MINERAL AND PARTICLE SHAPE CHARACTERIZATION OF LEUNGAH BEACH IRON SAND

[1]SAYUTI, M, [2]REZA PUTRA, [3]MUHAMMAD YUSUF

Department of Industrial Engineering, Faculty of Engineering UniversitasMalikussaleh, 24351 Aceh Indonesia.
E-mail: sayuti_m@unimal.ac.id

Abstract - Leungah iron sand and particle shape characterization analysis had been carried out and purposive sampling method was used. The physical parameters observed in this study were sand, sand shape and sand grain size. Mineral content was carried out with XRD (X-Ray Diffraction) and the form of particle was carried out using a microscope. The test results showed that the types of minerals identified were classified into volcanic mineral types from lithogeneous sedimentary types, black in colour, rounded in shape and has the average particle size of 0.14 mm. The results of the mineral content analysis showed that Leungah beach sand contains minerals which are dominated by Cr (Chromium), Hematite (Fe_2O_3), Calcium Carbonate $CaCO_3$.

Keywords - Iron Sand, Leungah Beach, Particle Shape, mineral.

I. INTRODUCTION

Compressive loads and more frequent thermal shock than their aircraft counterparts. In addition, Indonesia has abundant natural magnetic materials. These natural magnetic materials are found in iron sand. In Indonesia, iron sand is widely found on the island of Java, especially on the north and south coasts, and also can be found in Sumatra's Aceh province . Nowadays, iron sand is generally used as building material, whereas iron sand actually contains magnetic mineral material which is a natural resource for the development of devices in modern life. Iron sand which has been separated from non magnetic materials is widely used as raw material in the steel mill industry, as iron smelting material and as cement mixtures. On the other hand, magnetic minerals that contain magnetite, hematite and maghemite have great potential in industrial development[1][2].

Iron sand deposits are initially formed due to weathering processes of andesitic and basaltic rocks. During the weathering process, rocks are eroded and transported to the river and continue to be carried to the sea. During the transportation process, the rocks undergo a process of changing shape and size to become finer-sized particles. At sea, because of the impact of waves of sea water, transported particles are thrown to the beach and the returning water brings the light materials so the lighter particle parts will be separated from the heavier parts. As a result, the particles will be concentrated and accumulated as layers that form the boundary layer. The resulting layer will show an inverse sequence, ie particles that are finer and have a heavy mineral content will be below. Meanwhile, the more upward, the constituent particles of the layer are more rough and contain less heavy minerals. Layers that form along the coastline form deposits from iron sand deposits. Sand can be classified physically or the constituent mineral content. Classification based on the physical properties of sand can be distinguished based on the shape, size, color and density of sand. Some authors[3]; Arasan et all., (2010) are using three sub-quantities; one and each describing the shape but at different scales. The terms are morphology/form, roundness and surface[1]. In Figure 1 is shown how the scale terms are defined. Power (1952) also published a graphic scale to illustrate the quantitative measure (Figure 2)[4]. It is important to highlight that any comparing chart to describe particle properties has a high degree of subjectivity.Classification can also be done by looking at the differences of the chemical constituents of the sand. One method used to analyze mineral content in sand is X-ray diffraction (XRD) to calculate mineral percentages [5].

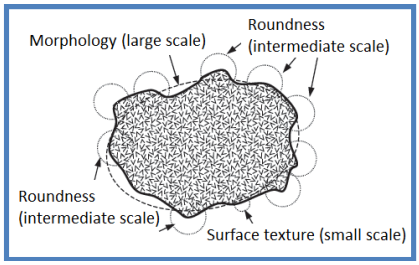


Fig. 1. Shape describing sub quantities

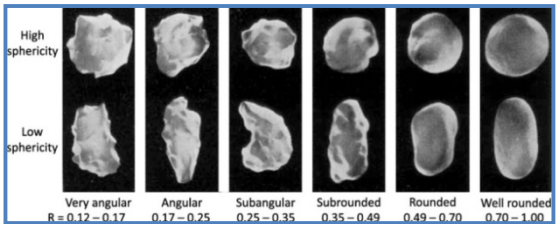


Fig.2. A Roundness qualitative scale [Powers, 1953]

Aceh is one of the provinces in Indonesia that has a lot of mineral resources. The area of Bireuen to Aceh Besar along the coast of Aceh contains a lot of iron sand. A study showed that there is a ferromagnetic magnetite mineral content with the main element containing Fe3O4 in Lampanah[2]. Mineral content in coastal sand is usually found in alluvial areas, such as rivers or seas which are connected to volcanic

source or volcano. Classification of sand or sediment in waters has an important role in providing information on the origin of the sand, including lithological rock sources and transport patterns [6]. The content of heavy metals in sand can describe the area of origin because different types of rocks have different heavy metal contents[7].

In order to explore the potential of Lengah beach iron sand, it is necessary to analyze the content of chemical compounds and particle shapes. Disclosure of mineral content and the shape of Leungah beach iron particles are expected to be able to find compounds that are unique and beneficial for industrial development so that they will be able to increase Aceh's regional income.

