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STUDY ON PHYSICAL-CHEMICAL PROPERTIES OF POWDER FURNACE NICKEL SLAG

STUDI SIFAT FISIKA-KIMIA BUBUK SLAG NIKEL FURNACE

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ABSTRAK

Penelitian ini bertujuan untuk menyiapkan bubuk slag nikel yang berasal dari furnace, yang dilanjutkan dengan mengidentifikasi dan menganalisis unsur atau paduan yang terkandung di dalamnya. Data diperoleh dengan melakukan analisis terhadap komposisi unsur, fasa mikrostruktur, ukuran Kristal, distribusi dan komposisi paduan dari sampel bubuk slag nikel furnace dengan menggunakan XRD tipe Rigaku Miniflex II dan SEM-EDS tipe Tescan Vega-3. Hasil analisis XRD menunjukkan bahwa formasi yang dihasilkan menyerupai fase amorf dan formasi yang terbentuk pada puncak 2θ = 28.01° diidentifikasi sebagai low quartz (SiO_2). Dengan menggunakan microcal origin 6.0 diperoleh FWHM 0.18 ° dan menggunakan persamaan Scherer diperoleh rata-rata ukuran kristal 53.37 nm. Hasil pengukuan SEM menunjukkan bahwa rata-rata ukuran butir dari sampel bubuk slag nikel furnace bervariasi antara minimal 1µm dan maksimum 4 µm. Berdasarkan pengukuran EDS diperoleh secara berturut-turut bahwa unsur utama penyusun paduan slag nikel furnace adalah Si 32.86 wt%, Mg 19.40 wt%, dan Fe 32.03 wt%.

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ABSTRACT

This research aims to prepare powder nickel slag from furnace machine, identify and analyze of the elements or compounds containing in the sample. The data retrieval was done with the analysis of elemental composition, phase microstructures, crystal size, distribution and composition of mapping compound of powder nickel slag samples by using XRD type Rigaku Miniflex II and SEM-EDS measurement type Tescan Vega-3. XRD analysis result indicates that the formation which similar with amorphous phase was identified and the formation at peak 2θ = 28.01° is identified as the low quartz (SiO_2). FWHM 0.18° was obtained using microcal origin 6.0 and average crystal size 53.37 nm was obtained by applying Scherer equation. SEM measurement results showed average grain size of powder furnace nickel slag samples is less than 1µm and maximum to 4µm. Based on EDS measurement showed that the main constituent elements are Si 32.86 wt%, Mg 19.40 wt%, and Fe 32.03 wt%, respectively.

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Keywords:chemical composition, grain size,nickel slag, physical-chemical properties, powder

INTRODUCTION

Many studies have conducted a nickel slag utilization, some of them are in the field of construction in various countries in the world, as considering the nickel slag production can reach thousands of ton every week (Predery, 2011; Huang et al, 2007; and Motz & Geizeler, 2010) addition, in the developing countries nickel slag utilized in the construction of highways such as for granular and hot-mix asphalt aggregate (engineered fill, sub base and base material, and asphalt concrete), aggregate of concrete manufacturing (fine and coarse aggregate) and cementations application (blended cement and raw material for cement manufacture) (Wang & Thompson, 2011) Nickel slag also used in industrial blast cleaning as ultra blast with a high density disposable blasting slag which has several advantages such as high production rates, non-reactant and non-detectable crystalline. Utilization of nickel slag depends on mechanical properties, electrical properties and morphology characteristics, which are largely determined by the physical-chemical composition and crystal structure (Zhang & Chou, 2012; and Ghosh et al, 2010). Information of the physical-chemical composition and crystal structure of nickel slag become very important to determine of future materials applications.

In this paper, the powder nickel slag samples come from the smelting process of nickel ore after furnace processing. The analysis was focused on the physical-chemical properties of materials base on the characterization data by using X-ray Diffraction (XRD), Scanning Electron Microscopy (SEM) and Energy Dispersive Spectroscopy (EDS) measurements.

METHOD

The procedure in this research starting from sample preparation of furnace nickel slag in solid form that processed into a powder, followed by analysis of micro structures through characterization by XRD and SEM and mineral composition analysis using EDS.

Sample Preparation. Hard chunks of furnace nickel slag, caused the process of nickel slag into a fine aggregate without using a machine becomes very difficult. Furnace nickel slag procedures into powder form begin with destruction to gravel size by using Jaw Crusher W 200 machine. Next, Slag size gravel rinsed with water to minimize contamination, then dried using a furnace at temperature of $170^{o}C$ for 30 minutes. The slag dried then crushed using a Jaw Crusher W 200 to produce shaped nickel slag sand. Slag which has been processed by Jaw Crusher W 200 then processed again by grinding mill PAL-M100M mill resulted swinging as the smooth output (this procedures also will be published elsewhere). The obtained sample from the processing chunk of nickel slag was formed at the laboratory of Material Sciences, Department of Physics, Universitas Negeri Makassar which is shown in Figure 1.

