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Increasing Paramagnetic Study at the Samples Zinc Ferrite Trapped in the Alternating Magnetic

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ABSTRACT: *Zinc Ferrite (ZF) is a material paramagnetic thats a presence in the universe magnetic force have different act, depend on the structure and composition of the materials. In some cases it's look almost the same on substances ZF reacted at temperatures between 60 0C to 90 0C. ZF 70 has no power at a temperature of 70 ^{0}C and tends rounded shape (spherical) or the particle size it's not perfect when it was the alternating magnetic presence. When electromagnetic warm surround it, the paramagnetic material tends to increase.*
Keyword: *Paramagnetic, magnetic force, structure,reacted, particle size*

I. INTRODUCTION

Zinc Ferrite (ZF) is a compound based on zinc ferrite and pasted material. These compounds are found among the ruins of the compound Fe3O4 and Fe2O3. ZF white can stand alone and are not attracted by the magnetic field.[1]. ZF is also the magnetic nanoparticles, nanopowder magnetic, magnetic nanocrystals, magnetic nanostructures, super paramagnetic, bulk magnetic nanomaterials, Fe, Ni, Co, Fe, ferrite magnets, magnetic alloys, magnetic oxides and magnetic nitride. Applications Nanoparticles Magnetic among other things; the data storage nanostructures (magnetic nanocrystal arrays), biomedical applications, optoelectronic, imaging probes intelligent, fluid nanostructured biomedical ferrofluid, biodegradable microspheres, drug and delivery system genes, separation biomagnetic, nanocomposites magnetic seal magnetic fluids , cancer treatment hyperthermic, synthesis magnet.[2,3] In stochiometri ideal expressed by equation ZnFe2 O4, a ferrimagnetic material with ;Spinnel structure M12 + 23 + .O4 .M2. Space group: Fd 3 m, Unit cell: cubic consist of 56 atoms, ions O2- 32, 24 cations M23 + M12 + and octahedral lattice dispersed in 16 pieces and in a tetrahedral lattice 8 pieces. Interstitials ion atomic number 96, 64 atom in a lattice formation tetra hedral, and 32 atoms in the lattice formation of oxygen ions O2 oktahedral.Posisi are in a face-centered cubic close packing [4,5]

The general formula AB_2O_4 spinel oxide, the two kinds of spinel, yalni; normal and inverse spinel spinel. In normal spinel A2 + ions are in the tetrahedral lattice and every atom A coordinated with four oxygen atoms while B2 + ions coordinated with six oxygen atoms in the lattice octahedral. In the inverse spinel ion A2 + and half of B2 + ions in octahedral lattice and a half of B2 + ions are in the lattice tetrahedral.contoh compound; Fe_3O_4, $FeTiFeO_4$, $FeMgFeO_4$, $FeNiFeO_4$.[5,6]. Noting the nature of normal and inverse equation A and B on AB2O4 defined by the equation; A = [M (1-λ) Feλ]; B = [M λFe (1-λ)]; O_4 [], λ stated degree of inversion, which states that for; 0 <λ <1 inverse spinel structure compound partially. λ = 0 normal spinel structure. λ = 1 inverse spinel, λ =2/3 random structure.[6,7]. Alternating current magnetic apply to ZnFerrite sample is placed in an overlay that is free from goods or other equipment. After that the sample is processed as usual.

II. EXPERIMENT

The material process needs 3x 24 hours, where the materials have been chemical process continuid by physical treatment such as grinding and magnetic process.

The Raw material in use are chemicals Pro Analyst Merc production, like a) FeCl3.6H2O b) FeCl2.4H2O c) ZnCl2. d) NaOH. e) Aqua demineralization [5-8]. Material preparation of the sample were prepared by co-precipitation method of the metal chloride salt. The materials are weighed according to the required stoichiometric ratio and dissolved of salt in distillated water as a mix solution. Mixing, drying, have done it since the material was apply,

With the chemical equation

$2(1\text{-}x)FeCl_2.4H_2O + 4\ FeCl_3.6H_2O + 2x.ZnCl_2 + 16\ NaOH \rightarrow 2\ Zn_xFe_{(3\text{-}x)}O_4 + 16\ NaCl + (40\text{-}8x)\ H_2$ [9]

