Sediment Characteristics of Iron Ore Waste on the Surface of Settling Ponds

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ABSTRACT

The Iron Ore Refining Industry in North Maluku, There is waste generated from the iron ore refining or extraction process that is deposited into a settling pond or shelter with a capacity of about 3 million cubic meters that is no longer in operation, This study describes the characteristics of iron ore waste sediments on the surface of the settling pond, with laboratory methods, namely testing physical properties based on SNI references for aggregate materials and identifying chemical compound elements with EDS. The physical characteristics of waste sediments have absorption of 3.20%, surface dry specific gravity of 3.11 gr/cc, sand equivalent of 94.4%, Modulus of Smoothness of 2.78 and Mud Content of 6.40% while for the content of chemical compounds contained in iron ore waste sediments based on the molar percentage of oxides, the highest is Iron oxide (FeO) of 70.08% then below that there is Silicon dioxide SiO2) of 18.29%.

Keywords: characteristics, EDS, iron ore, sediment, settling pond, waste.

INTRODUCTION

Indonesia, as one of the countries blessed with abundant natural resources [1]. one of them is iron ore mineral, As Mentioned in the data of the Ministry of Energy and Mineral Resources in 2010, Indonesia has resources of around 2 billion tons of iron ore in lump form, including primary iron ore in it with resources reaching 557 million tons [2]. However, in the process of mining and refining iron ore, some by-products or wastes are channeled into settling ponds or sumps. Iron ore waste, a type of solid waste after iron mining and refining [3], solid waste generated during the iron ore concentrate refining process is iron ore tailings [4]. the material left after the separation or extraction of iron-valued fractions from the mining rock processing, iron ore is mined and then taken to the processing plant for mineral refining, the refining process to separate unwanted material, from the process of separating or extracting iron ore leaves waste material consisting of small fragments of material particles, water, mud and then channeled to the Settling Pond or shelter through a conveyor pipe. Mineral extraction is very important to the economy of many countries [5]. Iron ore waste is known as a mixed composite, mainly composed of quartz, and less other minerals such as feldspar, mica, calcite [3].

There are various types of iron beneficiation processes. The choice of process depends on the mineral composition, iron content, and the degree of iron liberation from gangue minerals [6]. The most common beneficiation processes are magnetic separation, flotation, reverse flotation, electrostatic separation, gravity methods, and flocculation [7].

In general, iron ore processing involves operations to modify the particle size distribution and to increase the iron content, without changing the chemical or physical identity of the mineral [8]. In ores that are already high in iron content [9], the processing, normally, consists of simple grinding and size separation to obtain a product ready for sale [10]. However, BIF ores require concentration steps because size separation is not capable of producing a product with a high iron content. The problem is that these steps are generally done with water, which can result in large amounts of tailings

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Utilization of iron ore tailings in the construction and building materials industry is an attractive alternative due to the potentially large volume of tailings. However, these materials should be used only after first being characterized [11].

In North Maluku, iron ore waste generated from the iron ore refining or extraction process is deposited into settling ponds or reservoirs with a capacity of about 3 million cubic meters. On the surface of the waste deposited for a long time in the reservoir or settling pond there is sediment. Sediments are fragments of material that generally consist of a physical and chemical description of rocks. The particles range in size from large (boulder) to very fine (colloid), and vary in shape from round, oval to square. in other words, sediments are fragments, minerals, or organic materials that are transported from various sources and deposited through air, wind, ice, or water media [12]. small particles on the surface of the settling pond resemble fine aggregates from the iron ore waste deposition process. Although the waste collected into storage facilities is not discharged into the wild, it has a considerable environmental impact, one of the impacts is the loss of land and habitat, the construction of storage facilities often requires the diversion of large areas of land, which can lead to the loss of natural habitats for flora and fauna, areas previously used for local ecosystems will be disturbed, reducing biodiversity and changing system patterns, the second has a risk of structural failure that can cause disasters. Failure of storage facilities can result in massive overflows of waste into rivers or surrounding residential areas, from which it can cause greater environmental damage. based on existing conditions, so it is necessary for researchers to try to examine the characteristics of iron ore waste sediment deposits on the surface of the settling pond as a first step in utilizing the waste for use in the construction field later.

