Engineering and Innovative Materials III

Edited by
Axel Sikora, Muhammad Yahaya
and Sunny Su

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Engineering and Innovative Materials III

Selected, peer reviewed papers from the 2014 3rd International Conference on Engineering and Innovative Materials (ICEIM 2014), September 4-5, 2014, Kuala Lumpur, Malaysia

Edited by

Axel Sikora, Muhammad Yahaya and Sunny Su

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Axel Sikora
Muhammad Yahaya
Sunny Su

Preface

Dear Distinguished Delegates and Guests,

The Organizing Committee of ICEIM 2014 warmly welcomes you to the 2014 3rd International Conference on Engineering and Innovative Materials (ICEIM 2014), held on September 4-5, 2014 in Kuala Lumpur, Malaysia. ICEIM 2014 is sponsored by International Academy of Computer Technology (IACT).

The conference is aimed at providing a platform for all of you to present leading-edge work in the fields of Engineering and Innovative Materials. More than 100 papers were submitted to ICEIM 2014 and only 50 papers are accepted for the conference after peer reviewed by reviewers drawn from the scientific committee, external reviewers and editorial board depending on the subject matter of the paper. Reviewing and initial selection were undertaken electronically. After the peer-review process, the submitted papers were selected on the basis of originality, significance, and clarity for the purpose of the conference. The selected papers and additional late-breaking contributions to be presented as lectures will make an exciting technical program. The conference program is extremely rich, featuring high-impact presentations.

The proceeding records the fully refereed papers presented at the conference. The main conference themes and tracks are Engineering and Innovative Materials. The main goal of ICEIM 2014 is also to provide international scientific forums for exchange of new ideas focus on Engineering and Innovative Materials.

We would like to thank the program chairs, organization staff, and the members of the program committees for their work. Thanks also go to all those who have contributed to the success of ICEIM 2014. Hopefully, all participants and other interested readers benefit scientifically from the proceedings and also find it stimulating in the process. We hope all of you have a unique, rewarding and enjoyable week at ICEIM 2014 in Kuala Lumpur, Malaysia.

With our warmest regards,

Prof. Axel Sikora, University of Applied Sciences Offenburg, Germany
Prof. Muhammad Yahaya, Emeritus Professor in School of Applied Physics, UKM Malaysia
Ms. Sunny Su, International Academy of Computer Technology, USA

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CHAPTER 1:

Structure and Properties of Materials

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Nano-Yttrium Aluminium Garnet Interfacial Tension and Viscosity for Enhanced Oil Recovery

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Keywords: Yttrium Aluminium Garnet (YAG), nanoparticles (NPs), Electromagnetic (EM) wave, Enhanced Oil Recovery (EOR), nanofluid.

Abstract. This paper describes the synthesis of Yttrium Aluminum Garnet (YAG), $Y_3Al_5O_{12}$ nanoparticles(NPs) and their application in Enhanced Oil Recovery (EOR). YAG NPs were synthesized by using sol-gel method. These NPs were then synthesized by using Thermal Gravimetric Analysis (TGA), X-Ray Diffraction (XRD) and Transmission Electron Microscope (TEM). The monophasic YAG having crystallites size of 40.98nm and 40.91nm were obtained at annealed temperature of 1100 °C and 1200 °C as determined by XRD. Magnetic measurement results show that initial permeability of YAG increased and relative loss factor decreased at high frequency. In this paper, the feasibility of application of YAG nanofluid in EOR was determined by measuring oil-nanofluid interfacial tension and also viscosity of the nanofluid. YAG with 0.5 wt% yielded the lowest IFT. It can be concluded that the synthesized YAG nanoparticle has great potential in EOR applications in the near future.

