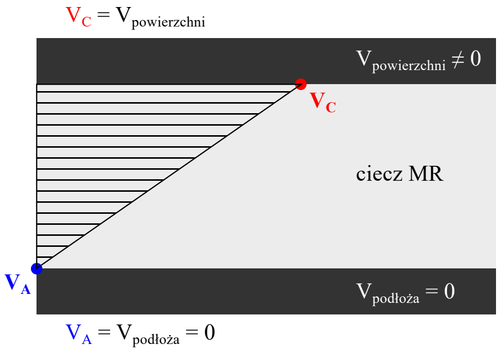
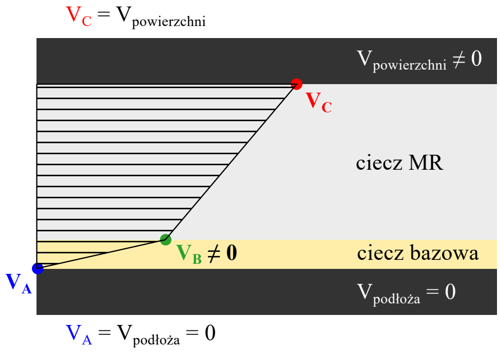
When analyzing the contact between a liquid and a solid surface, it is often assumed that the layer of liquid adjacent to the solid moves at the same velocity as the surface itself (Fig. 1a). In other words, there is no relative motion — or slip — between the liquid and the surface. This assumption is crucial for describing fluid flow and energy transfer efficiency. However, in practice, especially for complex or highly viscous fluids, partial or even complete slip may occur at the interface (Fig. 1b).



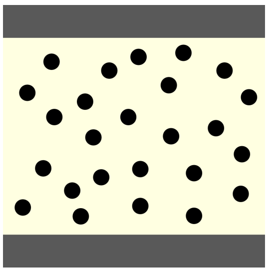
(a) Velocity profile without slip



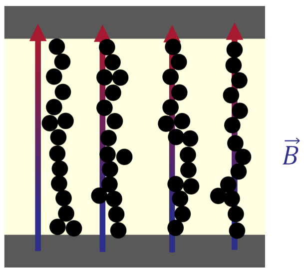
(b) Velocity profile with slip

Figure 1: Liquid velocity distribution near a solid boundary

Magnetorheological (MR) fluids are suspensions of ferromagnetic microparticles dispersed in a non-magnetic carrier liquid. In the absence of a magnetic field, an MR fluid resembles a grey, low-viscosity liquid, similar to thin oil (Fig. 2b). When subjected to a magnetic field, the particles align along the field lines, forming internal structures (Fig. 2c, 2d) that significantly increase the fluid's resistance to flow. At high field strengths, the fluid behaves like a plastic solid — similar in texture to hardened butter. By adjusting the magnetic field, it is possible to control the fluid's rheological properties in real time. This phenomenon is already used in a range of adaptive technologies, including shock absorbers, brakes, and vibration dampers.


(a) Randomly distributed magnetic particles


(b) MR fluid without magnetic field



(c) Particles aligned with magnetic field lines


(d) MR fluid in a magnetic field with visible structure

Figure 2: Behavior of MR fluids under different conditions

Since MR fluids are heterogeneous suspensions with field-dependent viscosity, slip at the solid–fluid interface can be expected under specific flow conditions. Preliminary experiments confirmed this hypothesis. The occurrence and intensity of slip depend on various factors: surface roughness, material type, MR fluid composition and concentration, fluid layer thickness, and magnetic field parameters.

The aim of the project is to identify the conditions under which slip occurs at the interface between MR fluids and solid surfaces, and to investigate the physical phenomena responsible for this behavior. The novelty of the proposed research lies in the development of a dedicated experimental method for measuring slip in smart fluids whose properties can be actively controlled. The results will contribute to the broader understanding of MR fluid behavior, lead to the development of a reliable slip measurement technique, and provide data for future modeling of this phenomenon. Studying slip mechanisms is crucial both for advancing fundamental knowledge and for the design of effective MR-based devices. Furthermore, the project will contribute to the development of modern experimental techniques.