Inertial flow transitions of particle-fluid suspensions in Taylor-Couette Geometry

Experiments were performed to study the effect of particles on the flow transitions when a neutrally buoyant non-Brownian suspension of rigid particles in Newtonian fluid is sheared in the annulus between two concentric cylinders. For pure fluid and very dilute suspensions, the flow transitioned from Wavy Vortex Flow (WVF) to Taylor Vortex Flow (TVF) to Circular Couette Flow (CCF) as the Reynolds number ($Re$, based on effective viscosity of the suspension) of the inner cylinder was reduced in a quasi-steady manner while keeping the outer cylinder stationary. For suspension volume fractions between $\phi=0.05$ and $\phi=0.20$, the flow transitioned from WVF to TVF to Spiral Vortex flow (SPF) to ribbons (RIB) and eventually into CCF. For suspension with $\phi=0.30$, the flow transitioned from Wavy Spiral Vortices (WSV) to SVF to CCF. Also, the transition $Re$ corresponding to each flow transition were observed to reduce with increase in particle concentration indicating earlier onset of instability. When the particle size is reduced at the same concentration ($\phi=0.1$), the flow transitioned from WVF to TVF to RIB to CCF without SVF and the flow region of non-axisymmetric flow structures between TVF and CCF reduced in $Re$ range compared to that of the suspension with large particles. These observations indicate that the particle size is the reason for appearance of non-axisymmetric flow structures (WSV, SVF and RIB).