AFT FATHOM™ CASE STUDY

Selecting Pump Upgrades and Operating Modifications for Existing Chilled Water System

General Facility

Applied Flow Technology

PROBLEM

Natraj Arjunan, engineer at L&T Technology Services in Chennai India, was tasked with reviewing and simulating an existing chilled water system to diagnose system issues and recommend design and operational improvements accordingly.

Four identical cooling systems needed pump replacements, creating an opportunity for system improvements. The client did not expect any change to the pump specification or the system since the system had been running for 20+ years without any change in cooling requirements.

SOLUTION

The calibrated model revealed that the volumetric flow rate of 99 m^3/hr (26,150 gal/hr) was above the pump's preferred operating range, beyond the heat exchanger's maximum flow rate, and led to main line velocities beyond the maximum. While peak pressures were within specification, pressure gradients were severe and contributed to higher pump energy use. Due to the analysis data, a proper pump was selected and the throttling valve position was optimized for the pump to operate at BEP.

The optimized pump selection and operating conditions reduced estimated pump energy use from 10.1 to 1.6 kW (13.5 to 2.1 hp). These changes dramatically lowered frictional pressure gradients, and kept mainline velocities within the desired range (Figure 2) while achieving necessary cooling performance and maximizing pump and heat exchanger lifespans. Because there are four identical cooling systems operating 8000 hours per year, this represents an annual energy savings of 272,000 kWh and annual cost savings of £50,320.

"When we create a model, we always use Design Alerts irrespective of how small the model is as they always help us during review time."

- Natraj Arjunan, L&T Technology Services

ANALYSIS

A model of one of the existing chilled water cooling systems was built in AFT Fathom from pipe drawings and manufacturer pump and heat exchanger datasheets. Valves were modeled using built-in AFT Fathom handbook data for pressure loss curves, the heat exchanger was modeled using the custom resistance curve option, while the pump was modeled with pump and power curves from the datasheet.

Design Alerts were set for coolant velocities with a desired velocity below 2.5 m/s (8.2 ft/s) and a maximum velocity of 3 m/s (9.8 ft/s) for the main lines. Additional design alerts were set for pump power at a maximum of 10 kW (13.4 hp), and static pressures limited to 9 barG (130 psig) throughout the system.

Comparison of the initial model to the sensors in the real system determined that the butterfly valve throttling the pump was actually partially closed. Pressure measurements were taken upstream and downstream of the valve and used to calibrate the open percentage of the modeled valve to achieve the same pressure delta.

System: London, UK

L&T Technology Services

ELEMENTS OF SUCCESS

The substantial energy savings, use of field data to validate the AFT Fathom model, and use of model results to understand the shortcomings of the existing configuration and to select optimal replacement pumps, earned Arjunan the Platinum Pipe Award for Operational Benefits and Sustainability.

FIGURE 1

Figure 1: Efficiency gains were achieved by reducing throttling valve resistance and system flowrate, downsizing the pump, and operating the new pump near its BEP.

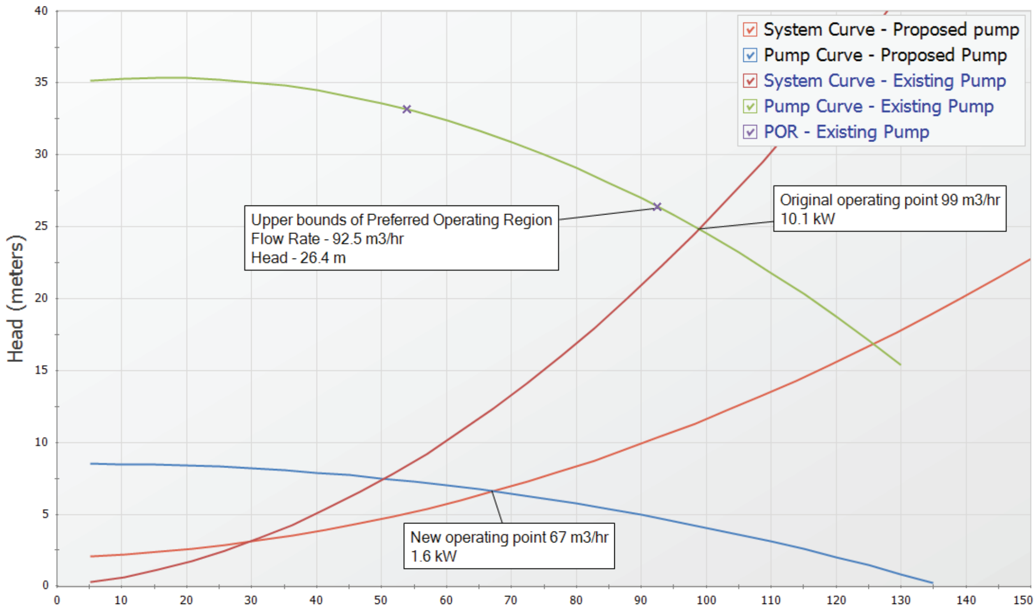

FIGURE 2

Figure 2: The proposed design improved pressure gradients and allowed velocities in main lines to remain within system specification.