The yield is $Zn_xFe_{(3\text{-}x)}O_4$ put in a small bowl, and the bowl is placed in a magnetic cage. Cage will be a magnetic back and forth when the system is activated. After that the yield is placed in another cage for the washing, drying and pressure process. Magnetic core is activated with the coil and magnetic core half closed, so most likely warming. Equation energy in cure magnetic is magnetic in out and output plus heat energy. After the yield generated ZF70 be included in the measurement tool. The laying of the sample into the magnetic cage done after making sure the magnetic cage active The time duration of treatment of approximately 10 minutes. Electric alternating current will generates alternating magnetic But careful use is only a short time (10 minutes), prolonged use can burn. due to the open coil will generate heat. Subsequently the samples is checked using x ray machine. For each reaction at a temperature of 60 0C, 70 0C and 80 0C. In each of each process is done deposition, several times washing, draining, and drying.until pH to approximately = 7. Grinding process is then performed with a degree of fineness of about 100 mesh, and printed by the printer cylindrical and pressed at a pressure of 6 tons. Yield of preprinted further tested by XRD machine and magnetic testing machine.

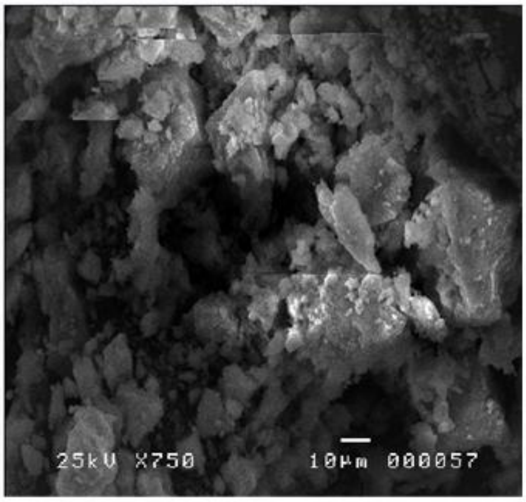


Figure 1. SEM of ZF70

The results of data processing Video Data Logger coprecipitation process zinc material Ferrite ZF60, ZF70 and ZF80 generate graphical form as follows; ZF60. ZF 70 and ZF80 From the sigmoidal graph data logger ZF60, ZF70 and ZF80 which give a Three ingredients yield expressed as Konet, Fisnet and Fisac. Lamer models and Dinegar is ZF70.

Illustrated three stage process of co-precipitation that is supersaturated in the 10th to 38 seconds, self nucleation at second to 38 to 50 and the growth occurring after the second 50..

ZF70 Scanning of Electron Microscope such as figure 1 as followe:

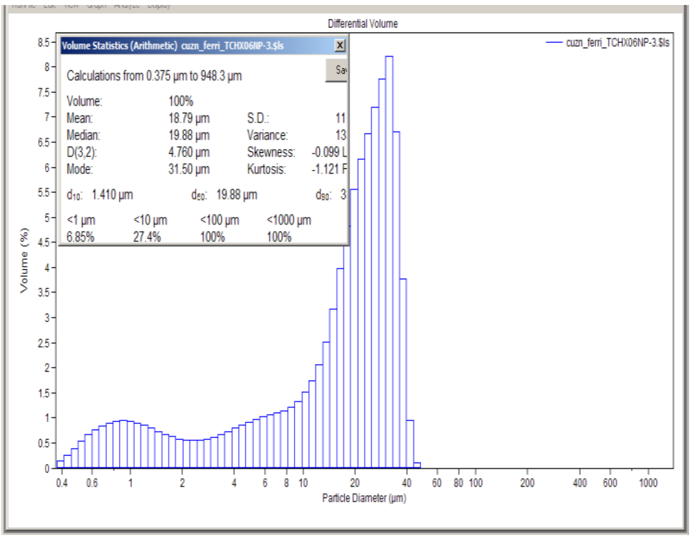


Figure 2. The Volume (%) versus Particle Diameter (um)

The Particle Size Analyzer give analyzer at;
The particle Size of ZF 70 may graphed as figure 2, where average of particle diameter 19.88 um.
And procent volume V/S Diameter
< 1% 1 um of 1% volume
< 1 % 10 um of 1.5 % voume
< 8% 30 um of 8 % volume
56 % 30 um to 44 um,
See that the particle tend as polidisperse, due by the particle tend perform every time, untill stagnant.