Figure 1. Sample of powder furnace nickel slag

Microstructure Analysis. Information of the microstructure sample gathered through the XRD and SEM data analysis. Microstructure properties of materials obtained from XRD such as crystal ability of material, the average of crystal size, and FWHM, can determine the electrical properties and

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Commented [t5]: Nama tak sessuai dengan Reff crystal quality of materials (Wickenden & Kisthemnacer, 1994; and Sujiono et al, 2001). On the other hands, the grain size and patterns of particle distribution are factor that can determine the mechanical properties of the materials. This data obtained from SEM analysis.

Mineral Composition. Analysis of EDS data results was used to determine the element of nickel slag samples. This result can be used to identify the dominant constituent element of materials. This data is very important as the basis of utilization of the materials based on the characteristics of the element constituting, and the basic separation of nickel slag elements by using the appropriate method such as reduction under vacuum condition (Deng et al, 2014). Average particle size can be calculated from the top of the highest intensity by using the Debye-Scherer:

$$t = k\lambda / B \cos \theta \qquad (1)$$

Where, t is the average of crystal size, k is the constant Scherer (0.89), λ is the wavelength of the X-rays, B is the FWHM in radiant, and θ is the angle of Bragg's diffraction, respectively (Khalil et al, 2012; and Kumar et al, 2013).

RESULT AND DISCUSSION

Characteristics of Powder Furnace Nickel Slag Samples. Based on the sample size aggregate of the nickel slag that can be set in the range of 0 – 30 mm, then the utilization of nickel slag furnace options were expended. For instance the slag with a grain size between <9.5 – 4.75 mm can be use as coarse aggregate and slag with a grain size between <4.75 – 0.075 mm can be served as a fine aggregate such as in application for prestressed concrete, concrete block, etc (ASA, 2011). While the nickel slag in the form of powder provide wide opportunities of utilize the nickel furnace slag and further research on mixing the powdered sample with other powder materials to improve the quality of materials in order to maximize its application.

Physical Properties: Analysis of SEM result was used to analyze the surface of morphology, size and form of granules, pattern of granules distribution, mapping elements and compounds of nickel slag furnace constituents. Figure 2.a shows the result of SEM characterization of nickel slag furnace with 81 times magnification, using an SE detector, and HV is 15 kV.The grain size of nickel slag which had been treated has a size of more than 1500 μm. it appeared bright white dots on the surface of grain were the Ti elements with percentage of 0.20% and constituent element was sampled with the highest atomic number that has the highest level of brightness......

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Figure 2.b shows the result of SEM characterization of nickel slag powder furnace with 2000 times magnification can be seen a grain of powdered nickel slag have a variety of different size ranging between <1 μm– 4 μm. It can provide a wide option for processing nickel slag furnace in micro scale particles . The result of EDS data indicates that the main elements of a sample is Si and Fe. The Si rich area on the SEM image (figure 2.b) is marked with "B" on darker part, whereas the Fe rich area is marked with "A" on the brighter part, which caused Fe elements has a higher atomic number than Si, where the smaller of their atomic number caused the lower of their reflection causing a darker area on the image of SEM characterization.

Figure 2.c showed nickel slag furnace powders with 5000 times magnification, while the scale of 5 μm is focused on the element Fe, which is in the picture it looks that the grain size for Fe element also varied from small to large, in some part of Fe element in the granules is also seen some discharge electron because on the grain boundary.

Chemical properties. Characterization result of x-ray diffraction (XRD) from powder furnace nickel slag shows the content or composition of the constituents in the form of compounds. Crystal phase was indicated by the presence of sharp peaks while the other phase resemble the amorphous phase that was indicated by the formation of the hump with an irregular intensity, which is a characteristic for sample in powder form.

X-ray diffraction pattern in Figure 3 shows the diffraction patterns from nickel slag powder which showed the emergence of some of the top of the crystal phase and amorphous like phase of nickel slag. Data retrieval at the angle of 2θ starts from 20º-80º with λ = 1.54 nm at 30 kV voltage and current of 15 mA.

