

# Investigation into the Effects of Surfactant on Itakpe Iron Concentrate Magnetic Fluids

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## Abstract

This research work encompasses the potentials of Itakpe Iron concentrate for Magneto-rheological behavior under the effect of a liquid soap as surfactant. The concentrate was first ball milled to size reduce it then subjected to magnetic strength from a locally made electromagnet, with the iron concentrate in-situ the magnetic fluid. Magnetic fluid potential increased as iron concentrate increased in the fluid but viscosity of the fluids was affected by increased surfactant concentration. These positive signs of magneto-rheology under low magnetic influence puts Itakpe Iron concentrate a candidate material for magnetic fluid potential and application in automobile shock absorbers, brakes etc.

**Index terms**— magneto-rheological, itakpe iron concentrate, temperature, in-situ, magnetic bits.

## 1 Introduction

(Claracq et al., 2003)

. In recent times, MR fluids have found application in automobile and aerospace technology and they possess higher field induced particles than ER fluids, hence the preference for ER fluids ??Jolley et al., 1996;Wereley, 1999).

Magnetic fluids can be made into solid structures at room temperature and turned liquid at slightly elevated temperature when paraffin based ferrofluid is used as the carrier liquid. Heating the fluid and cooling in the presence of a magnetic field will find application in solid magnetic nanostructures such as the gear-like structure (Jolley et al., 1999). Magnetorheological applications are generally classified as Shear mode where clutches and breaks are used; flow mode which includes shock absorbers and damper in medical devices and squeeze mode in vibration isolation systems in artificial limbs (Choi and Han, 2013). Several studies on magnetic fluid have been carried out with great engineering interest at room temperatures and more focus on the external magnetic field (electromagnets). However, other works have reported findings in small temperature ranges of 40 -45 o C in biomedical applications. This research therefore focuses on the effect of temperature (from room temperature to 70 o C and Iron concentrate of up to 25%) on permanent magnetic influenced ferrous particles in-situ Motor oil.

## 2 II.

## 3 Material and Methods

### 4 a) Equipment used

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### 5 b) Ball-milling the Iron ore

Iron ore concentrates at different sizes were put in a milling machine and milled for approximately 50 hours until the size of the sample was reduced to very tiny(nano) particles.

## 6 c) SEM Analysis

A scanning electron microscope (SEM) analysis was conducted to get the following information about the sample (iron ore concentrate); external texture, chemical composition, crystalline structure, orientation of materials making up the sample.

## 7 d) Experimental Procedure

First a basis of 100g was taken as the primary measurement for the process. According to literature, the volume of a typical magnetic fluid is 5% magnetic solids, 10% surfactant and 85% carrier but for the purpose of this research work, different ratios will be experimented to get a relationship between the viscosity of the magnetic fluid and volume of surfactant.

100g (100% loading) of oil with 0g (0% loading) of the iron concentrate and 0g of surfactant was measured, the behaviour of the oil without magnetic solids or surfactants at 200 RPM of the oil was then taken at room temperature using the viscometer. An external magnetic field in form of an electromagnet was wound around the cup of the viscometer. It was then placed on the magnetic stirrer which also served as the heat source with constant temperature.

## 8 III.

## 9 Results and Discussions

The viscometer used for this process measured shear rates in millipascal-seconds (mpa-s) equivalent to centipoise (cP). (Joseph and Suresh, 2014). Figure ?? shows the total dispersion of the iron particles inside the iron concentrate. This gives the microscopic overview of the relationship between the distance and gray value of the iron concentrate particles.