III. RESULT AND DISCUSSION

The parameter value table kinetic synthesis in different pH Alkaline Solution from the graph sigmoidal data logger ZF60, ZF70 and ZF80 which give a *Lamer* models and *Dinegar*, the ZF70 Illustrated in the three stage process of co-precipitation that supersaturated in the 10th to 38 seconds, self nucleation at second to 38 to 50 and the growth occurring after the second 50.

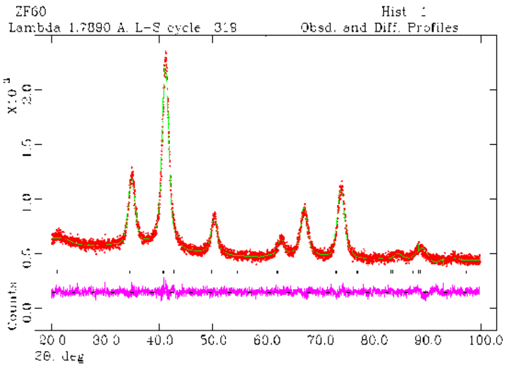
The dynamics of the formation of the yield of the reaction is determined by the value copresipitasi kinetic parameters. The Parameter Value of the Kinetic Table Syntesa Co-precipitasi confirm to Environmental Conditions Different pH Alkaline Solution.[9]

Temperature	Previous pH	K Constant	N Avrami Constant	T [K]	t 0.5	1/T	Ln t 0.5
60	12.68	0.17035	0.1306	333	18.58	0.003003	-5.808142
70	12.7	23.1	1.403	343	23.1	0.0029155	-5.83773
80	12.16	0.5743	0.042	353	24.42	0.0028329	-5.866468

The Kinetic parameters (k, n) depending on the temperature and the initial pH and the half-life t0.5 the reaction temperature between 600 and 800 shows the linear nature of the temperature. The more towards the longer the half-life of 800.Coprecipitation process energy is obtained from the slope of the graph Ln t0.5versus 1 / T. Retrieved Qe / R = 342.31, so the energy of formation of the three materials ZnFerrite (ZF60, ZF70 and ZF80) is Qe = 342.31 x 8314 = 2845 joules / mol = 0.68 kcal / mol. (NB; joules = 0.7376 ft-lb = 0.239 cal =107 ergs). Entropy at a temperature of 333K = 2:04 [cal.mol-1 K-1]. [9,11]

As an illustration of the validity of calculation of enthalpy levels ZF illustrated graph entropy simple spinel formation of A.Navrotsky, 1967 [10] as material for comparison, as follows GSAS Refinement;

GSAS Refinement of x-ray diffraction profile sample ZF60

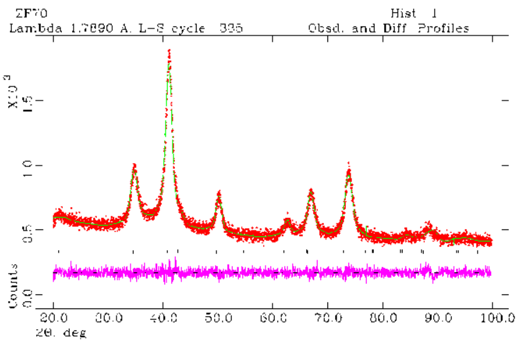


$ZnFe_2O_4$ Phase, Zn=0.4091, Fe=2.5909
space group : F d -3 m (227) Crystal System : Cubic
Latic Parameter: *a* = 8.5092(1) Å, *b* = 8.5092(1) Å and *c* = 8.5092(1) Å,
$\alpha=\beta=\gamma = 90^o$, V = 616.1(3) $Å^3$ dan □ = 3.221 $gr.cm^3$
R Factor (wRp=4.32, Rp=3.40, χ^2 (chi-squared) = 1.134