II. DETAILS EXPERIMENTAL

The iron sand studied was the iron sand of Leungah Aceh Besar beach and the test used X-Ray Diffraction (XRD). Sample preparation began with drying the iron sand at a temperature of 100 ^{0}C to eliminate water content. Specimen (concentrate of iron sand) was prepared by separating the particles with similar character by sieving and magnetic separation (Figure 3).Iron sand was characterized by using XRD equipment. Then the mineral content was analyzed based on field distance data (d), the two theta angle (2θ) that was compared or matched with the Handbook of Minerals arranged by X-ray Powder Diffraction and database of JCPDS (joint committee for powder diffraction standard). Characteristic observation of the sand shape was conducted using a microscope. The shape of each sample was then compared with the image of the sand form described by Power [1953].



Fig.3. Concentrate of Leungah Iron Sand

III. RESULTS AND DISCUSSION

3.1. Mineral Content

The dominant mineral in the material will produce high intensity values on the XRD spectra. Each iron sand in one sample, each has a different mineral content with different compositions, each different angle θ in a set of spectra will show the different intensity values of the dominant minerals. The defraction pattern produced in the form of a row of peaks, diffraction with high energy will produce intensity with high X rays. XRD test results showed that iron sand content was dominated by the main mineral content of Cr (Chromium), Hematite (Fe_2O_3), Calcium Carbonate $CaCO_3$. (Figure 4) and peak list in Table 1. In the XRD results it can be seen that the content of the Cr element in the magnetic material is large. The level of Cr element is quite large because the element Cr is also a magnetic element. Therefore, when the magnetic material of iron sand is pulled by an external magnet, the element Cr is also attracted to the external magnet. In addition, it is suspected that the area obtained by the sample is also an area producing chromium mineral resources, so that the magnetic material obtained still contains significant amounts of Cr. Mineral content affects the color of iron sand [8]. The iron sand is black because it is dominated by Cromite with a hiterogeneous color layer structure, which is the layer that contains a mixture of red, brown, white and solid black. This color identification is in accordance with SHORT's color identification which can be seen in Table 2. The sand content is very dependent on the source of the local stone and environmental conditions. The bright white sand found on the beach is limestone or silica and some sand which is rich in dark magmatic so that blackness comes from volcanoes and oxides. In black sand, the dominant minerals are Magnetite (Fe_3O_4), Ilmenite ($FeTiO_3$), Diamond (C), or Chromite [(Mg, Fe) Cr_2O_4]. The darker the color of the sand, the higher the concentration of Fe elements or chromite.

Table 1. Peak List of XRD Testing

Pos. [°2Th.]	Height [cts]	FWHM Left [°2Th.]	d-spacing [Å]	Rel. Int. [%]
30,0229	131,28	0,3070	2,97645	22,85
35,1865	574,45	0,0768	2,55060	100,00
35,4268	482,85	0,1535	2,53385	84,05
36,9992	69,78	0,3070	2,42969	12,15
38,2234	96,31	0,2047	2,35465	16,76
43,0457	91,06	0,3070	2,10138	15,85
44,5004	520,29	0,1791	2,03601	90,57
56,7465	258,69	0,2047	1,62230	45,03
62,3745	179,05	0,3582	1,48877	31,17

Tabel2. Color Identification acoording to Short

Color	Type of Mineral/Compound/Element
Red	Hematite (Fe_2O_3), Cuprite (CuO_2), atau Pyrope ($Mg,Al2SiO_{12}$)
Yellow	Marcasite (FeS), Sulfur (S), Chalcopyrite ($CuFeS_2$) or Vanadium (V)
Black	Magnetite (Fe_3O_4), Ilmenite ($FeTiO_3$), Diamond (C), or Chromite [$(Mg,Fe)Cr_2O_4$]
Brown	TiO_2 compound or Spinel ($MgAl_2O_4$)
White	SiO_2 compound or Orthoclase ($KalSi_3O_8$)
Light green	Uvarovite ($Ca_3Cr_2Si_3O_{12}$) or olivine [$(Mg,Fe)_2SiO_4$],
Orange	Spessartine ($Mn_3Al_2Si_3O_{12}$)

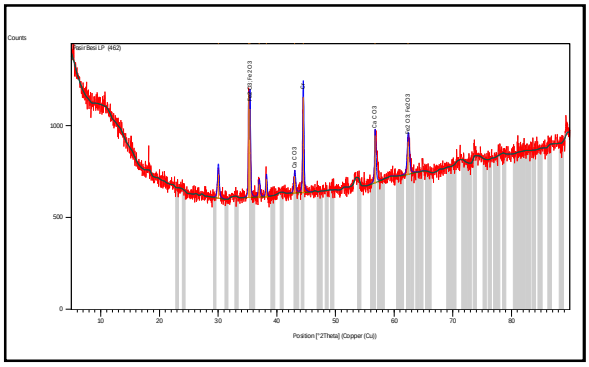


Fig.4. Composition of Iron Sand Concentrate .

