Surge Analysis for Complex Pipeline Network Systems of a Thermal Power Plant

Swaminathan.S
Process Systems Engineer
Gyan Data Private Limited
Chennai-600113 India
swaminathan@gyandata.com

About the Client

Thermosystems Pvt. Ltd. is a complete EPC and turnkey solution provider with in-house design and engineering facilities. Their services entail design, engineering, mechanical fabrication, erection and commissioning of low pressure piping such as river water intake piping and cooling water piping.

Motivation

Water hammer is a pressure surge phenomenon caused when a fluid in motion is forced to stop or change direction suddenly. During operation of the piping network, this phenomenon is often observed routinely without no apparent causes. Any pipeline network design performed without taking this into account has a high potential for equipment damage and pipeline fracture due to extremely high impact and hoop stresses in the pipe. Its importance is amplified for design of failure proof systems such as Thermal Power Plants. Understanding this need, Thermosystems Pvt. Ltd approached Gyan Data for performing surge analysis of the pipeline subsystem of a thermal power plant planned to be commissioned at Cuttack, India.

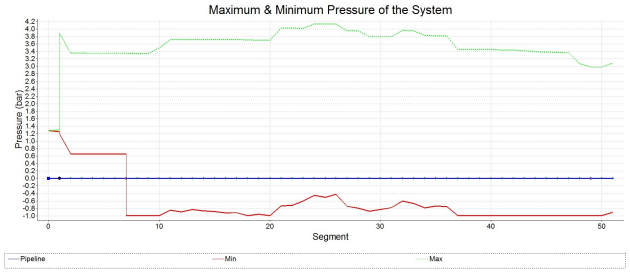
Problem

The problem involves finding the locations in the system where cavitation occurs (System pressure drops below the vapor pressure of the fluid) and ensuring that the maximum pressure obtained during transient events, does not increase beyond the maximum allowable pressure of the pipe. The underlying pipeline network comprised of three subsystems viz. the river water, cooling water-1 (CW1) and cooling water-2 (CW2).

The analysis was performed using commercially available software package KY Pipe. Though the software provided much of the needed features, some network specific modifications had to be made as there was no out-of-the-box solution available for handling heat transfer equipment such as condensers, evaporators and active systems used in the power plant.

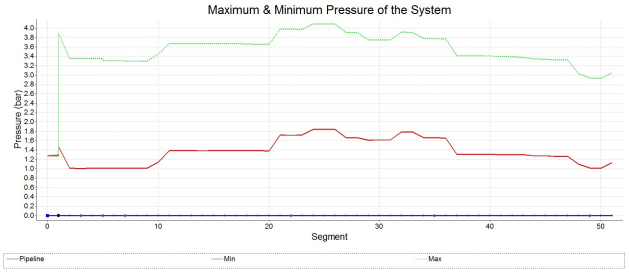
Solution

KY Pipe's hydraulic engine is based on the Lagrangian Wave Plan method which implements the numerical discrete vapor cavity model for use in simulating transient conditions. The approach taken was to model the entire pipeline network without any surge protection.



Pressure profile : No surge protection

The challenge was the selection of the appropriate resistance model for each of the valves and other pipe fittings. Once the initial analysis was complete and a clear quantifiable need for surge protection was identified, iterative addition of surge protection modules and their effect on the overall system profile were studied. The condensers in the system were modeled as equivalent pipe sections to circumvent the shortcomings of the software.



Pressure profile : With surge protection

Several scenarios were analyzed for each of the subsystems and optimal placement for surge protection equipment in the pipeline network were identified. This resulted in modifications of the original design of the pipeline network, helping the client commission a robust and failure free pipeline network for the power plant.