Numerical Simulation of Power Law and Yield Stress Fluid Flow in a Double Concentric Cylinder Rheometer with a Slotted Rotor (DCCR/SR) and a Vane Rheometer

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Three dimensional steady state flow in a double concentric cylinder rheometer with a slotted rotor (DCCR/SR) and a vane rheometer have been numerically simulated via the computational fluid dynamics (CFD) method. Based on the numerical data, we have analyzed and compared the systematic errors in rheological measurement of different test fluids (Newtonian fluids, power law fluids with shear thinning properties, and yield stress fluids) between these two designs. Our results indicate that: (1) the DCCR/SR is able to accurately measure rheological properties of a wider spectrum of test fluids than a vane rheometer because of a significant reduction of end and secondary flow effects; (2) the rheometer design can be optimized by analyzing the accuracy coefficients separately which allows us to determine the dominant source of the measurement error and then to provide a solution for reduction or even elimination of this source.

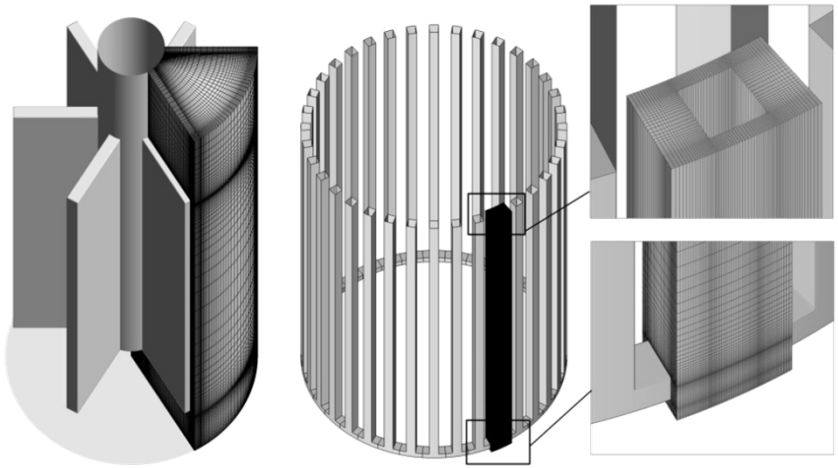

Figure 1. Geometries and CFD meshes for the DCCR/SR and Vane Rheometer

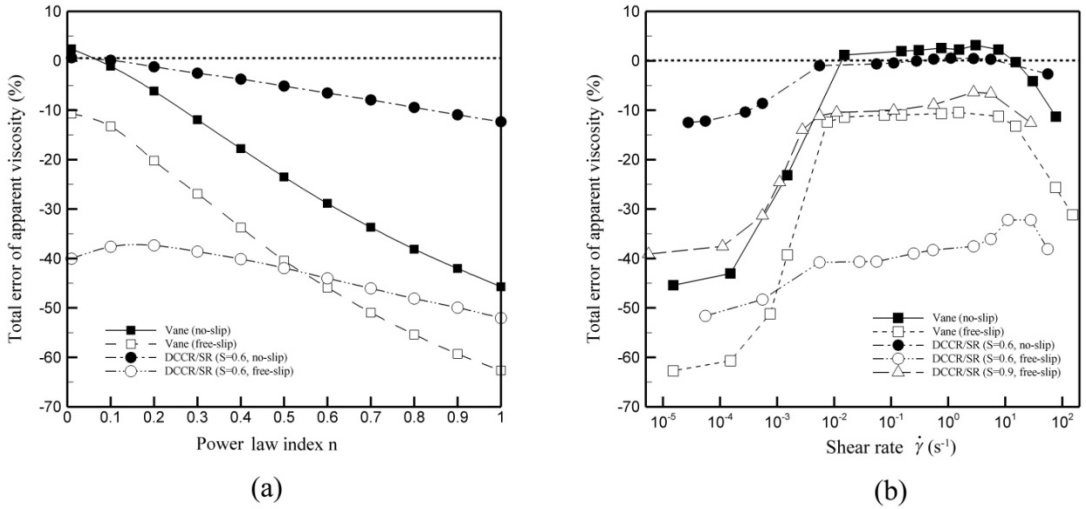

Figure 2: Comparison of the total systematic error in apparent viscosity measurement between a vane rheometer and DCCR/SR for (a) power-law fluids and (b) a yield stress fluid.