Visualizing the turbulent heat transfer of supercritical CO_2 in the SCO_2PE facility

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Energy conversion systems at supercritical pressures are promising candidates for the sustainable generation of power and heat. However, an insufficient understanding of the complex, non-ideal heat transfer of supercritical media hinders the development of reliable and effective heat transfer equipment in these supercritical power systems. When non-ideal behavior is induced through heat transfer with a supercritical medium, existing single-phase models and theory for the modulation of turbulence, hydrodynamic stability or heat transfer no longer directly apply. Additionally, as buoyant effects can quickly dominate flows of supercritical fluids, changes of the direction of heat transfer and its configuration can significantly alter the perceived hydrodynamics and heat transfer.

So far, experimental investigations of the above challenges have remained limited to measurements of wall surface temperatures. As such investigations give no direct insight in the flow itself, little discussion can be had on the non-ideal mechanics that underlie any observed deviatory heat transfer. The aim of our work is to gain a better understanding of the non-ideal hydrodynamics of supercritical media, by performing optical investigations. Here, various optical diagnostics are used to yield two-dimensional data of a developing, continuous channel flow of supercritical carbon dioxide to which there is bi-lateral optical access. With this, we aim to help explain and understand existing and future heat transfer investigations, for the reliable development of heat exchangers for future supercritical energy conversion cycles.