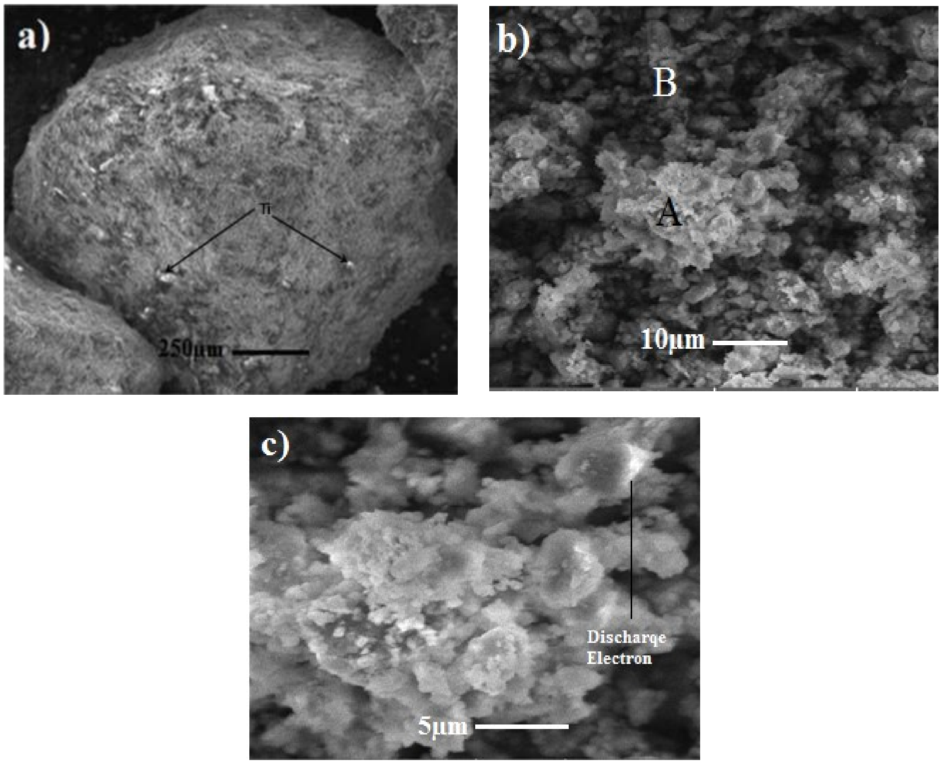

Figure 2. SEM image of: a) Nickel slag furnace with 81 times magnification (Ti showed by bright dots). b) Nickel slag furnace with 2000 times magnification (A=Fe rich area; B= Si rich Area). c) Nickel slag furnace with 5000 times magnification.

The most dominant peak is on hkl $d_{(113)}$ field with the intensity of the 1866 counts at the angle of 2θ is 28.01º. The field shows the phase hypothetical silica (SiO_2) with 32.86 wt% is similar with the dominant mineral in powder furnace nickel slag from literature (Pan et al, 2013) but this sample has a larger FeO, so its possible to make a new alloy material rich with FeO by adding powder nickel slag as an aggregate. FWHM value obtained from the Microcal Origin 6.0 was 0.18º, this value is quite small refer to literature, that mean this phase has a good crystal structure and electrical properties (Wickenden & Kisthemnacer, 1994; and Sujiono et al, 2001) and by Scherer equation acquired crystal size of 53.37 nm. Next on the field of hkl d($_{221}$) and intensity of the 482 counts at an angle of 2θ 29.69º and in field hkl d($_{310}$) with the intensity of 1470 counts at an angle 2θ is 30.99º showed shows the clinoenstatite ($Mg(SiO_3)$) phase. In the field of hkl d($_{122}$) and the intensity of the 178 counts at an angle 2θ of 42.36º showed the phases of silimanite $Al_2(SiO_4)O$. In the field of hkl d($_{110}$) and the intensity of 1169 counts at an angle of 2θ 36.36º, showed the phases of Magnetite (Fe_2O_3). Whereas in the field of hkl d($_{200}$) and the intensity of the 849 counts at an angle of 2θ is 35.58^0, showed the phases of calcium peroxide (CaO_2). The formation of both clinoenstatite ($Mg(SiO_3)$) and silimanite $Al_2(SiO_4)O$ phase showed that Si can bound with Mg and Al. The absence of compound between Si and Fe or Ca indicated that these elements cannot bound together or the diffraction is quite small to detect by XRD detector.

Chemical composition of powder furnace nickel slag from XRD analysis as shown in figure 4 shows that the highest phase is clinoenstatite 68%. In addition there is another chemical compound like hypothetical silica 13%, iron (III) oxide 12%, silimanite 4% and calcium peroxide 3%.

