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Efficiency & Reliability in Boiler Feed Water Applications

By Keith Hamilton, published August 15, 2018

Optimized pumps ease the day-to-day process for university cogeneration facilities

The steam/cogeneration facility at one of the oldest Ivy League colleges in the United States plays a critical role for faculty and students—providing seasonal heat and air conditioning, plus electricity for the labs and instruments used throughout the campus.

Like many cogen plants around the country, segmented ring pumps were installed decades ago for boiler feedwater applications. During this time, it was common practice to deploy smaller versions of pumping and piping infrastructure that worked well in large utilities. It was assumed that proven technology for utility-grade power plants could be scaled down for universities or hospitals. But in practice, many cogen plants like this one experienced a technology transfer gone bad, due to a common constraint tied to the height of the roofline.
n most boiler rooms at older universities around the country (as well as many hospitals and pharmaceutical companies), the height of the roofline limits the vertical distance between the deaerator and the boiler feedwater pumps. As a result, net positive suction head available (NPSHa) to pumps is limited, and suction transient conditions enable vapor to travel from the deaerator to the pump. This causes cavitation, pump failures and—in some cases—plant shutdowns. Larger utilities do not suffer this problem because the physical distance between the deaerator and boiler feedwater pumps can be three to five times larger.

For this university's maintenance team, the setup caused weekly maintenance work on their segmented-ring pumps. A review of maintenance logs showed that more than 1,600 hours of work was required to keep their ring pumps operating. Thirty-two work orders were placed to repair seals and rebuild bearings. During a four-year period, they experienced four catastrophic pump failures. Downtime is never acceptable for plants in cold winter environments such as the Northeast.

Image 1. An Ivy League college needed an update to its cogen facilities. (Images courtesy of Sundyne)

The maintenance requirements for this university's ring pumps reached an untenable position, requiring constant monitoring to check the seals or inspect the bearings. Beyond the financial costs—$75,000 for parts and labor—morale for the maintenance team had reached a breaking point. Each winter morning's commute brought anxiety and the anticipation of pump problems awaiting the start of each day.

Improvements for the boiler feedwater applications came by making a switch to the pumping infrastructure. After extensive equipment analysis and a review of more than eight years of data, the segmented ring pumps were replaced with industrial grade pumps.

They also implemented a new configuration to enhance the steam rate, improve efficiency and permanently solve the excessive maintenance problems.
Integrally geared high-pressure pumps feature thrust bearings as part of their unique modular shaft assembly, which is sized to handle axial thrust without problematic balancing devices. The previous ring pumps were multi-stage designs that required a dynamic hydraulic balancing disc. Under normal operating conditions, water flowing through the pump kept everything in balance, but the suction transient conditions enabled vapor to reach the bearings. This upset the balance and caused the rotor to shift back and forth. Because the clearances are extremely tight in ring pumps, even a slight shift can cause the impeller to hit the casing, which can lead to pump failures.

The new pumps featured single-stage designs, with optimized suction inducer technology that addresses low NPSH requirements in a way that eliminates pump cavitation. They also featured high-pressure impeller technology that is optimized to deliver high head. These features enabled the new pumps

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to withstand the upset conditions that plagued the previous ring pumps.

Once the suction transient conditions were addressed, the next step was to enhance the plant's efficiency, and implement a flexible configuration that could be varied from season-to-season. The university's engineers were quick to point out how the seasonal load swing increased the strain on the ring pumps, which exacerbated maintenance issues every time they made a switchover. After reviewing the data, it was determined that instead of running two pumps at 50 percent capacity, the university would be better served running three pumps at 33 percent capacity. Hydraulic casing, gear ratio and impeller speed can be easily varied on the industrial grade pumps, providing turndown flexibility for warmer months—and the ability to boost steam output in winter months—without ever exceeding the pump's best efficiency point (BEP).

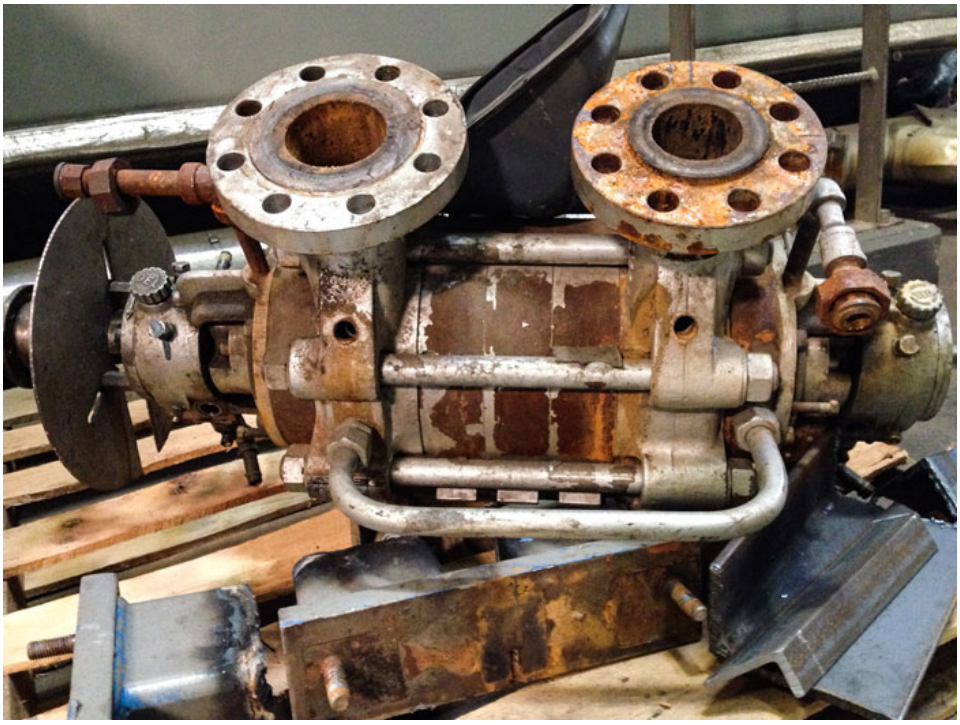

Image 2. Rusted segmented ring pump

The Value of Streamlined Maintenance

The first maintenance benefit the university noticed about the new pumps was the simplified service access. Their ring pumps were difficult to access. Each ring pump weighed almost 300 pounds and required an A-frame and chain hoist to lift and remove for service. The situation was complicated by very little head space in the boiler room. Once a ring pump was removed, it could be out of duty for months awaiting parts, which are difficult to procure on short lead times.

The new industrial grade pumps feature a modular shaft assembly that can be serviced in place. Over the last four years, the university has only had to replace one shaft assembly, and the job was accomplished by simply swapping in a new module without having to disconnect the motor. Beyond this one issue, the only other maintenance required has been regularly scheduled oil changes every six months versus daily inspections for the ring pumps and what seemed to be nonstop maintenance.

For the university's engineering team, addressing the suction transient issues and solving their pump failures was job one. Enhancing efficiency with a more flexible approach for each season was their second priority. But the best improvement gained from the new industrial grade pumps came from the streamlining of their maintenance program.

The pump upgrade has enabled the university's maintenance team to be more effective. Instead of always focusing on boiler feed pump problems, they are now able to spread time and resources out across the entire campus—providing a return on their investment that is not only measured in dollars, but also in time and peace of mind.
About the Author

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