NUMERICAL AND EXPERIMENTAL VALIDATION OF THE COX-MERZ RULE IN NEWTONIAN SUSPENSIONS

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The validity of the Cox-Merz rule for suspensions has been widely debated in the literature and particular attention has been paid to the non-Newtonian case in semidilute regime. We here focus on suspensions made of non-Brownian spheres immersed in a Newtonian fluid with solid volume fraction up to 45% and we limited our investigation to the shear rate range where the suspensions are Newtonian.
We show both numerically and experimentally that the Cox-Merz rule holds up to a solid volume fraction of about 20%, while fails for higher concentrations. It is also shown that the higher the concentration the larger the difference between the complex and dynamic viscosity. In particular, the complex viscosity results to be always smaller than the dynamic one. This difference strongly depends on the applied strain in the dynamical experiments and the higher the strain the smaller the complex viscosity. The agreement between experiments and predictions is satisfactory.
Numerically it is shown that the oscillatory flow induces a structure modification. A key role is played by the suspended particles initial configuration, indeed if it is richer of clusters than the average one, the oscillatory flow causes some dilation in the structure and thus the complex viscosity results smaller than the dynamic one, the contrary holds for the case with a initial configuration with less clusters than the average. Both these effects were quantified.
The experiments were run with a rotational stress controlled rheometer (NOVA by Reologica) while the numerical simulations were based on the Stokesian dynamics theory.