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Optimizing heat transfer in turbulent impinging jets Array: A Computational Fluid Dynamics Investigation and Machine Learning approach for predicting the average Nusselt number

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Abstract:

In this study, a CFD (computational Fluid Dynamics) analysis is performed to explore how the number of nozzles (N) and the impingement height (H) influence heat transfer (HT) within an impinging jets array (IJA). To simulate the dynamic flow and the HT characteristics, the two-equation k-ω turbulence model was used. The results show that as the number of nozzles increases and impingement height decreases, local and mean Nusselt numbers increase. Linear regression method is adopted to estimate the average Nusselt number along the plate, correlation given by this method shows moderate agreement with the numerical results. To improve the accuracy of the estimated values, AI (Artificial Intelligence) techniques are applied to find an optimal Machine Learning (ML) model for predicting the average Nusselt number based on a set of input features, including (N) and engineered polynomial transformations of (H). Modeling was accomplished using Deep Learning (DL) through a multi-layer neural network to capture complex relationships.

Keywords: Jets array, Turbulence, CFD, heat transfer, impingement height, Nusselt number, Machine Learning.

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