



Shippensburg Pump Company, Inc.

BOILER FEED • CONDENSATE • DEAERATOR • VACUUM

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May 7, 2010

Re: When and why Variable Frequency Drives (VFD's) are used on Boiler-Feed and Deaerator Steam systems that are typically designed for pressures over 50 psig.

Applications Appropriate For VFD's:

There are instances in a boiler-feed or Deaerator steam system that makes use of VFD's practical

- Often times steam systems have boilers that operate at lower operating pressures than the boilers' safety relief valve is designed to meet. The ASME code requires the pumps discharge design pressure to be the safety relief valves set point - plus 3 %. Design engineers frequently fail to lower the relief valve set point on the boiler to match the lower "actual" operating pressure. A VFD is recommend when operating the boiler(s) at a pressure more than 30 psig below the safety relief valve setting.¹

A VFD can electronically "ramp down" a centrifugal pump² to the lower required discharge pressure to match the "real time" boiler operating pressure and keep the pump's **NPSH requirement** (NPSHr) in check or "hold the pump on curve". Failure to "ramp the pump down" with a VFD will allow the centrifugal pump to seek its own operating pressure and thus the pump starts to cavitate based on a lower operating pressure.

- Shipco[®] provides an automatic flow control valve (as opposed to utilizing manual balancing valves) as a standard of design recommendations. When the pressure difference between boiler design pressure and boiler actual operating pressure reaches a significant differential (which we consider 30 psig), using a VFD reduces energy consumption. The automatic flow control valve is limited in the amount of pressure differential it can compensate. We do not like to go beyond 60 psig differential as a general rule for depending on automatic flow control valve to function as the mechanism for resistance. When the auto flow control valve opens it allows the pump flow rate (GPM) increases and thus, the pump's NPSHr also increases and the pump starts to cavitate.
- Continuous run applications can use the modulating feedwater valve to help keep the centrifugal pump on its curve. When significant pressure differences discussed previously occur (e.g., on boiler blow down situations or boiler start-up situations when immediate demand is high) the modulating valve will open fully. The automatic flow control valve may not be able to absorb the differential pressure when the modulating valve is open fully. When those significant pressure

¹ Check all local and state codes, regulations, and laws on boiler operation to verify that it is legal to operate boiler at a lower pressure the originally designed.

² Shipco Pumps does not recommend these same instructions when a turbine pump is being used due to entirely different design characteristics of a turbine impeller and its relevant pump curve.

differences occur and the automatic flow control valve starts opening up the pump flow (GPM) increases rapidly and in turn causes the pump NPSHr to increase. When this happens a centrifugal pump can cavitate. When utilizing a VFD, the pump user can “ramp up” and “ramp down” the pump discharge pressure to immediately respond and address these significant pressure differentials.

Shipco[®] Pumps’ Recommendations:

Based on the factors already discussed and our trouble shooting experience as a pump manufacturer, it is Shipco’s[®] position that the best applications for VFD’s in feed water service is to utilize a VFD where the following conditions exist:

- In order to reduce energy costs and increase energy efficiency on steam systems when there are significant varying boiler operating pressures (night or summer setbacks, factory shut downs / slow downs, significant process load variances, wood burning boilers), the use of a VFD can save energy. When the motor RPM is controlled electronically so the pump discharge pressure will more efficiently match the boiler operating pressure in “real time” the horsepower required is reduced by a factor in proportion to cube of the speed reduction. (see pump affinity laws)
- A VFD is recommended when operating the boiler(s) at a pressure more than 30 psig below the safety relief valve setting.
- Protecting a centrifugal pump from cavitation in a high-pressure system on applications where there are severe pressure differentials between boiler operation points and original boiler design points and an auto flow control valve is being used to provide artificial back pressure on the pump.
- Boiler feedwater and deaerator applications where the centrifugal pump discharge pressure is 75 PSIG and higher and where the relief valve setting on the boiler is not changed to closely match the operating conditions of the boiler and steam system.
- Continuously running feed water centrifugal pump applications where the motor horsepower is 15 horsepower and larger.

Shipco[®] is a pump manufacturer, therefore, it is important that we strongly encourage engineers of steam systems to consider the variables discussed in this article and how they affect the operation of the steam system being designed at the outset and not retroactively.

Most importantly to us, this includes picking the appropriate feedwater pump for the condition points the pump will be expected to perform at during its operation cycles. This will not only reduce overall initial costs of a project, but it will extend the life of the mechanical equipment significantly, and it will reduce or eliminate substantial maintenance and replacement costs of pumps.