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Computational Fluid Dynamics Simulation of a Boiler Outlet Header Constructed of Inconel Alloy 740H

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Abstract : Headers play a critical role in conveying steam to regulate heating system temperatures. While various materials like steel grades 91 and 92 have been traditionally used for pipes, this research proposes the use of a robust and innovative material, INCONEL Alloy 740H. Boilers in power plant configurations are exposed to cycling conditions due to factors such as daily, seasonal, and yearly variations in weather. These cycling conditions can lead to the deterioration of headers, which are vital components with intricate geometries. Header failures result in substantial financial losses from repair costs and power plant shutdowns, along with significant public inconveniences such as the loss of heating and hot water. To address this issue and seek solutions, a mechanical analysis, as well as a structural analysis, are recommended. Transient analysis to predict heat transfer conditions is of paramount importance, as the direction of heat transfer within the header walls and the passing steam can vary based on the location of interest, load, and operating conditions. The geometry and material of the header are also crucial design factors, and the choice of pipe material depends on its usage. In this context, the heat transfer coefficient plays a vital role in header design and analysis. This research employs ANSYS Fluent, a numerical simulation program, to understand header behavior, predict heat transfer, and analyze mechanical phenomena within the header. Transient simulations are conducted to investigate parameters like heat transfer coefficient, pressure loss coefficients, and heat flux, with the results used to optimize header design.

Keywords : CFD, header, power plant, heat transfer coefficient, simulation using experimental data
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