C Table 1

Figure ?? showed that at different loading (i.e. concentration) of the iron filings in the magnetic fluid, its viscosity also changed. From the experimental procedure, as the loading was increased, the fluid naturally became denser and it was that the increase in density meant the viscosity will increase. The figure above confirmed that assertion as it is seen that as the iron filing concentration increased, the viscosity also increased without the effect of an electromagnetic field (E.M.F), and with the effect of an E.M.F. This implies that an influence of an E.M.F affects the C hydrodynamic behavior of a magnetic fluid by increasing its density and hence its viscosity. From the figure ??, just like figure ?? it was seen that at different loading (i.e. concentration) of the iron filings in the magnetic fluid, its viscosity also changed. Also from the experimental procedure, as the loading was increased, the fluid naturally became denser and it was assumed that the increase in density meant the viscosity will increase. But in this case, it was quite different because of the addition of liquid soap which served as the surfactant. As the iron filing concentration increased, the viscosity also increased as usual even similar to figure ?? but here it was more uniform because of the influence of the surfactant. The addition of the surfactant reduced the surface tension of the fluid and also prevented aggregation or clumping of the iron particles at the bottom of the fluid, allowing them to be suspended and stable in all parts of the fluid (i.e. there's no separation between the solid and liquid nor agglomeration of particles is seen even under a strong magnetic field [www.sigma-hc.co.jp, 2015]. Also, it increases the shear stress (thickness) of the fluid and hence the viscosity.

## 10 IV. Conclusions and Recommendations

1. The Iron concentrates although with wide distribution of particle size showed prospects of magneto-rheology. 2. Magneto-rheology increases with Iron concentrate content in the motor oil up to 25%. 3. Surfactant has more influence on the viscosity of the fluid when under influence of weak magnetic effect.

a) Recommendations/Future work 1. A more efficient method to size-reduce the iron concentrate to uniform size in Nano scale rather than ball-milling for plenty hours. 2. Electromagnetic effect with higher and known magnetic strength will be used for future studies. Year 2019( D D D D ) C