Figure 3. Refinement of x-ray diffraction profiles of samples ZF60 with GSAS

Avrami parameter behavior formation yield fraction f (t), k and n of the Avrami equation f (t) = 1- exp (-ktn), acquired in the expectation of a linear trend graphs the relationship Ln {-Ln (1-f (t)) } VS Ln t as shown below.Slope states intercept parameter n = 0.1306 stated Ln k = -1.7699, so k = 0.17035. Yield formation of the equation fractions expressed by the equation;f(t)= 1 – exp (-0.17035 $t^{0.1306}$)

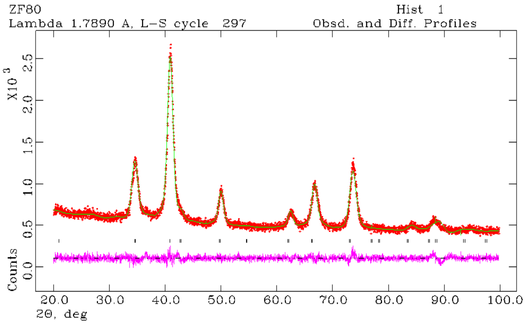
GSAS Refinement of x-ray diffraction profile sample ZF70



$ZnFe_2O_4$, Zn=0.4157, Fe=2.5096
space group : F d -3 m (227) Crystal Sistem : Cubic ,Lattice Parameter : *a* = 8.5096(1) Å, *b* = 8.5096(1) Å and *c* = 8.5096(1) Å, □ = □ = □ = 90^o, V = 616.2(3) $Å^3$ dan □ = 3.020 $gr.cm^{-3}$
R Factor (wRp=4.54 Rp=3.58, χ^2 (chi-squared) = 1.155)

Figure 3 .Refinement profile x-ray diffraction sample ZF70 with GSAS

GSAS Refinement of x-ray diffraction profile sample ZF 80



$ZnFe_2O_4$, Zn=0.4115, Fe=2.5885
space group : F d -3 m (227) l : Cubic
Parameter kisi : *a* = 8.5062(1) Å, *b* = 8.5062(1) Å dan *c* = 8.5062(1) Å,
$\alpha = \beta = = 90^o$, V = 615.4(2) $Å^3$ dan ρ = 3.191 $gr.cm^{-3}$
R Factor (wRp =4.58 , Rp = 3.6 χ^2 (chi-squared) = 1.267)

Figure 4. Refinement profile x-ray diffraction sample ZF80 with GSAS, Refinement profil X-ray difraction sampel ZF80 by GSAS

The reaction methods label name Chemical formula lattice parameter description Konet Zn0.245Fe2.755O4 lattice parameters: a = 8,589 (4) Å, b = 8589 (4) Å and c = 8589 (4) Å, $\alpha = \beta = \gamma = 90$ °, V = 615.4 (2) A3 and ρ = 5,582 gr.cm-3 reactor in the form of flash with 3 nek, equipped with a mechanical stirrer, pH electrode meters, electrodes thermometer.

Fisnet $Zn_{0.428}Fe_{2.572O4}$ lattice parameters: a = 8524 (4) Å, b = 8524 (4) Å and c = 8524 (4) Å, $\alpha = \beta = \gamma = 90$ °, V = 619.3 (1) A3 and ρ = 5,084 gr.cm-3 reactors in the form of a coil hose equipped with injector, ..

The enthalpy of the product depends on stochiometri obtained from XRD analysis as follows;

a. ZF60= $Zn_{0.409}Fe_{2.591}O_4$

$$\Delta H_{ZF\ 60} = 0.409\ x\Delta H^{0}_{ZNO} + 0.591\ xH^{0}_{FeO} + 2\,xH^{0}_{Fe\,2O\,3} = (0.409\ x3.504 + 0.591\ x2.720 + 8.24 =$$

11.283 $[kJoule\ /\ mole\ ] = 2.696$ kcal/mole

b. ZF70= $Zn_{0.416}Fe_{2.584}O_4$

$$\Delta H_{ZF\ 60} = 0.416\ xH^{0}_{ZNO} + 0.584\ xH^{0}_{FeO} + 2\,xH^{0}_{Fe\,2O\,3} = (0.409\ x3.504 + 0.564\ x2.720 + 8.24 =$$