Based on the mineral content obtained, the particle size of iron sand is fine. Arstrong [2014] study suggested that the tendency of high levels of SiO_2 and Calcium (Ca) to be found in medium-sized sand, while in fine sand, the mineral content found is generally Iron sand (Fe), Al_2O_3 and Titanium (Ti). In connection with this, it is suspected that these minerals belong to the type of volcanic minerals and Lithogenous sediments because the position of the Leungah coast is adjacent to the Seulawah volcano and the minerals are carried by currents to the coast through the river flow.

3.2. Particle shape

It can be seen in Figure 5 that the grain of the sand is irregular in form which means that the higher roundness value or the round shape of the sandindicate that the grain has undergone a further transport process resulting in the fine sand grains. The sand or the particle is shaped by abrasion during transportation, where there are collisions between particles or with bedrock so that the shape changes from angled / pointed to rounded. The farther the distance traveled the more complex and the more rounded the particle form Friedman [9]. Sphericity is a measure that describes the tendency of a grain shape towards a spherical shape [10].

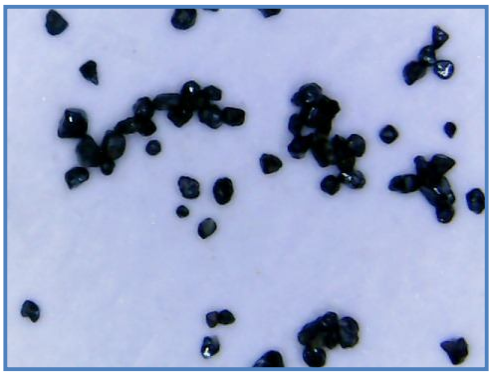


Fig. 5. Particle shape of Leungah Iron Sand

Based on the analysis of the sediment fraction, it is obtained that the average particle size of sand is 0.14 mm which means that Leungah beach sand can be categorized as fine. Based on the observation of the sample, it was known that the sand sample is in form of coral. The size of the sediment granules in the study location is inseparable from the surrounding environmental conditions that help sediment formation, one of which is the source of sedimentary components from the land such as the process of abrasion or erosion which is then carried by the river. Ingmanson (1985) states that the factor that influences the size of the sedimentation grain is the sediment material transport mechanism that will determine the depositional variation that occurs, so that the more coarse the size of a particle the easier it is to be depositedbecause it is affected by hydro-oceanographic factors such as water flow and tides [8].

CONCLUSIONS

XRD test results showed that Leungah iron sand content was dominated by the main mineral content of Cr (Chromium), Hematite (Fe_2O_3), Calcium Carbonate $CaCO_3$ and black in color mixed with red, brown, and white. While the characteristic of the sand form of Leungah beach is rounded with an average grain size of 0.14mm. In connection with this, it is suspected that these minerals belong to the type of volcanic minerals and Lithogenous sediments because the position of the Leungah beach is adjacent to Seulawah volcano and the minerals are carried by currents to Leungah beach through the river flow.

ACKNOWLEDGMENTS

The authors would like to express their deep gratitude to the Ministry of Research, Technology and Higher Education (Kemenristekdikti) of the Republic of Indonesia for the HIKOM 2018 Grant. We also extend our thanks to LPPM of Universitas Malikussaleh, mechanical engineering, civil engineering, and industrial engineering laboratories, National Nuclear Energy Agency of Indonesia and all of laboratory assistant that have made this research possible and run well.

REFERENCES

[1] S. Arasan, A. S. Hasiloglu, and S. Akbulut, “Shape particle of natural and crished aggregate using image analysis,” Int. J. civel Struct. Eng., vol. 1, no. 2, pp. 2210–233, 2010.

[2] M. Sayuti, A. Ibrahim, M. Yusuf, and R. Putra., “Development of Aceh Iron Sand to Produce Pig Iron: Studies on Hardness Properties Malang,” in The 2nd International Mechanical and Industrial Engineering Conference (IMIEC), 2018.

[3] M. J. K and S. Kenichi., Fundamental of soil behaviour, Third edit. New York: Willy, 2006.

[4] M. C. Powers, “A new roundness scale for sedimentary particles,” J. Sediment. Petrol., vol. 23, no. 2, pp. 117–119, 1953.

[5] R. D. Holtz and W. D. Kovacs, An introduction to geotechnical engineering. New Jersey: Prentice Hall, 1981.

[6] J. . Webster, P. K. Roy, S. W. Ryan, and A. C. Christopher, “Heavy Mineral Analysis of Sandstones by Rietveld Analysis.,” JCPDS - Int. Cent. Diffr. Data. Adv. X-ray Anal., vol. 46, pp. 198–203, 2003.

[7] J. F. Hubert, Procedures in sedimentary petrology. New York: Wiley-Interscience, 1971.
[8] D. E. Ingmanson and W.J. Wallace, Oceanography: an introduction. Belmont California: Wadsworth Publishing Co, 1973.
[9] Gerald M Friedman, "Differences in size distributions of populations of particles among sands of various origins," dddendum to IAS Pres. Address, vol. 26, no. 6, pp. 859–862, 1979.
[10] M. Tucker, Sedimentary Petrology: An Introduction to the Origin of Sedimentary Rocks, Third edit. New York: Wiley & Sons, 2009.

★★★