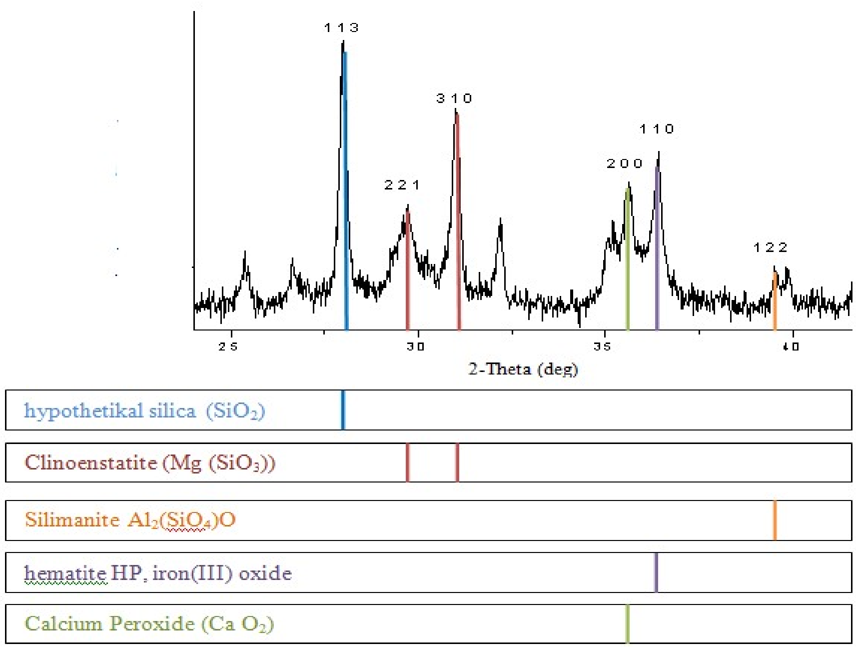

Figure 3. XRD pattern of powder furnace nickel slag.

Chemical Composition. The result analysis of EDS (Energy Dispersive Spectroscopy) provides information on the chemical composition of furnace nickel slag as shown in the table 1. It is shown that there are three dominant elements Si, Fe, and Mg. These elements could be extracted from powder furnace nickel slag for further application, such as to extract Mg using carbonation process (Wen-ning et al, 2010) nd to extract Fe element using precipitation method.

Furthermore, the presence of Si and Al element with ratio larger than 8 in powder furnace nickel slag give a possibility to use it as raw material in synthesis geopolymer (Davidovits, 1994; and Rangan, 2010), which has chain structure from Si and Al ions (Cheng & Chiu, 2003; and Ioannis et al, 2009). Based on these results of the compounds contained in samples of powdered, furnace nickel slag can be separated using physical chemical methods whose results are expected to support the acceleration of the Indonesia economic development master plan.

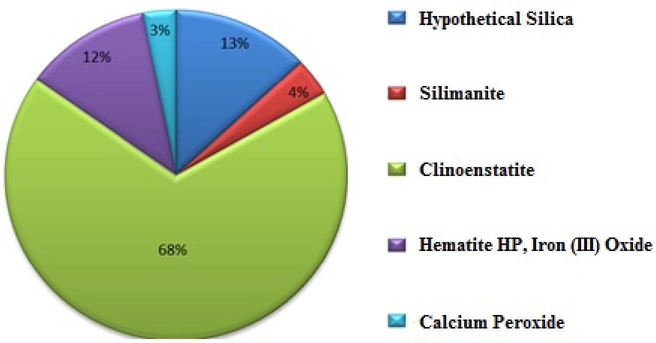

Figure 4. Percentage of compound in powder furnace nickel slag sample

Table 1. The result of EDS characterization powder furnace nickel slag

Symbol	Si	Al	Na	Fe	Mn	Cr	Ca	Mg	S	Ti	Co
Percentage [%]	32.86	4.02	0.25	32.03	0.50	2.07	7.82	19.40	0.24	0.20	0.60

CONCLUSION

Sample powder of furnace nickel slag with varied grain size on the first stage has successfully produced. SEM measurement data analysis result showed grain size for sample furnace slag powder on average <1 μm– 4 μm. Result of XRD data analysis indicated resemble an amorphous phase formation was characterized by the presence of hump, with its highest peak at 2θ = 28.01° which is a phase of low quartz (SiO_2), with the average FWHM of 0.18 and crystal size 53.37nm. The analysis of EDS indicates that major elements of nickel furnace slag powder are Si 32.86 % wt, Mg 19.40 %wt and Fe 32.03 %wt, respectively. .....

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Dateline tgl 29 mei 2016.

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STUDY ON PHYSICAL-CHEMICAL PROPERTIES OF POWDER FURNACE NICKEL SLAG AS GEOPOLYMER APPLICATION

STUDI SIFAT FISIKA-KIMIA BUBUK SLAG NIKEL FURNACE UNTUK APLIKASI GEOPOLYMER

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Sample Preparation. Hard chunks of furnace nickel slag, caused the process of nickel slag into a fine aggregate without using a machine becomes very difficult. Furnace nickel slag procedures into powder form begin with destruction to gravel size by using Jaw Crusher W 200 machine. Next, Slag size gravel rinsed with water to minimize contamination, then dried using a furnace at temperature of 170ºC for 30 minutes. The slag dried then crushed using a Jaw Crusher W 200 to produce shaped nickel slag sand. Slag which has been processed by Jaw Crusher W 200 then processed again by grinding mill PAL-M100M mill resulted swinging as the smooth output (this procedures also will be published elsewhere). The obtained sample from the processing chunk of nickel slag was formed at the laboratory of Material Sciences, Department of Physics, Universitas Negeri Makassar which is shown in Figure 1.

