Proceedings of the Virtual International Conference on Energy and Heat Transfer (V-ICEHT'26)
May 2026 | Virtual Conference
DOI: 10.11159/iceht26.002

Flow Architectures, From Heat Transfer Applications to Blood Transport Through Organs

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Abstract

Flow systems in nature have evolved in time toward greater efficiency by adapting, or 'morphing', their configuration to decrease resistance to the currents flowing through them. Observations at various scales indicate that the distribution of flow is the most efficient when it happens through a dendritic architecture. Flow channels function in concert with the structures around them, as a combination of long and fast flows along the channels, with short and slow flows through the surrounding medium. The ability to predict flow patterns enables engineers to propose flow designs for heat, mass, and fluid flows. Our previous work theorized the deterministic nature of morphing and showed how to obtain efficient flow configurations for combined and sometimes competing objectives.

In this talk we will discuss (1) the benefit of Raleigh-Benard convection in Latent Energy Storage, (2) the design of capillary networks for the cooling of high-power electronic components, and (3) we will move to the blood flow architecture of the liver, the largest organ in the body, predicting the main features of this flow system and represent the hepatic blood circulatory system as a deterministic combination of dendritic networks and porous systems made of rigid or elastic vessels.