$11.496\ [kJoule\ /\ mole\ ] = 2.747\ kcal\ /\ mole$

c. ZF80= $Zn_{0.412}Fe_{2.588}O_4$

$$\Delta H_{ZF\ 60} = 0.412\ xH^{0}_{ZNO} + 0.584\ xH^{0}_{FeO} + 2\,xH^{0}_{Fe\,2O\,3} = (0.412\ x3.504 + 0.584\ x2.720 + 8.24 =$$

$11.272\ [kJoule\ /\ mole\ ] = 2.694\ kcal\ /\ mole$

The results of the XRD formation defraktogram ZF60, ZF70 and ZF80 have compatibility with graphics 2-3 spinel formation.The enthalpy change during co-precipitation reaction at 2,845 joules / mol it can predict the energy levels of the reactants is;

a. enthalpy of reactants ZF60 = (11. 283-2845) = 8,438 kJoule / mole.
b. enthalpy of reactants ZF70 = (11.496-2.845) = 8,651 kJoule / mole.
c. enthalpy of reactants ZF80 = (11.272-2.845) = 8,427 kJoule / mole.

In the defraktograf material has a number of Zn atoms ZF70 more than ZF60 and ZF80. If the terms of the parameters in which the reaction temperature ranged ZF60 at temperatures 650-700, and ZF 80 at temperatures ranging from 850-900 looks strong correlation that increased temperature synthesis Zink Zn ferrite adding a portion of the atoms are included in ZnF spinel structure. But it turns out that correlation does not occur in ZnF70 which has a portion of Zn atoms which enter into the structure spinnel ZnF70 greater than Zn60 and Zn80.

Alternating Magnetic Test

From this fact seen any indication that the alternating magnetic treatment on material synthesis process provides process yields the interstitial atom in the zinc ferrite material is higher than the effect of changes in temperature synthesis.

Crystal size is calculated by the formula Debey Sherrer

$d = B.\ \lambda/\beta.\mathrm{Cos}\ \theta$ [9]

λ is the wave length of X-ray beam used, β is the full-with half maximum (FWHM) of diffraction and θ is the Bragg's angle. [9] d Debey = (0.9 x λ) / FWHM [rad] θ xCos θ ,With λ = wavelength of X-rays = 1.790300 Å Data obtained from the peak of XRD (Match and Bella as follow;

Data angle Peak ZF60; 29.46, 41.22, 50.30, 67.08, 73.94 FWHM 1.7600
Data angle Peak ZF70; 34.79, 41.10, 50.2, 66.96, 73.82, FWHM 2.0800
Data angle Peak ZF80 ; 34.62, 40.9, 50 882, 66.76, 73.66, FWHM 1.4000

Table Debey of three kinds Zinc-Ferrite.

Kode Bhn	2θ311	Cos θ311	FWHM	FWHM[rad]	D (debey)[nm]
ZF60	50.3	0.905293	1.76	0.0307022	5.797081875
ZF70	50.2	0.905663	2.08	0.0362844	4.903218248
ZF80	50.882	0.903125	1.4	0.0244222	7.305254902

It is seen that the influence of the alternating field ZF70 provide significant crystal size that is 4.9 nm, Effect of temperature rise resulting in an increased size of the crystals look significantly different in ZF60 to ZF80. In ZF70 despite the increase in temperature but it is compensated by the influence of the alternating field causes the crystal size dropped precipitously

Noting the nature of normal and inverse equation A and B on AB2O4 defined by the equation;

A= [$M_{(1-\lambda)}Fe\lambda$]; B= [$M_{\lambda}Fe_{(1-\lambda)}$];$O_4$ [10]