Figure 1. Sample of powder furnace nickel slag

Microstructure Analysis. Information of the microstructure sample gathered through the XRD and SEM data analysis. Microstructure properties of materials obtained from XRD such as crystal ability of material, the average of crystal size, and FWHM, can determine the electrical properties and crystal quality of materials (Wickenden & Kisthemnacer, 1994; and Sujiono et al, 2001). On the other hands, the grain size and patterns of

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Commented [t5]: Nama tak sessuai dengan Reff particle distribution are factor that can determine the mechanical properties of the materials. This data obtained from SEM analysis.

Mineral Composition. Analysis of EDS data results was used to determine the element of nickel slag samples. This result can be used to identify the dominant constituent element of materials. This data is very important as the basis of utilization of the materials based on the characteristics of the element constituting, and the basic separation of nickel slag elements by using the appropriate method such as reduction under vacuum condition (Deng et al, 2014). Average particle size can be calculated from the top of the highest intensity by using the Debye-Scherer:

$$t = k\lambda / B \cos\theta \quad (1)$$

Where, t is the average of crystal size, k is the constant Scherer (0.89), λ is the wavelength of the X-rays, B is the FWHM in radiant, and θ is the angle of Bragg's diffraction, respectively (Khalil et al, 2012; and Kumar et al, 2013).

RESULT AND DISCUSSION

Characteristics of Powder Furnace Nickel Slag Samples. Based on the sample size aggregate of the nickel slag that can be set in the range of 0 – 30 mm, then the utilization of nickel slag furnace options were expended. For instance the slag with a grain size between <9.5 – 4.75 mm can be use as coarse aggregate and slag with a grain size between <4.75 – 0.075 mm can be served as a fine aggregate such as in application for prestressed concrete, concrete block, etc (ASA, 2011). While the nickel slag in the form of powder provide wide opportunities of utilize the nickel furnace slag and further research on mixing the powdered sample with other powder materials to improve the quality of materials in order to maximize its application.

Physical Properties: Analysis of SEM result was used to analyze the surface of morphology, size and form of granules, pattern of granules distribution, mapping elements and compounds of nickel slag furnace constituents. Figure 2.a shows the result of SEM characterization of nickel slag furnace with 81 times magnification, using an SE detector, and HV is 15 kV.The grain size of nickel slag which had been treated has a size of more than 1500 µm. it appeared bright white dots on the surface of grain were the Ti elements with percentage of 0.20% and constituent element was sampled with the highest atomic number that has the highest level of brightness.

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Figure 2.b shows the result of SEM characterization of nickel slag powder furnace with 2000 times magnification can be seen a grain of powdered nickel slag have a variety of different size ranging between <1 µm– 4 µm. It can provide a wide option for processing nickel slag furnace in micro scale particles . The result of EDS data indicates that the main elements of a sample is Si and Fe. The Si rich area on the SEM image (figure 2.b) is marked with "B" on darker part, whereas the Fe rich area is marked with "A" on the brighter part, which caused Fe elements has a higher atomic number than Si, where the smaller of their atomic number caused the lower of their reflection causing a darker area on the image of SEM characterization.

Figure 2.c showed nickel slag furnace powders with 5000 times magnification, while the scale of 5 µm is focused on the element Fe, which is in the picture it looks that the grain size for Fe element also varied from small to large, in some part of Fe element in the granules is also seen some discharge electron because on the grain boundary.

Chemical properties. Characterization result of x-ray diffraction (XRD) from powder furnace nickel slag shows the content or composition of the constituents in the form of compounds. Crystal phase was indicated by the presence of sharp peaks while the other phase resemble the amorphous phase that was indicated by the formation of the hump with an irregular intensity, which is a characteristic for sample in powder form.

X-ray diffraction pattern in Figure 3 shows the diffraction patterns from nickel slag powder which showed the emergence of some of the top of the crystal phase and amorphous like phase of nickel slag. Data retrieval at the angle of 2θ starts from 20^o-80^o with λ = 1.54 nm at 30 kV voltage and current of 15 mA.

