Order Restoration in Perturbed Electrorheological Fluids

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It is known that applying electric field is able to adjust the viscosity of a non-conducting fluid emerged with dielectric particles, known as electrorheological (ER) fluid, and the viscosity of an ER fluid is controlled by the degree of alignment of the dielectric particles. In this study, a non-linear behavior of the ER fluid is observed. I use a simple ER fluid system that contained silica particles, silicone oil and little surfactant (triton x-100); the fluid's viscosity is able to be changed largely by the electric field. Results show that surfactant's appearance will enhance the fluid's ER behavior, and silicone oil's initial viscosity also has an effect on it too. The mechanism of how these factors influence the fluid is related to both the fluid's static configuration and dynamic response. When ER fluid's initial viscosity is low, the stabilization of ER fluid's inner particle-chain alignment mainly results from order restoration of disengaged particles under flow. While adding surfactant increases polarization of the particles by creating a high permittivity layer around it, faster restoration of particle chain is observed, effectively increases the fluid's viscosity under electric field. As for ER fluids made of higher viscosity, the fluid's static configuration plays a more important role, since a slow restoration rate can't contribute much to the viscosity change. In conclusion, our results suggest that the ER fluid's rheological property not only relates to the fluid's inner structure but also the structure's dynamic response. By considering dynamic response, we might be able to create an effective adjustable damper from low-initial viscosity ER fluids.

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