The pattern of the magnetic moment of spinel inversion normal to inverse spinel. To the degree inversion i, then the magnetic moment M obtained = MB-MA = {3i + 5 (2-i)} - {5i + 3 (1-i)} μB = {7-4i} μB. Thus obtained magnetic moment ZF60 = MZF60 7-4x0.591} = {μB = 4.636 μB
7-4x0.584 MZF70 = {} μB = 4,664 μB 7-4x0.588 MZF80 = {4648} μB
If in this case the magnetic moment μB is Bohr = The spin magnetic moment is a constant called the Bohr magneton with asumsion $\mu_B = \frac{q_e \hbar}{2.m_e}$,μ_B=9.27400915×10^{-24}Joule/Tesla=9.27400915×10^{-21}Erg/Gauss
Or μ_B= 5.7883817555(79)×10^{-5} eV/Tesla =9.27 x 10^{-27} A.m^2= 9.27 x 10^{-24} J/T
Magnetic moment of ZF 60 = 6.02x 10^{23} x 9.27 x 10^{-24} [J/T.Mole] = 5.580 [J/T.Mole]

From the graph B-H diagram (Hysteresis Diagram) that both ZF60, ZF70 and ZF80 is paramagnetic, but BH diagrams thinnest is ZF70, it states Hysteresis loss of energy in the system. The energy loss is proportional to the loop area , therefore more ZF70 are more paramagnetic than the ZF60 and ZF80

In connection with the treatment at the time of synthesis, the effect of alternating magnetic field it produces an increase in the paramagnetic properties Yield. So when the ferrimagnetic material particles are formed, alternating magnetic field from the outside would try to move the particles towards the external field. But the material is not able to follow the movement of the terrain, so the alternating field energy is not converted into a back and forth motion. Energy field besides excess will be converted into heat but also move the atoms of materials. to occupy the vacancy position corresponds to the atomic se owned atomic energy level/s.
Reaction Methods Label name Chemical formula Lattice Parameter Description.

Konet $Zn_{0.245}Fe_{2.755O4}$ lattice parameters: a = 8,589 (4) Å, b = 8589 (4) Å and c = 8589 (4) Å, = 5,582 gr.cm-3 reactor inρ = 90 °, V = 615.4 (2) A3 and γ = β = α the form of flash with 3 nek, equipped with a mechanical stirrer, pH electrode meters, electrodes thermometer
Fisnet $Zn_{0.42}8Fe_{2.572}O4$ lattice parameters: a = 8524 (4) Å, b = 8524 (4) Å and c = 8524 (4) Å,
= 5,084 gr.cm-3 reactors inρ = 90 °, V = 619.3 (1) A3 and γ = β = α the form of a coil hose equipped with injtor, the yield of container,
Fisac FIS $Zn_{0.739Fe2.261O4}$ a = 8,572 (7) Å, b = 8,572 (7) Å and c = 8,572 (7) Å,
= 4,918 gr.cm-3 reactors inρ = 90 °, V = 629.9 (1) A3 and γ = β = α the form of a coil hose equipped with injector, the yield of container, equipped with magnetic coil AC 50Hz [11]
Reaction Kinetics Analysis of Results-Based Record Defraktogram XRD.

The enthalpy of the product depends on stochiometri obtained from XRD analysis as follows; The results of XRD formation defraktogram ZF60, ZF70 and ZF80 have compatibility with graphics 2-3 spinel formation.The enthalpy change during coprecipitation reaction at 2,845 joules / mol it can predict the energy levels of the reactants is; [11]

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field causes the crystal size dropped precipitously. Noting the nature of normal and inverse equation A and B on AB2O4 defined by the equation; λ stated degree of inversion, which states that for; 0 <λ <1 inverse

spinel structure compound partially. λ = 0 normal spinel structure., λ = 1 inverse spinel structure, λ = 2/3 random structure.[12] means ZF60, ZF70, ZF80 including as a partial inverse spinel.

The pattern of the magnetic moment of spinel inversion normal to inverse spinel. To the degree inversion i, then the magnetic moment M obtained = MB-MA = {3i + 5 (2-i)} - {5i + 3 (1-i)} μB = {7-4i} μB. Thus obtained magnetic moment ZF60 = MZF60 7-4x0.591} = {μB = 4.636 μB7-4x0.584 MZF70 μB = 4,664 μB 7-4x0.588 MZF80 = {4648} μB = μB. If in this case the magnetic moment μB is Bohr = The spin magnetic moment is a constant called the Bohr magneton.[13]

From the graph B-H diagram (Hysteresis Diagram) that both ZF60, ZF70 and ZF80 is paramagnetic, but BH diagrams thinnest is ZF70, it states Hysteresis loss of energy in the system. The energy loss is proportional to the loop area. So if the broad field of Hysteresis 0 (identical to the extensive line). Therefore more ZF70 are more paramagnetic than the ZF60 and ZF80.