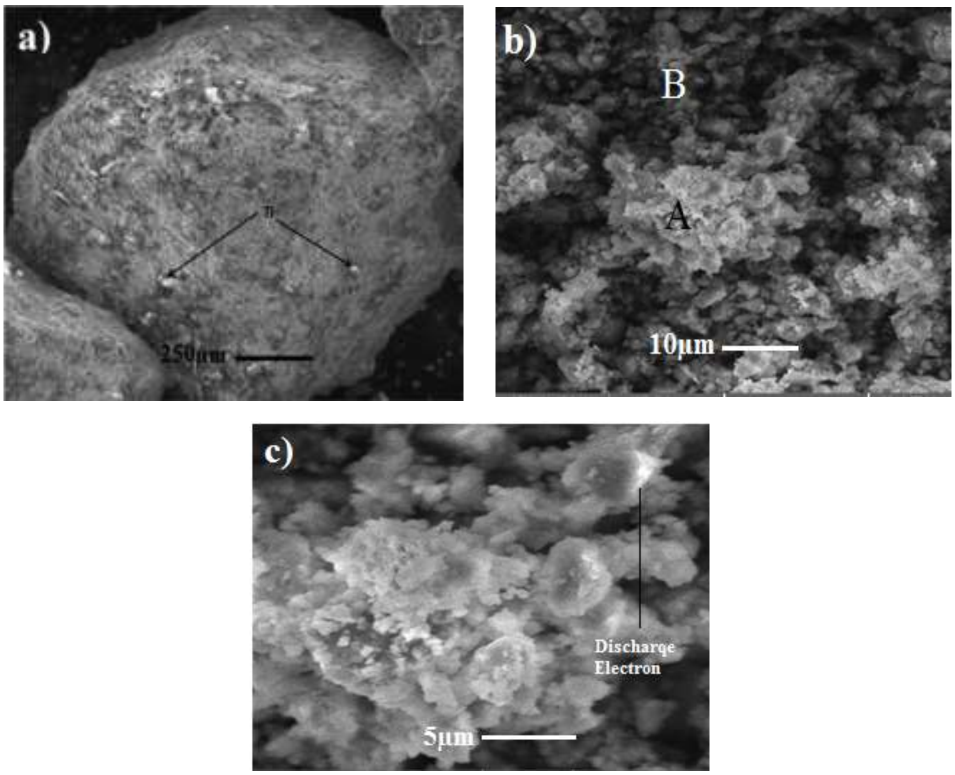

Figure 2. SEM image of: a) Nickel slag furnace with 81 times magnification (Ti showed by bright dots). b) Nickel slag furnace with 2000 times magnification (A=Fe rich area; B= Si rich Area). c) Nickel slag furnace with 5000 times magnification.

The most dominant peak is on hkl $d_{(113)}$ field with the intensity of the 1866 counts at the angle of 2θ is 28.01^o. The field shows the phase hypothetical silica (SiO_2) with 32.86 wt% is similar with the dominant mineral in powder furnace nickel slag from literature (Pan et al, 2013) but this sample has a larger FeO, so its possible to make a new alloy material rich with FeO by adding powder nickel slag as an aggregate. FWHM value obtained from the Microcal Origin 6.0 was 0.18^o, this value is quite small refer to literature, that mean this phase has a good crystal structure and electrical properties (Wickenden & Kisthemnacer, 1994; and Sujiono et al, 2001) and by Scherer equation acquired crystal size of 53.37 nm. Next on the field of hkl $d_{(221)}$ and intensity of the 482 counts at an angle of 2θ 29.69^o and in field hkl $d_{(310)}$ with the intensity of 1470 counts at an angle 2θ is 30.99^o showed shows the clinoenstatite ($Mg(SiO_3)$) phase. In the field of hkl $d_{(122)}$ and the intensity of the 178 counts at an angle 2θ of 42.36° showed the phases of silimanite $Al_2(SiO_4)O$. In the field of hkl $d_{(110)}$ and the intensity of 1169 counts at an angle of 2θ 36.36°, showed the phases of Magnetite (Fe_2O_3). Whereas in the field of hkl $d_{(200)}$ and the intensity of the 849 counts at an angle of 2θ is 35.58°, showed the phases of calcium peroxide (CaO_2). The formation of both clinoenstatite ($Mg(SiO_3)$) and silimanite $Al_2(SiO_4)O$ phase showed that Si can bound with Mg and Al. The absence of compound between Si and Fe or Ca indicated that these elements cannot bound together or the diffraction is quite small to detect by XRD detector.

Chemical composition of powder furnace nickel slag from XRD analysis as shown in figure 4 shows that the highest phase is clinoenstatite 68%. In addition there is another chemical compound like hypothetical silica 13%, iron (III) oxide 12%, silimanite 4% and calcium peroxide 3%.