RESEARCH METHODS

Materials

The iron ore waste sediment material used in this study is tailings or unwanted leftover material from the iron ore refining process in the processing plant and then channeled into the settling pond or storage facility through a conveyor pipe, then a natural deposition process occurs for a long time until on the surface of the settling pond there is sedimented material shaped like aggregate grains in the form of small particles similar to sand.

Figure 1. Iron ore waste sediment

Methods

The study used laboratory methods to obtain characteristics of the physical properties and elements of chemical compounds contained in iron ore waste sediment material samples, material samples were taken from the iron ore processing industry located in North Maluku. The sequence of testing is shown in Figure 2, testing the characteristics of physical properties refers to the Indonesian National Standard for testing aggregate materials, which is divided into several tests, namely sieve analysis, Absorption, specific gravity, sand equivalent, Modulus of Smoothness, and mud content. while testing the characteristics to determine the elements of chemical compounds contained in iron ore waste sediments using the EDS testing method, EDS testing shows the composition of mass and atomic percentages in the sample [12], [13], EDS (Energy Dispersive X-Ray Spectroscopy) produced from X-rays, namely by firing X-rays at the position you want to know the composition. After being fired at the desired position, certain peaks will appear that represent an element contained [14], [15].

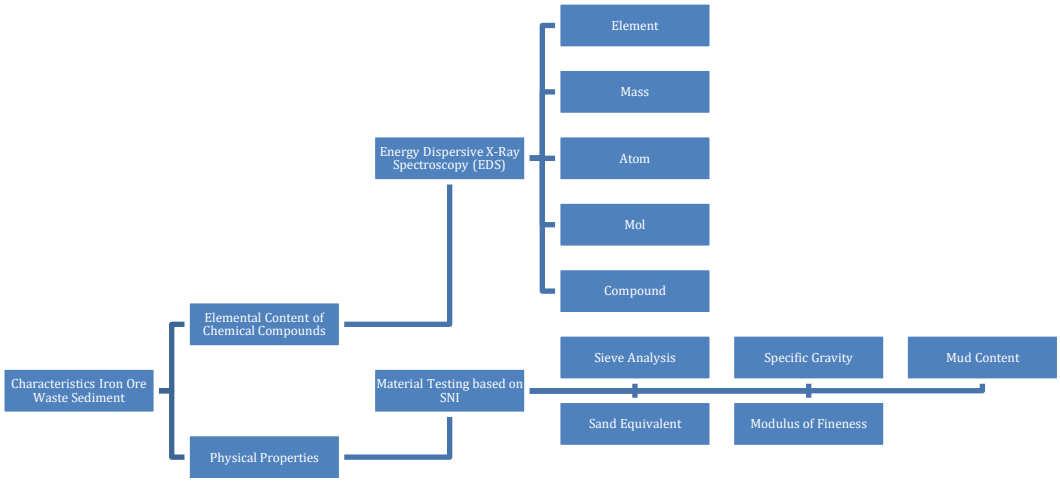

Figure 2. Flowchart of Testing the Characteristics of Iron ore waste sediment

Data Analysis

Data analysis researchers examine the characteristics of a material, namely iron ore waste sediment from physical properties which include sieve analysis, absorption, specific gravity, sand equivalent, fineness modulus and mud content referring to SNI Testing Standards for aggregate materials, as well as the elemental content of chemical compounds based on mass, atomic and mole percentages with Energy Dispersive X-Ray Spectroscopy (EDS) testing [16].

RESULT AND DISCUSSION

Characteristic testing for physical properties of iron ore waste sediments consisted of testing specific gravity and water absorption, sand equivalent, mud content, sieve analysis, and grain fineness modulus. Iron ore waste sediment has a high specific gravity in the saturated dry state (SSD) of 3.11. In contrast to the specific gravity value, the water absorption value of iron ore waste sediment shows a high value of 3.20%. The sand equivalent of iron ore waste sediment has a low value when compared to natural sand in general, which is 94.4%, this is because the clay content of ore waste sediment is higher than natural sand. In the value of mud content, iron ore waste sediment has a high mud content, which is 6.40%, where this value is in line with the absorption value. The value of several physical parameters for iron ore waste sediment has a very high water absorption because texturally it is more varied due to the grinding process during the iron ore refining process and similarly the mud content is quite high, Table 1 shows the value of physical properties of iron ore waste sediment test results for specific gravity, water absorption,sand equivalent, moudulus of fineness and mud content.

