SINTESIS DAN KAJIAN STABILITAS FERROFLUIDA Fe_3O_4 SERTA POTENSI APLIKASINYA PADA *ELECTROMAGNETIC VIBRATION ENERGY HARVESTER*

SKRIPSI

Diajukan untuk penulisan sebuah skripsi untuk memenuhi salah satu
syarat untuk memperoleh gelar Sarjana Sains
Program Studi Fisika

Oleh
Sulissetiawati
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PROGRAM STUDI FISIKA
FAKULTAS PENDIDIKAN MATEMATIKA DAN ILMU PENGETAHUAN ALAM
UNIVERSITAS PENDIDIKAN INDONESIA
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Kelompok Bidang Kajian Fisika Material
FPMIPA UPI

LEMBAR PENGESAHAN

SULISSETIAWATI

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LEMBAR PERNYATAAN

Dengan ini saya menyatakan bahwa skripsi dengan judul "*Sintesis dan Kajian Stabilitas Ferrofluida* Fe_3O_4 *Serta Potensi Aplikasinya Pada Electromagnetic Vibration Energy Harvester*" ini beserta seluruh isinya adalah benar-benar karya saya sendiri. Saya tidak melakukan penjiplakan atau pengutipan dengan cara-cara yang tidak sesuai dengan etika ilmu yang berlaku dalam masyarakat keilmuan. Atas pernyataan ini, saya siap menanggung risiko/sanksi apabila di kemudian hari ditemukan adanya pelanggaran etika keilmuan atau ada klaim dari pihak lain terhadap keaslian karya saya ini.

Bandung, Juli 2024
Yang membuat pernyataan,

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Penulis

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ABSTRAK

Ferrofluida merupakan material magnetik yang tersusun atas nanopartikel magnetik yang distabilisasi surfaktan dan terdispersi pada pelarut organik atau air. Salah satu aplikasi ferrofluida yaitu sebagai pelumas magnet induksi pada *Electromagnetic Vibration Energi Harvester* (EVEH) untuk stabilisasi gerak dan mengurangi abrasi material. Dalam penelitian ini, nanopartikel Fe_3O_4 disintesis melalui metode kopresipitasi, dihasilkan dari reaksi ion Fe^{3+} dan Fe^{2+} dalam media basa yang dicapai melalui penambahan ammonia hingga pH 9. Ferrofluida dibuat dari nanopartikel Fe_3O_4 distabilisasi asam oleat terdispersi dalam kerosin melalui metode dua langkah. Kestabilan ferrofluida dikaji melalui pengaruh rasio Fe_3O_4-asam oleat sebesar 1:1, 1,25:1, 1,5:1, dan 1,75:1. Nanopartikel Fe_3O_4 telah disintesis dengan metode kopresipitasi memiliki kemurnian 75,6% dengan struktur kristal *cubic inverse spinel*, ukuran kristalit sebesar 10,05 nm, ukuran diameter hidrodinamik melalui PSA diperoleh sebesar 17,24 nm, dan magnetisasi saturasi melalui VSM sebesar 22,93 emu/g. Aglomerasi dan keberadaan pengotor pada sampel menyebabkan sifat magnet nanopartikel Fe_3O_4 tidak ideal. Analisis kestabilan ferrofluida nanopartikel Fe_3O_4 distabilisasi asam oleat dianalisis secara kualitatif maupun kuantitatif. Secara kualitatif stabilitas ferrofluida dikaji melalui pengamatan visual, diketahui terjadi sedimentasi di hari ke-8 dan cenderung tidak berubah setelahnya hingga hari ke-29. Berdasarkan hasil pengamatan visual, ferrofluida dengan rasio 1,75:1 menunjukkan pembentukan sedimentasi paling sedikit. Sedangkan secara kuantitatif ferrofluida dianalisis melalui absorbansi UV-Vis, menunjukkan bahwa adanya sedimentasi melalui peningkatan absorbansi di hari ke-29 dibandingkan hari ke-0 pengedapan dengan perubahan absorbansi semua sampel cenderung sama. Aplikasi ferrofluida pada EVEH menunjukkan peran sebagai komponen pendukung untuk stabilisasi gerak magnet induksi dalam EVEH, dengan daya keluaran EVEH sebesar 3,555 mW.

Kata Kunci: Ferrofluida; Nanopartikel Magnetik Fe_3O_4; Asam Oleat; Kestabilan; *Electromagnetic Vibration Energy Harvester*

ABSTRACT

Ferrofluid is a magnetic materials composed of magnetic nanoparticles stabilized by surfactants and dispersed in an organic solvent or water. One application of ferrofluid is as lubricant in Electromagnetic Vibration Energy Harvesters (EVEH) to stabilize movement and reduce material abrasion. In this study, Fe_3O_4 nanoparticles were synthesized via the coprecipitation method, resulting from the reaction of Fe^{3+} and Fe^{2+} ions in a alkaline medium achieved by the addition of ammonia until pH 9. The ferrofluid was made from Fe_3O_4 nanoparticles stabilized by oleic acid and dispersed in kerosene using a two-step method. The stability of the ferrofluid was examined based on the influence of Fe_3O_4-oleic acid ratios of 1:1, 1,25:1, 1,5:1, and 1,75:1. The Fe_3O_4 nanoparticles synthesized by the coprecipitation method have a purity of 75,6%, with a cubic inverse spinel crystal structure, a crystallite size of 10.05 nm, a hydrodynamic diameter of 17,24 nm obtained through PSA, and a saturation magnetization of 22,93 emu/g measured by VSM. The presence of agglomeration and impurities in the sample resulted in the Fe_3O_4 nanoparticles having non-ideal magnetic properties. The stability of the Fe_3O_4 nanoparticle ferrofluid stabilized with oleic acid was analyzed both qualitatively and quantitatively. Qualitatively, the stability of the ferrofluid was examined through visual observation, revealing sedimentation on day 8, which remained unchanged until day 29. Based on visual observations, the ferrofluid with a ratio of 1,75:1 showed the least sedimentation formation. Quantitatively, the ferrofluid was analyzed using UV-Vis absorbance, indicating sedimentation through increased absorbance on day 29 compared to day 0, with the change in absorbance being consistent across all sample. The application of ferrofluid in EVEH demonstrated its role as a supporting component for stabilizing the movement of the induction magnet in EVEH, with the EVEH output power being 3.555 mW.

Keywords: *Ferrofluid; Magnetic Fe_3O_4 Nanoparticles; Oleic Acid; Stability; Electromagnetic Vibration Energy Harvester*

DAFTAR ISI

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