On Magnetic Fluid Particles Dynamics Investigation

Petr Polcar, Josef Český, Tomáš Charvát

Faculty of Electrical Engineering, University of West Bohemia, Univerzitni 26, Pilsen 30614, Czech Republic,
e-mail: {polcarp, cesky}@kte.zcu.cz; charvatt806@gmail.com

Abstract **This paper deals with the investigation of the dynamics of magnetorheological fluid. The response of ferromagnetic particles to changes in external magnetic field is observed with the use of high speed camera. Optically obtained data are processed with the use of scientific tool ImageJ. Functions and limit values of the particles dynamics are determined with the use of statistic methods afterwards.**

Keywords **Magnetorheological fluid, magnetoviscous effect, determination of time response, optical methods, ImageJ.**

I. Introduction

Magnetic liquids represent one of modern intelligent materials. These fluids are being used in wide range of technical applications nowadays, e.g. controlled dampers, clutches and seals, various sensors and actuators [1]. The knowledge of the dynamics of the fluids is required to properly design these devices [2]. This paper deals with the investigation of time response of magnetorheological fluid to the change of external magnetic field.

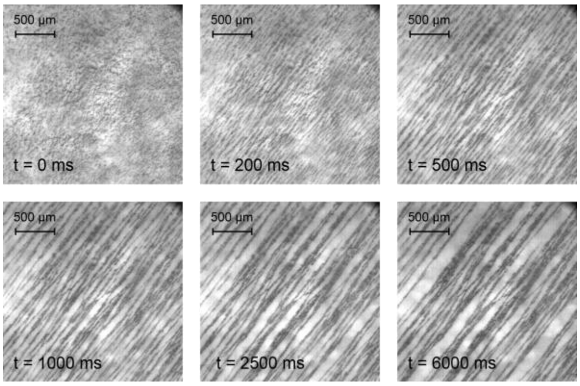

Fig. 1. Example of magnetic particles chaining, B = 22 mT, MR fluid MRHCCS4-B; high speed camera

II. Experimental Setup

An experimental device was designed and built. The variable magnetic field is generated by the permanent magnet placed on movable body driven by the electric machine. Sample of the MR fluid is placed in the static area of magnetic field. Strength and distribution of the magnetic field can be changed by positioning its source, its time variability can be regulated by the torque of electric machine. The particles dynamics was filmed on high speed camera.

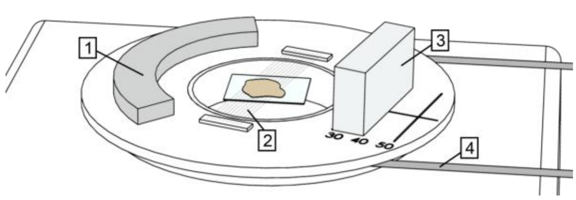

Fig. 2. Sketch of the experimental setup: 1. counterweight; 2. guiding fibres, 3. permanent magnet, 4. drive towlines

III. Data Acquisition

Acquired video samples were split to individual images and processed with the use of an open source scientific tool ImageJ [2]. The angle between lines of the magnetic field generated by the permanent magnet and the chains of ferromagnetic particles were observed for different torques. The time response was determined from this value. More than 4000 samples were processed.

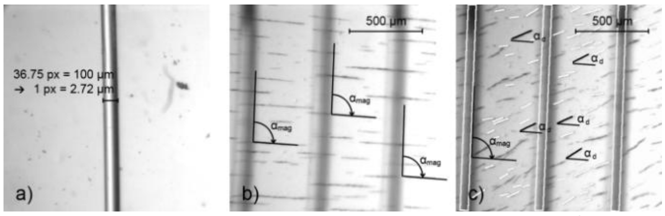

Fig. 3. Data acquisition procedure; ImageJ: a) scaling with the use of nylon fibre benchmark; b) stationary angle determination; c) difference angle measurement

IV. Conclusion

The functions of the time response and threshold values for typical applications were determined with the use of presented method. This work is an introduction to the forthcoming research on the ferromagnetic particles dynamics.

V. Acknowledgements

The financial support of University of West Bohemia, namely research project SGS-2015-035, is gratefully acknowledged.

VI. References

[1] Wang, J, Meng, G. Magnetorheological fluid devices: principles, characteristics and applications in mechanical engineering. *Proceedings of the Institution of Mechanical Engineers, Part L: Journal of Materials: Design and Applications*. 2001, vol. 215, issue 3, s. 165-174 [cit. 2015-04-05]. DOI: 10.1243/1464420011545012.

[2] Nguyen, Q., Seung-Bok, CH. Optimal Design Methodology of Magnetorheological Fluid Based Mechanisms. In: *Smart Actuation and Sensing Systems - Recent Advances and Future Challenges*. InTech, 2012-10-17 [cit. 2015-03-15]. ISBN 978-953-51-0798-9. DOI: 10.5772/51078.

[3] Rasband, W.S., ImageJ, U. S. National Institutes of Health, Bethesda, Maryland, USA, http://imagej.nih.gov/ij/, 1997-2014.