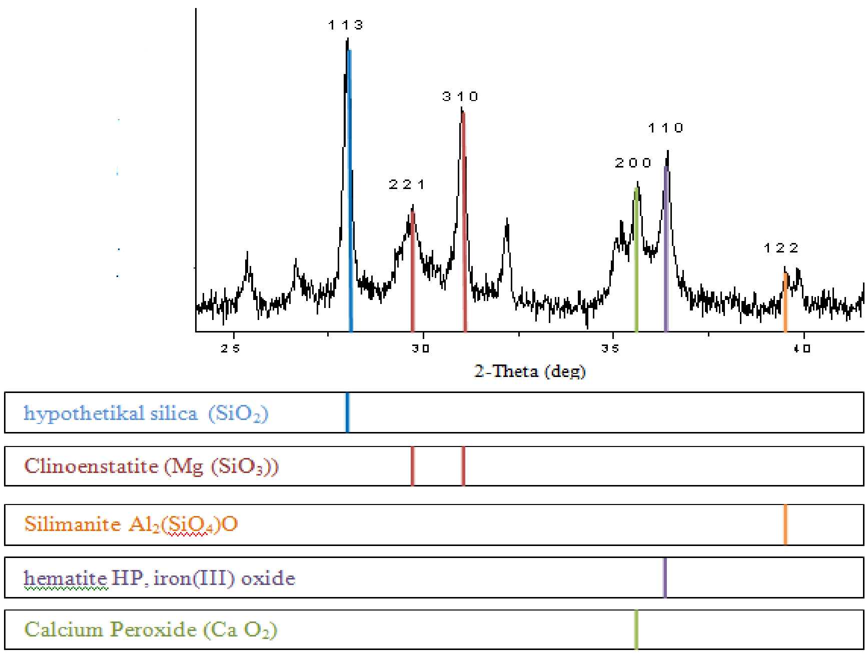

Figure 3. XRD pattern of powder furnace nickel slag.

Chemical Composition. The result analysis of EDS (Energy Dispersive Spectroscopy) provides information on the chemical composition of furnace nickel slag as shown in the table 1. It is shown that there are three dominant elements Si, Fe, and Mg. These elements could be extracted from powder furnace nickel slag for further application, such as to extract Mg using carbonation process (Wen-ning et al, 2010) nd to extract Fe element using precipitation method.

Furthermore, the presence of Si and Al element with ratio larger than 8 in powder furnace nickel slag give a possibility to use it as raw material in synthesis geopolymer (Davidovits, 1994; and Rangan, 2010), which has chain structure from Si and Al ions (Cheng & Chiu, 2003;

and Ioannis et al, 2009). Based on these results of the compounds contained in samples of powdered, furnace nickel slag can be separated using physical chemical methods whose results are expected to support the acceleration of the Indonesia economic development master plan.

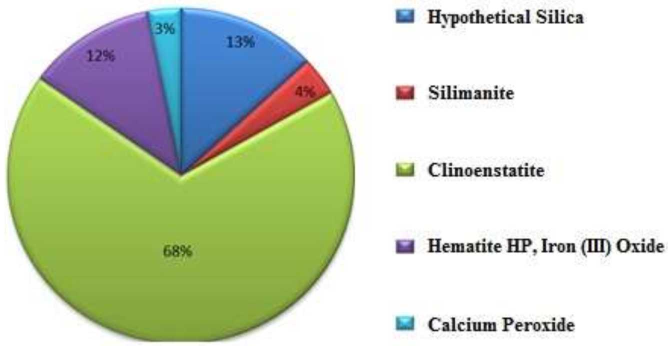

Figure 4. Percentage of compound in powder furnace nickel slag sample

Table 1. The result of EDS characterization powder furnace nickel slag

Symbol	Si	Al	Na	Fe	Mn	Cr	Ca	Mg	S	Ti	Co
Percentage [%]	32.86	4.02	0.25	32.03	0.50	2.07	7.82	19.40	0.24	0.20	0.60

CONCLUSION

Sample powder of furnace nickel slag with varied grain size on the first stage has successfully produced. SEM measurement data analysis result showed grain size for sample furnace slag powder on average <1 μm– 4 μm. Result of XRD data analysis indicated resemble an amorphous phase formation was characterized by the presence of hump, with its highest peak at 2θ = 28.01° which is a phase of low quartz (SiO_2), with the average FWHM of 0.18 and crystal size 53.37nm. The analysis of EDS indicates that major elements of nickel furnace slag powder are Si 32.86 % wt, Mg 19.40 %wt and Fe 32.03 %wt, respectively. The presence of Si and Al element with ratio larger than 8 in powder furnace nickel slag give a possibility to use it as raw material in synthesis geopolymer

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-Karakteristik nickel slag apa sudah sesuai dengan industry?

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Berdasarkan penilaian dan rekomendasi mitra bebestari, naskah bapak/ibu/saudara dengan judul **"STUDY ON PHYSICAL-CHEMICAL PROPERTIES OF FURNACE-NICKEL-SLAG POWDER for geopolymer application" (S. Samnur[1], H. Husain[2], A. Zulfi[2], E.H. ,Sujiono[2*])** diterima untuk dipublikasikan dalam Jurnal Pendidikan Fisika Indonesia (JPFI), vol. 12, no.2, Juli 2016**.**
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(PENPRINAS MP3EI 2011-2025)

EKSPLORASI POTENSI *SLAG* NIKEL (Ni) DI SULAWESI
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Tahun Ke-1 dari Rencana 3 Tahun

Ketua Tim Peneliti:

