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Technical Notes by Dr. Mel
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Selecting a Variable Speed Drive for Pumps, Fans or Compressors

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Efficiency and Reliability...a drive that delivers both

With rising energy costs and stricter environmental regulation, there is a corresponding interest in reduced operating expenditures and emissions. It is well known that operating pumps, fans and compressors at variable speed offers greater efficiency and lower costs.

When choosing a variable speed drive, the questions are:

What is the application?

What type of drive?

What is the efficiency?

What is the reliability?

For high powered drives over 3,000 hp, there are three different and competing variable speed power sources:

Mechanical drive steam turbines

Electronic variable frequency drives

Variable speed fluid drives

A track record comparison for these three choices may be surprising to many

Electronic Variable Frequency Drives (VFDs) are built on solid state technology using assorted items such as thyristors, SCRs, and the like. They function as on-off switches for voltage and current to provide step functions in the alternating current electronic wave patterns. As such, there are very high frequency components that are transmitted to the driving motors and are reflected back throughout the electrical neighborhood. Big pulses occur when high torque is required such as when big speed increases are demanded by the controller. While the main AC to DC and DC to AC portion of the process may be 95% efficient, the addition of input isolation transformers, output transformers, and air conditioning adds considerable losses such that the net overall efficiency could likely be in the range of 85% to 90%. Solid state equipment has a number of issues to consider: (a) When an electronic component fails, the entire drive unit usually shuts down causing serious problems for the rest of the plant, particularly for processes that do not have redundancies, such as a single main boiler feed pump. (b) Components become obsolete. It is almost always necessary to use components made by a specific OEM. Over the course of years, components and OEMs change and maintenance can become a big problem.

Additional requirements for solid state drives should be addressed:

(c) Specially built motors, input isolation transformers, output transformers, filters, and oversized cables,

(d) heavy duty air conditioning is required to control the environment for the solid state electronics: temperature, dirt, and other airborne materials such as salt.

Mechanical drive steam turbines have a maximum efficiency converting steam energy to mechanical energy of approximately 70% as compared to an efficiency of 90+% for main steam turbines. Generally, they are relatively reliable, but these turbines have substantial maintenance of control valves and steam path components that erode or wear and need to be rebuilt every 6-10 years. Mechanical drive steam turbines used for starting up a power plant require an auxiliary boiler, which has its own issues.

Variable speed fluid drives are mechanical devices that can be built with many different arrangements. Units built exclusively with film bearings in the straight through arrangement or utilizing speed changing gears have excellent reliability records with very low maintenance costs. They run for years, often for at least ten year inspection intervals. They are rarely opened. The efficiency of these fluid drives for properly designed equipment trains ranges from a low of approximately 65% at the low speed, low power end of the normal operating range to 93% to 95% at the top end of the normal operating speed range.

Certain types of variable speed fluid drives depend upon rolling element bearings. Because rolling element bearings have a limited life expectancy, these fluid drives occasionally experience untimely failures during operation which can shut down a plant.

In recent years, some fluid drive vendors have attempted to use complex gearing to achieve very high efficiencies in the normal load range, typically 83% to 93%. However, they depend upon rolling element bearings to achieve this high efficiency. Recent experience with this design suggests that

some of the rolling element bearings are suffering unanticipated and premature failures. A rolling element bearing failure can cause immediate shutdown of a process. Further, this fluid drive design is so complex that it almost always has to go back to the factory for rebuilding.

TRI has developed high efficiency geared fluid drive designs that use only film bearings throughout. These fluid drives have operating efficiencies between 80% and 93% throughout the normal load range. This design has two parallel fluid drives with two different gear ratios to provide two separate peak efficiency points within the operating speed range, shifting smoothly from one range to the other as the speed varies. The peak efficiency point, approximately 93%, that is within the speed range can be selected to maximize the efficiency of the process. Using only film bearings and using AGMA class 12 -13 gears, these fluid drive units are highly reliable. No rolling element bearings are used. These fluid drives can be adapted to almost any pump, fan, or compressor application, and can be maintained by almost any reasonably well equipped repair facility. These fluid drives can be driven by an induction motor, a synchronous motor, or from the end of a turbine-generator. The later arrangement provides the most efficient method of driving a boiler feed pump for a steam turbine-generator power plant.

It is becoming more common for motor driven variable speed fluid drives to be used to replace mechanical drive steam turbines in various processes. In electrical generating plants, such replacements keep the steam passing entirely through the main steam turbine, which is sufficiently more efficient that more electricity can be produced by the main turbine-generator than will be consumed by the replacement electric motors and variable speed fluid drives. This increases the amount of electricity available for sale.

In refinery processes, in addition to higher relative efficiencies in operation with motor driven fluid drives, benefits accrue due to substantially reduced maintenance costs, and elimination of the issues related to steam piping and condensers.

Motor driven fluid drives permit load equipment (pumps, fans, compressors) to be used for start-up eliminating the need for auxiliary boilers which are needed to start-up mechanical drive steam turbines.

It is also becoming more common for variable speed fluid drives to be used to replace variable frequency drives (VFDs) because fluid drives are more reliable and do not have the instantaneous modes of failure that VFDs have.

Contact TRI for details for how

TRI Variable Speed Fluid Drives can improve

your application, whether new or retro-fit.

TRI product & service information is available at www.turboresearch.com

We make “house calls” Emergency tel: 610-283-9077

For more solutions to common problems, visit our “Case Studies” published on our web site:

http://www.turboresearch.com/index_casestudies.asp

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