## 11 Conflict of Interest

There is no conflict of interest associated with this work. <sup>1</sup>

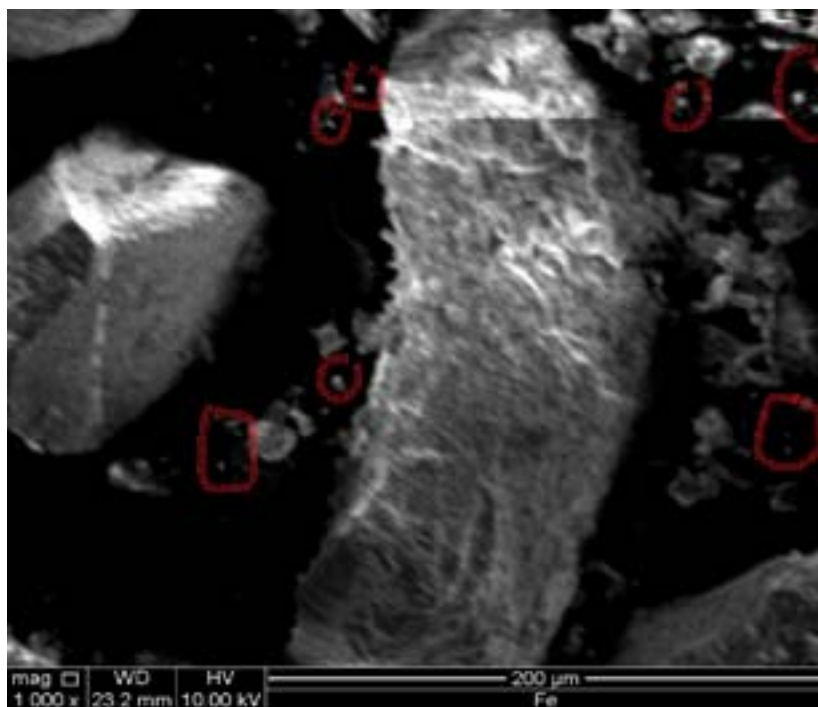
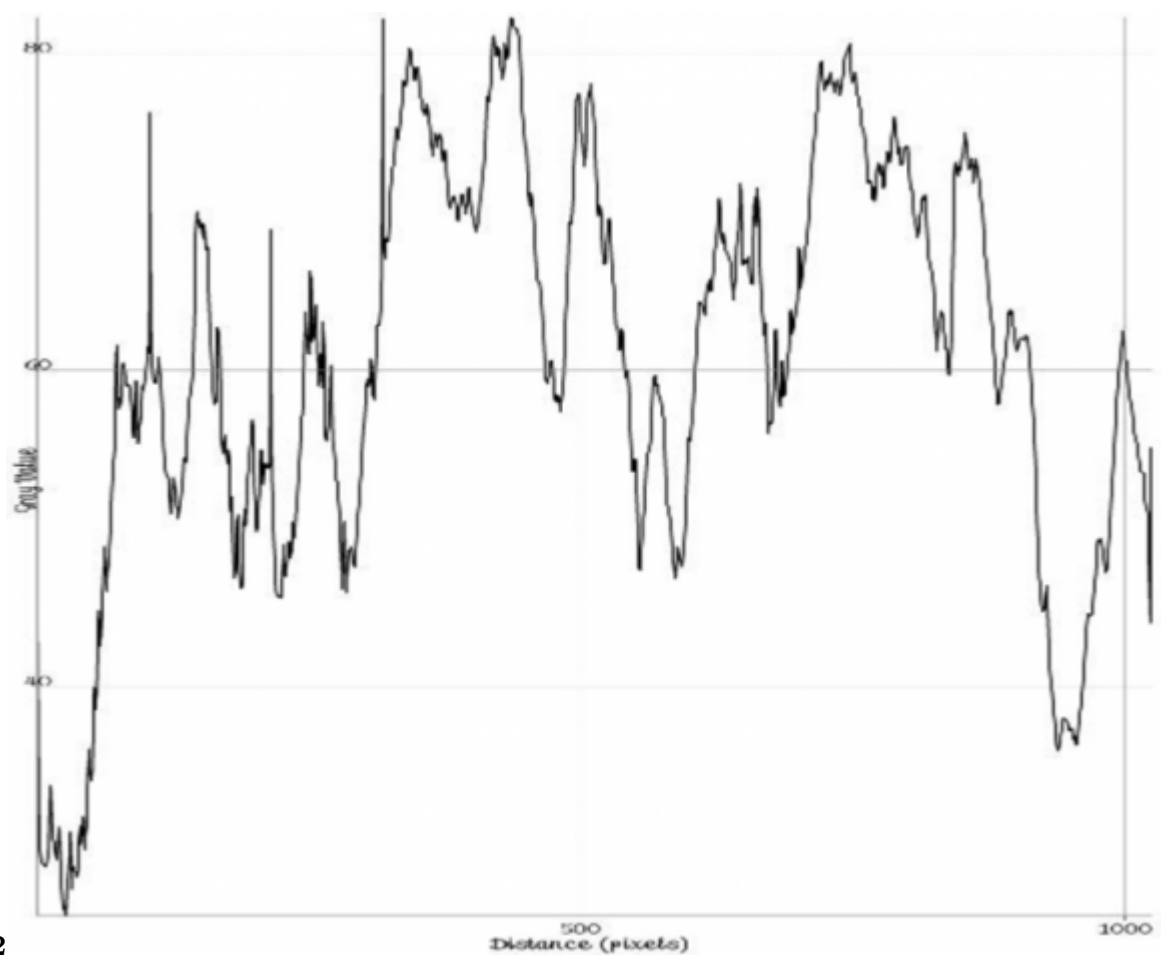


Figure 1: C



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Figure 2: Figure 1 :Figure 2 :

S/N	MATERIAL/EQUIPMENT	MANUFACTURER	SOURCE
1	Motor Oil	Ammasco synthetic 5w/30 3 mm (1/8") x 12 mm	Zaria Market
2	Magnetic Stirrer bars	(½"),VWR Octagon Spinbar	Chemical Engineering Department, ABU Zaria
3	Weighing Balance	Sauter Mode	Chemical Engineering Department, ABU Zaria
4	Thermometer		Chemical Engineering Department, ABU Zaria
5	Viscometer	Fann Instrument Company, Model 35	Chemical Engineering Department, ABU Zaria
6	Iron Concentrate		Itakpe Iron Mining Site, Kogi state Nigeria
7	Ball milling Machine	Kere Soesterberg, 057748	Chemical Engineering Department, ABU Zaria
8	Scanning Electron Microscope	Q30	Kaduna Geological Centre.

Figure 3:

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