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DIRECT NUMERICAL SIMULATION APPLIED TO THE ANALYSIS OF THE CONVECTIVE HEAT TRANSFER ENHANCEMENT IN AN ARC-SHAPED WALL CORRUGATED TUBE

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ABSTRACT The Direct Numerical Simulation approach is here adopted to study the forced convection problem in an arc-shaped wall corrugated tube. This kind of geometry is representative of a widely used passive heat transfer enhancement technique (i.e. wall corrugation) mainly adopted for improving the efficiency of heat transfer equipment. The augmentation mechanism is mainly due to the onset of instabilities in the flow that lead to an early departure from the laminar flow regime. The present work deals with the numerical description of the influence of the flow instabilities on the heat transfer mechanism. The numerical simulations point out that in the unsteady flow regime, due to the formation and disruption of the vortices, the flow loses the symmetry property about the tube axis by developing time dependent velocity component in all the directions. This effect, registered for $Re>54$, encourages a fluid mixing that greatly enhances the heat transfer mechanism. The augmentation effect is discussed also by adopting the field synergy principle approach which confirms that in the stable regime the convective contribution to the heat transfer mechanism is almost ineffective in a wide region of the domain while the instability reduces the extent of the domain that does not positively contribute to the convective heat transfer.