Introduction

Enhanced Oil Recovery is a word that refers to the method used for recovering oil beyond that recoverable by primary and secondary methods. The recent global rise in energy demand has highlighted the importance of EOR. There are several types of conventional method of EOR such as chemical injection, gas injection, thermal injection, and microbial injection. However, these current methods have their own limitation such as they failed to perform under High Temperature High Pressure (HTHP) reservoir condition. In order to cope the high demand of oil, oil and gas industry has just started to develop the application of nanotechnology to solve reservoir problem especially in EOR area and many researchers have claimed that nanoparticles have their own capability to improve oil recovery due to ultra-small size, large surface area, can act as an alternative surfactant and in-situ agent for reservoir problem [1-3]. N.A Ogolo stated that common nanoparticle that are likely to be used include oxides of Aluminium, Zinc, Magnesium, Iron, Zirconium, Nickel, Ti and Silicon. The ability of nanoparticles to alter certain factors in the formation and in oil properties can be taken as advantage to enhance recovery. Besides that, many researchers have studies the use of electromagnetic method for enhance oil recovery [4-7]. However, only a few researches have been done by combining both the application of nanotechnology and electromagnetic wave which is seen to have high tendency to be developed as one of the methods for EOR purpose.

Methodology

The experimental part consists of two major parts which are (i) YAG NPs preparation and characterization, and (ii) nanofluid preparation and characterization.

(i) YAG NPs preparation and characterization

Yttrium Aluminium Garnet nanoparticles were synthesized by using sol-gel method. Yttrium Nitrate Hexahydrate [$3Y(NO_3)_3.6H_2O$] and Aluminium Nitrate Nanohydrate $Al(NO_3)_3.9H_2O$ were used as the raw materials. Nitric acid was used as a solvent for this mixture. The precursor will be annealed in different temperature based on TGA results in order to obtain different nanoparticles sizes which will be evaluated using XRD and TEM.

(ii) Nanofluid preparation and characterization

Three different concentration of YAG nanofluid was prepared; 0.05wt%, 0.1wt% and 0.5wt%. Nanoparticles power were mechanically mixed in deionized water to form a suspension and 0.3wt% of Sodium Dodecyl Sulphate (SDS) was added as a stabilizer. The nanoparticles suspensions were placed in an ultrasonic bath for 40min at 45 ˚C to reduce agglomeration and ensure longer dispersion of powder particles on aqueous solution. After the nanofluids were prepared, viscosity and density test were carried out to check the viscosity and density for each sample. Finally, IFT test was performed to study the relationship between the viscosities of nanofluid prepared from the samples with different particle sizes for EOR applications.

Results and Discussion

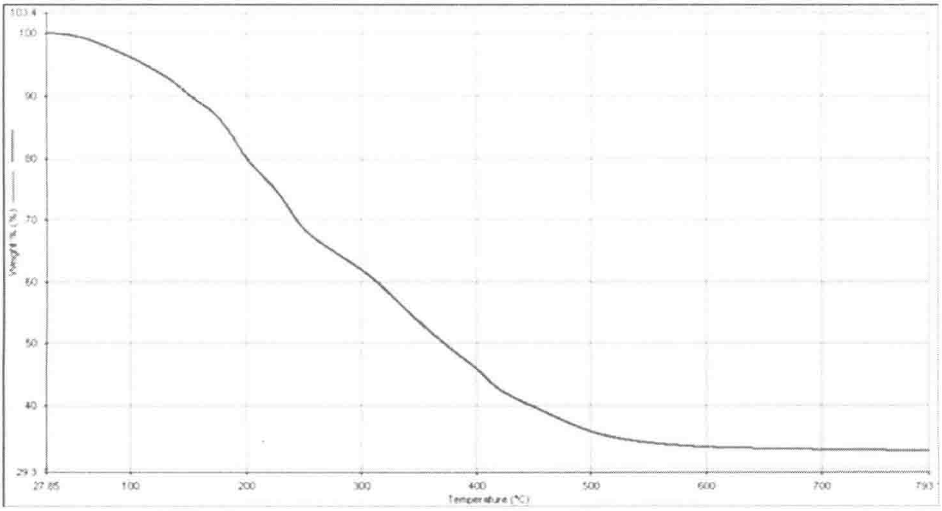

Figure 1 : TGA of YAG precursor

The results of the TGA is depicted in Fig. 1. The weight losses observed in the TGA of the YAG precursor (dry gel)(Fig.1) indicated dehydration, decomposition of the nitrate and decarbonisation (oxidation) of the decomposition products, respectively. The weight loss ~150 ˚C can be attributed to dehydration. Nitrates appear to decompose rapidly above 200 ˚C leading to weight at ~400 ˚C. Weight loss at ~400 ˚C is attributed to the decarbonisation of the decomposes products, a process which continues beyond 600˚C, through slowly. The weight loss was negligible after 620 ˚C. Thus, the TGA analysis concluded that decomposition of the gel was nearly completely by 620 ˚C with a weight loss of ~80%.