Saturation occurs when μH / kT is very large, it means that a large H or T is low will tend to produce moments rectification process or address the effects of thermal interference irregularity, so if μH / kT is small, the magnetization M to be linear with respect to H [14]

Table 6. Comparison ZF60, ZF70 and ZF80.[15]

Material	Temperatur Proses	Magnetisation Process	Time Processess (t_t) (detik)	Chemical Equation	Zn:Fe	Magnetic Field	saturatin magnetizatio [kA/m]	Coerciviy magnetizatio [kA/m]
ZF60	65-70	Tidak	60	$Zn_{0.409}Fe_{2.591}O_4$	0.409/ 2.591	Paramagnetik	16.67	4.97
ZF70	75-80	Yess	52	$Zn_{0.416}Fe_{2.584}O$	0.416/ 2.584	Paramagnetik	8.91	1.89
ZF80	85-90	No	60	$Zn_{0.412}Fe_{2.588}O_4$	0.412/ 2.588	Paramagnetik	28.5	8.1

In connection with the treatment at the time of synthesis, the effect of alternating magnetic field it produces an increase in the paramagnetic properties yield., so when the ferrimagnetic material particles are formed [16,17], alternating magnetic field from the outside would try to move the particles towards the external field. But the material is not able to follow the movement of the terrain, so the alternating field energy is not converted into a back and forth motion. Energy field besides excess will be converted into heat but also move the atoms of materials. atoms to occupy the vacancy position corresponds to the atomic se owned atomic energy levels.

ZF crystal structure that has been synthesized in the above-mentioned each have a degree of inversion λ and magnetization as follows:

a) ZF60, λ = 0591 and the magnetization M = (7- 4. 0591) μB = 4.636 μB
b) ZF70, λ = 0584 and the magnetization M = (7- 4. 0584) μB = 4,664 μB
c) ZF80, λ = 0588 and the magnetization M = (7- 4. 0588) μB = 4648 μB

Magnetic parameters obtained from the test results with permagraf tabulated as Paramagnetic have an odd number of electrons (spin total is not equal to zero), for example in the NO gas, organic free radicals.

Under the influence of the external field moments of atoms located at random so they can cancel each other and the total magnetic moment is equal to zero.. Thermal disturbance atoms will inhibit the tendency of alignment and tends to maintain moments of atoms in a state of random, and there is little alignment moments in the direction of the field.

IV. CONCLUSION

GSAS Refinement gave a vivid description of ingredients, so that we can compare one with the other compounds, but not enough to compare other physical properties. Need to examine the physical properties of other materials, example properties of magnetism.

Time synthesis process as the core of zinc Ferrite ferrofluid successfully recorded and graphed each of each sigmoidal process temperature in order to obtain specific energy formation process Zn Ferrite with specifications Zn / Fe = 0:15 by Qe = 342.31 x 8,314 = 2,845 joules / mol. Effect of temperature on the synthesis of zinc Ferrite to the limit below 90 ^{0}C does not provide a significant difference to the formation phase. The alternating magnetic field has significant impact on the process of the interstitial metal atoms occupy the vacancy Zn 2+ to Fe 2+ metal atom. Seen properties that the number of Zn atoms on more than ZF60 ZF70 and ZF80. This has an impact on the particle size ZF70 larger and smaller density.

As a result ZF70 has a number of Zn atoms, permagraf noted that ZF70 has paramagnetic properties that are much stronger than ZF60 and ZF80. This is reinforced by the data corsivity ZF70 magnetism be smaller than ZF60 and ZF80 . Of profile defraktogram seen that ZF70 more harshly than others, it can indicate that the particle ZF70 has not yet rounded shape (spherical) or the particle size is not perfect, and paramagnetic of yield ZF70 tend increased.

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