

Cooling Water

Chemical & Petrochemical Industry



Ingenero Technologies Pvt. Ltd.

Thane, India

Platinum Pipe Award Honorable Mention: Correlation to Test/Field Data

Ingenero Technologies engineers Santosh Kumar and Swapnil A Paingankar were tasked with analyzing a petrochemical cooling water system which was unable to meet system design requirements. Insufficient cooling water supply limited plant capacity, thus reducing the profitability of the plant. The team performed their hydraulic analysis in AFT Fathom, revealing the shortcomings of the existing system and providing design alternatives to return to design capacity.

Kumar and Swapnil's analysis began by collecting design data provided by the client. This data included isometrics of the network, P&IDs of the system, and many component datasheets for pumps, valves, and heat exchangers to accurately translate the system into Fathom. Other component information such as valves characteristics, heat exchanger resistance curves, and flow meter resistance curves were implemented using field data in built-in Fathom features. The final model is found in Figure 1 with its color-coded supply and return lines, annotating the different consumer user groups.

“The plant validation simulation in AFT Fathom opened up avenues for possible improvements which were inconceivable solely based on plant data analysis.”

In addition to design information, survey data for critical consumers was collected in the field to validate software results. The team found flow rate deviation between model predictions and survey data was often within the acceptable +/- 10% range. Similarly, pressure deviations were within +/- 5% for the available measurements.

The exact flow and pressure variation in each user group is found in Tables 1 and 2 respectively, highlighting the validity of the model. Components of the model solely specified from design information had larger variance, likely indicating performance deterioration as the system aged.

Model analysis also revealed the system's main header flowmeter was miscalibrated, reporting 14,000 GPM (3,200 m³/hr) more than the summation of individual readings, roughly a 10% deviation. The summation of individual values aligned with AFT Fathom determined flowrates, and the flowmeter was thus corrected.

Following calibration, analysis of the model indicated several consumers with much greater pressure drop than was designed. In some cases, a consumer saw a pressure drop of 2.5 kg/cm² (35.5 psid, 2.54 bar), more than 5 times the designed pressure drop of 0.5 kg/cm² (7 psid, 0.48 bar). The team cites AFT Fathom's Visual Report for accelerating the analysis of the system, allowing them to focus on specific problem areas to simulate, observe, analyze, fix, and validate their proposals.

The team's proposals were determined from sensitivity analysis in AFT Fathom, exploring configuration changes such as valve setting, replacing components, and variable pump operation. By replacing a particular consumer group, hydraulic analysis revealed the client could reduce the number of operating parallel pumps and still meet demand. Operating 4 of the existing 5 pumps would improve operational flexibility (with the optional standby pump which could increase capacity) and reduce power consumption, increasing the plant's profitability.

The team also considered increasing pump impeller diameter, shifting the composite pump curves and potential operating points. With options to change the number of pumps running, impeller diameter, system configurations, or a combination of all the above, the team relied on Fathom's pump-system curves to easily determine system operation. Figure 2 below explores running various pumps for different system configurations. Multi-Scenario pump-system curves

A global provider of high-end specialized engineering and process engineering services, Ingenero provides continuous remote monitoring and operations guidance for the processing industry. Ingenero's main offices are in Houston, USA and Mumbai, India. A combination of a dedicated industry skilled teams with cutting edge technical tools and expertise, along with state-of-art software enables Ingenero to provide continual support to client's customized goals.

concisely condense potential operating points for a system to a single figure, especially useful during sensitivity analysis.

Through their diverse analysis in AFT Fathom, Kumar and Paingankar were able to easily calibrate, quickly understand, and intuitively visualize how the system would react to their changes. AFT Fathom accelerated their progress toward a resolution, ensuring their customer was able to recover their lost production while lowering operating costs in the process.