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RINGKASAN

Penelitian ini direncanakan untuk mengindentifikasi dan mengkaji unsur atau senyawa yang terkandung dalam bahan *slag* nikel, menghasilkan produk berbahan dasar paduan *slag* nikel, kemungkinan metode daur ulang *slag* nikel dan aplikasi penggunaan *slag* nikel untuk konstruksi jalan raya atau potensi aplikasi lainnya. S*lag* nikel merupakan produk sampingan atau limbah dari proses penambangan nikel. Proses penelitian meliputi pembuatan sampel berbentuk bulk (*pellet*) dilakukan dengan menggunakan metode reaksi padatan *(solid state reaction)* atau proses sintesis dengan cara pelelehan/*melting* di laboratorium Fisika Material Jurusan Fisika UNM, pengambilan data dimulai dengan pengkajian secara mendalam tentang komposisi dan fase mikrostruktur melalui analisis SEM-EDAX (*Scanning electon microscopy-energy dispersive X-ray*) dan XRD (*X-Ray Difraction*) serta pengukuran sifat-sifat mekanik melalui pengujian kekerasan/*hardness*, *stress/strain* dan *modulus young*. Pada tahun pertama telah dianalisis komposisi yang terkandung dalam *slag* melalui karakterisasi SEM-EDAX, XRF dan sifat-sifat mekanik berupa tingkat kekerasan bahan, dan karakteristik DTA-TG, serta analisis fase dan mikrostruktur dengan XRD. Juga berhasil mensintesis *slag nikel* dari bentuk bongkahan padatan menjadi bubuk/serbuk. Publikasi hasil penelitian **tahun pertama 2013** yaitu pada *The 3rd International Conference on Theoretical and Applied Physics* dan Simposium Fisika Nasional XXVI di Universitas Negeri Malang, seminar nasional Fisika di Universitas Hasanuddin Makassar, dan publikasi pada Jurnal Pendidikan Fisika Indonesia terakreditasi B Dikti Kemdikbud (terkirim/*submitted*), serta draft publikasi pada jurnal internasional *Materials Science and Engineering*. Dari data ini dapat ditentukan potensi aplikasi bahan *slag* nikel dan *treatment* apa yang dapat diberikan untuk meningkatkan kualitas bahan. Pada tahun kedua, dan ketiga diharapkan peneliti dapat mengkaji mengenai perpaduan bahan *slag* nikel dengan bahan yang lain baik sebagai bahan dasar atau bahan penambah untuk menghasilkan bahan paduan baru yang memiliki nilai manfaat yang lebih luas, baik untuk aplikasi industri maupun manfaat ekonomi bagi kesejahteraan masyarakat. Luaran yang diharapkan pada akhir penelitian adalah produk berbahan dasar *slag* nikel, metode daur ulang *slag* nikel, dan diagram alur pemanfaatan *slag* nikel untuk kontruksi jalan raya atau potensi aplikasi lainnya.

PRAKATA

Puji syukur kami panjatkan kehadirat Allah SWT, berkat rahmat dan karunianya sehingga laporan penelitian MP3EI tahun pertama dengan judul "**Eksplorasi Potensi *Slag* Nikel (Ni) di Sulawesi dan Potensi Aplikasinya**" dapat diselesaikan tepat pada waktunya. Penelitian MP3EI ini dilaksanakan sebagai salah satu upaya yang dilakukan oleh tim peneliti dalam rangka ikut berperan serta secara aktif dalam usaha mempercepat dan memperkuat pembangunan ekonomi sesuai dengan keunggulan dan potensi strategis wilayah terutama pada koridor ekonomi Sulawesi, dimana Nikel merupakan salah satu komoditas unggulan yang diharapkan dapat mengembangkan potensi ekonomi wilayah, memperkuat konektivitas nasional yang terintegrasi secara lokal dan global serta memperkuat kemampuan sumberdaya manusia dan iptek nasional untuk mendukung pengembangan program utama di koridor Sulawesi.

Laporan penelitian ini disusun sebagai bentuk pertanggungjawaban dan pelaporan atas kegiatan penelitian beserta capaiannya yang telah dilaksanakan pada tahun pertama dari rencana penelitian selama 3 tahun dan menjadi dasar dalam penentuan keberlanjutan penelitian pada tahun selanjutnya.

Pada kesempatan ini tim peneliti juga tidak lupa mengucapkan terimakasih kepada Direktorat Penelitian dan Pengabdian Kepada Masyarakat Dirjen DIKTI yang telah mendanai penelitian ini melalui skema penelitian prioritas nasional Masterplan Percepatan dan Perluasan Pembangunan Ekonomi Indonesia (MP3EI) Tahun Anggaran 2013 yang tertuang dalam kontrak pelaksanaan penelitian Nomor : 284/SP2H/PL/Dit. Litabmas/VII/2013, tanggal 15 Juli 2013. Ucapan terimakasih juga disampaikan kepada Lembaga Penelitian dan Pengabdian Kepada Masyarakat UNM, penanggungjawab dan staf laboratorium Fisika FMIPA UNM dan UM serta berbagai pihak yang telah turut serta dalam membantu kelancaran pelaksanaan penelitian ini yang tidak dapat disebutkan satu persatu.

Akhirnya semoga laporan penelitian ini dapat bermanfaat bagi kita semua.

DAFTAR ISI