Experimental analysis of pulsatile flow in a transitional-type cavity

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The combination of flow separation and pulsatile flow phenomena is common in the biomedicine field of research, where the blood flow in arteries is dominated by the unsteady flow. Furthermore, pulsatile flow investigations in various lab-on-chip devices are also at the top of interest nowadays as it is often applicable in many engineering and biomedical applications. An experimental investigation of pulsatile flow structure is performed in a transitional-type cavity with a length-to-depth ratio of 8 using a micro-particle image velocimetry system. The pulsatile flow is generated by pulsating the inlet pressure in sinusoidal pulses with a pressure control unit. Stationary flow and four sets of pulsatile parameters were investigated: two pulsation amplitudes (A = 0.15 and A = 0.6) and two pulsation frequencies (f = 0.5 Hz and f = 1 Hz) at the Re range of 50–2000. Recirculation flow dynamics in a cavity were analyzed, taking a deeper look into the influence of pulsations on the flow structure and statistical flow parameters such as vorticity, shear rate, and turbulence intensity. Analysis revealed that the influence of pulsation amplitude on recirculation zone dynamics has a more prominent role than pulsation frequency. The magnitude of the recirculation zone reduction effect, achieved by pulsatile flow, is inversely proportionate to pulsation amplitude. The reduction of the recirculation zone impacts the shear rate distribution along the cavity by decreasing it when the recirculation zone length is reduced. Additionally, the analysis of turbulence intensity revealed the negligible impact of pulsations when the flow approaches the turbulent flow regime.

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