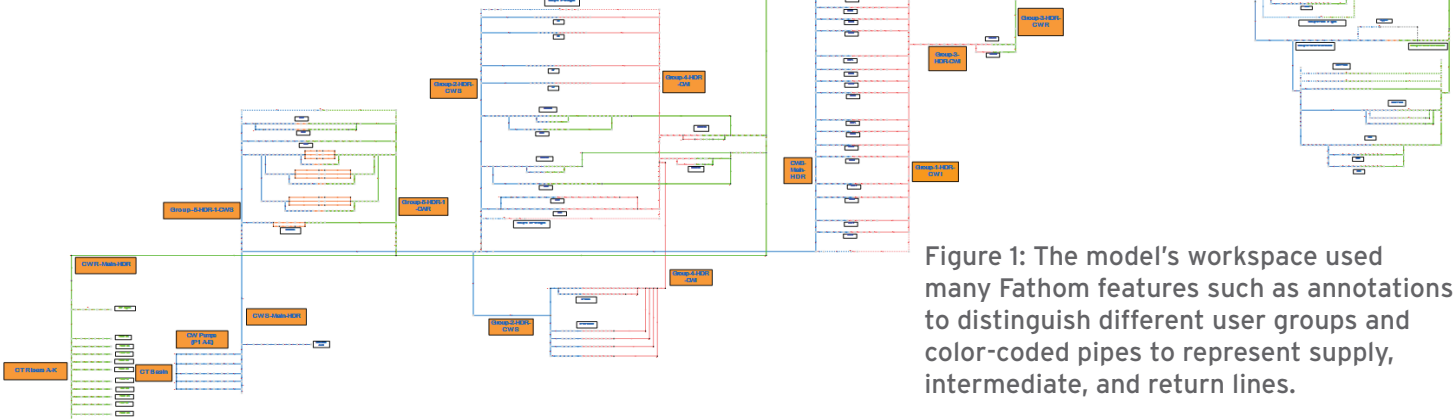


Figure 1: The model's workspace used many Fathom features such as annotations to distinguish different user groups and color-coded pipes to represent supply, intermediate, and return lines.

Flow Result Comparison	Survey GPM (m3/hr)	Model GPM (m3/hr)	% Difference
Primary Users - Group 1 <i>Cracked Gas Aftercooler</i>	27,811 (7,585)	33,395 (6,317)	18%
Primary Users - Group 2 <i>Reactor Intercooler/Cooler</i>	56,708 (12,942)	56,982 (12,880)	0%
Intermediate Users - Group 3 <i>Turbine Surface Condenser</i>	31,844 (7,585)	33,395 (7,233)	5%
Intermediate Users - Group 4 <i>Turbine Surface Condenser</i>	56,822 (13,333)	58,702 (12,906)	3%
Primary Users - Group 5 <i>Quench and Condensate Cooler</i>	24,123 (5,509)	24,254 (5,479)	1%

Table 1: The comparison between flow survey results and modeled results indicated reasonable correlation and trustworthy model results.

Pressure Result Comparison	Survey psig (barG)	Model psig (barG)	% Difference
CW Pump P1-A discharge	78.0 (5.38)	75.1 (5.18)	3%
CW Pump P1-B discharge	78.0 (5.38)	75.1 (5.18)	3%
CW Pump P1-C discharge	78.0 (5.38)	75.0 (5.17)	3%
CW Pump P1-D discharge	78.0 (5.38)	74.6 (5.14)	4%
CW Pump P1-E discharge	78.0 (5.38)	74.1 (5.11)	4%
CW supply header	76.4 (5.27)	73.6 (5.07)	3%

Table 2: Pressure surveys for pump discharge correlated with model results even more so than flow results.

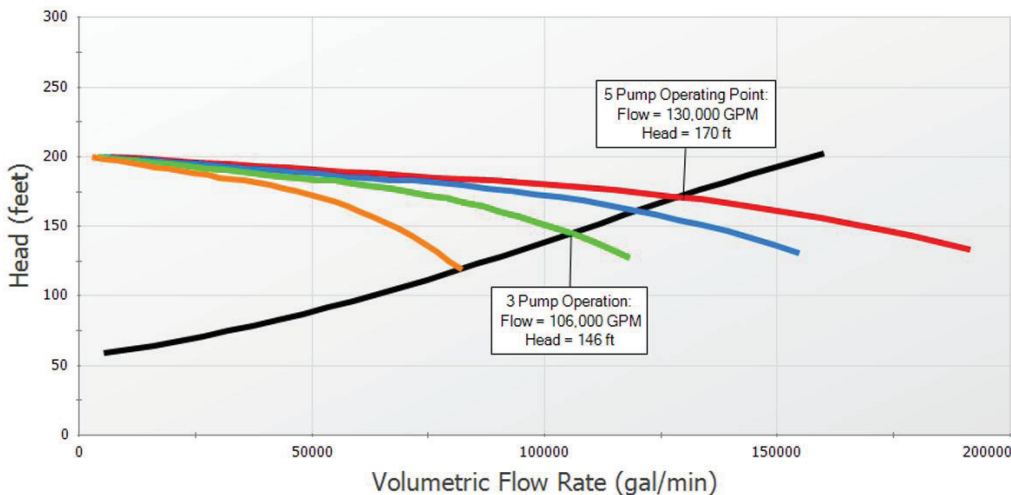


Figure 2: Multi-Scenario pump-system curves allowed the engineers to view the diverse operating points found by selectively running pumps in parallel.