Table 1. Test Results for Physical Properties of Iron Ore Waste Sediment

Test Type	Value
Absorption (%)	3,20
Bulk Specific gravity (gr/cc)	3,01
SSD Specific gravity (gr/cc)	3,11
App Specific gravity (gr/cc)	3,33
Sand Equivalent (%)	94,4
Modulus of Fineness	2,78
Mud Content %	6,40

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For sieve analysis as shown in Table 2, it is known that the iron ore waste sediment type belongs to the area characterized by a rather coarse grain distribution. The ore waste sediment has a high grain fineness modulus value of 2.78.

Table 2. Iron ore waste sediment sieve analysis test results

Sieve Size	Weight retained on sieve	cumulative number of sieve retained	Cumulative Percentage (%)	
mm (inch)	Gram (a)	Gram (b)	stuck in the sieve (c)	passes the sieve (d)
4,75 mm (No.4)			0.0	100.0
2,36 mm (No.8)	114	114	11.4	88.6
1,18 mm (No.16)	162	276	27.6	72.4
0,6 mm (No.30)	433	709	70.9	29.1
0,3 mm (No.50)	75	784	78.4	21.6
0,15 mm (No.100)	126	910	91.0	9.0
0,075 mm (No.200)	14	924	92.4	7.6
Pan	76	1000	100.0	0.0

The EDS test spectra of iron ore waste sediment samples are shown in Table 2, containing the following 5 chemical elements O, Mg, Al, Si, and Fe. Based on the atomic percentage, it appears that the element that has a high atomic value is O (45.14%), followed by Fe (37.02%), Si (9.67%), Mg (4.11%) and Al (4.05%) respectively. The highest compound composition based on molar oxide is FeO of 70.08% followed by SiO2 18.29%, Al2O3 3.84% and finally MgO 7.79%.

Table 3. EDS Testing Results for Elemental and Chemical Composition of Iron Ore waste Sediment

Element	Ec Minimum Emission Voltage (keV)	Mass %	Atom %	Mol %	Compound
O K	0.525	22.08	45.14	-	-
Mg K	1.253	3.06	4.11	7.79	MgO
Al K	1.486	3.34	4.05	3.84	Al2O3
Si K	1.739	8.30	9.67	18.29	SiO2
Fe K	6.398	63.22	37.02	70.08	FeO

CONCLUSION

The characteristic test results for the physical properties of iron ore waste sediment show that iron ore waste sediment has a high specific gravity in a saturated dry surface (SSD) state of 3.11. The water absorption value of iron ore waste sediment shows a high value of 3.20%. For sand equivalent, iron ore waste sediment has a low value compared to natural sand, which is 94.4%, this is due to the higher clay content in iron ore waste sediment compared to natural sand. In the mud content value, iron ore waste sediment has a higher mud content, which is 6.40% so that the use of ore waste sediment if it wants to be used as a material in a construction, it needs to be washed, where this value is in line with the absorption value, and it is also known that for iron ore waste sediment when compared with similar materials based on grain shape and size such as natural sand, iron ore waste sediment is included in the area with the characteristics of a rather coarse grain distribution with a fineness modulus value, which is 2.78. While from the characteristic testing for the elemental content of chemical compounds contained in iron ore waste sediments, it shows the highest chemical element based on the atomic percentage is Oxigen (O) of 45.14% which is then below Iron (Fe) of 37.02%, and for Chemical Compounds based on molar oxides shows the highest is Iron Oxide (FeO) of 70.08% following below it is Silicon Dioxide (SiO2) of 18.29%. So overall based on the results

of the characteristics test, this makes that iron ore waste sediment has the potential to be used as an alternative fine aggregate material with special or certain handling treatments.

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