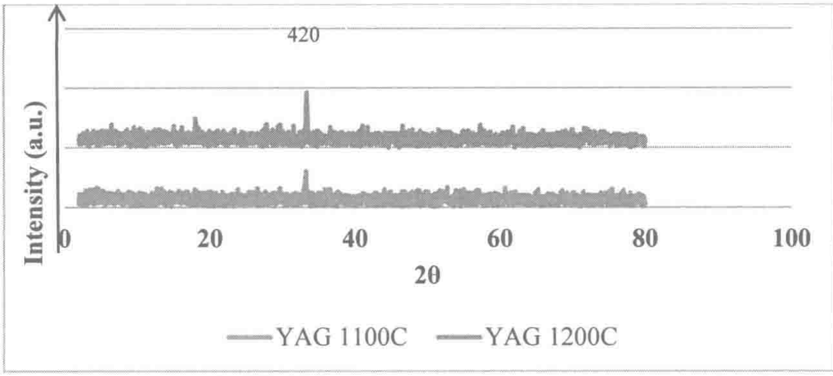

Figure 2 : XRD Pattern of YAG annealed at different temperature

Figure 2 shows the XRD patterns of YAG nanoparticles prepared with peak [420] at sintering temperature of 1100 °C and 1200°C. By applying Scherer equation 1100 °C sample and 1200 °C sample give almost same crystalline sizes which are 40.98 nm and 40.91 nm.

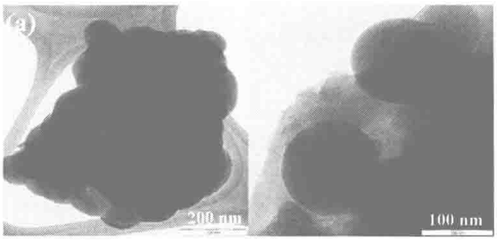

Figure 3: TEM images for YAG NPs annealed at (a)1100 °C and (b)1200 °C

According to TEM results, it was clearly seen that the shape and distribution of the particle improved with the increase in annealing temperature. Good nanocrystalline of YAG particles was observed at sintering temperature of 1200 °C with the crystallite size of 40.91nm and lattice parameter a=b=c=12.01 based on XRD results.

According to Table 1, 0.5wt% give the lowest value of IFT. When low IFT value is achieved, the near miscibility between those two interfaces will occur, thus creates an intermediate layer, called emulsion. This emulsion has higher viscosity than its original components, thus adding up another mechanism to oil recovery by controlling mobility ratio between oil and water which in turn provide more force to push the trapped oil.

Table 1 : IFT at different concentration of YAG nanofluids

Concentration of nanofluid(wt%)	Interfacial Tension,mN/m (IFT)
0.5	14.621412
0.1	15.013075
0.05	15.49005

Table 2 : Viscosity of YAG nanofluid and Brine

Injection Fluid	Viscosity (cP)
Brine	1.92
0.5wt% YAG	2.36

According to the IFT measurement, sample with concentration of 0.5wt% was chosen to be used for viscosity measurements due to lowest IFT. Table 2 shows the dynamic viscosity of the brine fluid and nanoparticles suspension. As predicted earlier, viscosity of the suspensions will be higher than its brine fluid. Among these two injections, YAG nanofluid has higher viscosity compared to brine fluid upto 23%. For coreflooding application, injection fluid with high value of viscosity is needed. If the injection fluid has high value of viscosity, this will ensure that oil will flow smoothly and lead to piston like displacement flow. As a result, this can increase the displacement efficiency.

Conclusions and Recommendations

Synthesis and characterization of YAG nanoparticle had been performed with the crystallite size ranging from 30 nm to 40 nm. The understanding of concepts and mechanism behind the injection of YAG nanofluid to reduce IFT and viscosity is also achieved. Higher wt% of YAG nanofluid gave the smallest IFT and viscosity for YAG nanfluid is higher than brine fluid. 0.5 wt% yielded the lowest IFT and the nanofluid viscosity is 23% higher compared to brine. Therefore YAG has high potential in EOR applications under HTHP conditions, since YAG is highly stable at high temperature.

Acknowledgement

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