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Bare Rod Bundles Fuel Assembly Coolant Flow Analysis through a Hybrid-Based CFD Methodology

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The heat produced in the nuclear fuel rod is dissipated by the coolant running through the channels in the fuel assembly. The flow between fuel assembly rods shows oscillating behavior, having a noticeable effect on the cooling process. Additionally, the flow effects extend to the fuel assembly causing vibration in its structural system. The design and reliable operation of nuclear systems depend heavily on a comprehensive understanding of flow and temperature in a fuel assembly. In aiming to enhance the nuclear reactor's efficiency, safety and stability, a thorough understanding of fuel assembly coolant is crucial. Therefore, this study analyzes the flow between bare rod bundle fuel assembly configuration utilizing advanced computational fluid dynamics (CFD) approaches. In this regard, a hybrid (LES/RANS) turbulence modelling approach has been adopted to study a square lattice bare rod bundle configuration. By minimizing the overall computational cost, the best aspects of Large Eddy Simulation (LES) and Reynolds-Averaged Navier-Stokes (RANS) are employed. The obtained results are thoroughly compared with the available reference Direct Numerical Simulation (DNS) database of a closely-spaced bar rod bundle based on the well-known Hooper experiment. The hybrid methodology is evaluated through a qualitative comparison of the velocity field with the DNS database. Additionally, the prediction of the flow pulsation is analyzed numerically. The findings in this work justify the usage of hybrid (RANS/LES) for these types of complex flow configurations and show its reliability.

Speaker Bio

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