the long-term benefits, expenses, and maintenance requirements when choosing the right drive technologies. As evidenced here many operations have returned to time-tested and proven eddy current technology for variable speed pumping applications.