**Title:**  Study of reological properties of ferrofluid.

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**Introduction**

Colloidal dispersions of nanomagnetic particles in a passive liquid matrix are known as ferrofluids or FF.

Magnetic drug targeting (MDT) and magnetic cell separation (MCS) sealing application and magnetic fluid separation technique in diamond mining are the current applications of FF. Iron oxide (usually magnetite and maghemite) nanoparticles are mostly used as magnetic particles in ferrofluids due to their high saturation magnetization and high magnetic susceptibility. The stability of the colloid can be achieved through competitions between attractions due to magnetic and Van der Waals forces which naturally exist between nanoparticles and repulsive interactions in the system. The latter can be controlled by steric repulsion (surfactant-coated FFs and polymer-coated FFs), electrostatic repulsion (ionic FFs), or combination of these mechanisms (double-layer surfactant-coated FFs). The zero field viscosity of a suspension of magnetic particles, *η*0, is mainly determined by the viscosity of the carrier liquid *η*c and the total volume concentration of suspended material C. For a ferrofluid C accounts at least for the particles including their surfactant layer, so for a given fraction of magnetic material in the suspension the viscosity of ion stable ferrofluid is very different to the viscosity of surfactant stable ferrofluid.In this work iron oxide nanoparticles have ben synthesized and their physical properties have been studied. A ionic ferrofluid, have been fabricated using this nanoparticles and its properties have been studied.

**Methods**

Co-precipitation method was used to synthesize magnetic iron oxide nanoparticles. In a typical procedure

desirable amount of Iron (II) and Iron (III) salts were added to distilled water and a mixture of salt solution were prepared. 12 ml of salt solution drop wise were added to 120 ml ammonia solution under nitrogen atmosphere and given temperature. The solution was stirred 30 min. Black precipitate was decanted by a permanent magnet and washed by distilled water three times and treated by by tetrametthyl amoniom hydroxide and dispersed in water. So a ionic ferrofluid was prepared. By adding extra water to ionic ferrofluid diluted samples was prepared. Tree samples were prepared in which the volume concentration of magnetic nanoparticles in them were 0.7%, 0.9% and 1.9%.

**Results**

The results show that concentration of FF can affect its reological properties. Magnetic properties of

nanoparticles showed that they are superparamagnetism and soft particles so their relaxation in magnetic field is of Néelian type, hence the rotational viscosity, friction between particles and surrounding fluid, can not be the main reason of magnetoviscous effect. Hence as Odenbach mentioned we can suppose the FF as bidisperse system. In this approach a large fraction of small particles determines the overall magnetic properties of the fluid but does not significantly contribute to the magnetoviscous phenomena. A second fraction with small volume content and a large particle diameter is able to form chains and thus important for the magnetic effects in rheology. The experimental results demonstrated that the FF is a

non-Newtonian fluid with shear- thinning behavior in either absence or presence of a magnetic field.

Moreover, remarkable magnetoviscous effect was seen in FF. An unexpected increase of magnetoviscous effect at low shear rates in absence of magnetic field and an increase-decrease-increase behavior of magnetoviscous effect with magnetic filed in low shear rates was observed and discussed in text via simple bidisperse system model.