Preliminary Study Of Processing Manganese Ore From Pringsewu District Of Lampung Province

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ABSTRACT

Manganese ore coming from Pringsewu district of Lampung province belongs to manganiferous ore. Containing approximately 32.27% Mn and 14.87% Fe, this Pringsewu manganese ore is classified into low grade manganese ore (Mn<40%). Processing by hydrometallurgy technique has some shortcomings, and one of them is expensive additional cost for reprocessing used chemical materials. The objective of this research was to process low grade manganese ore by using composite pellets followed with pyrometallurgy process. The first process was started by milling, sieving, stirring, and composite pellet making. The next process was composite pellet reduction by using hot blast cupola and induction furnace into pig iron with manganese containing, and this was usually called as *spiegeleisen*. Reduction process by using hot blast cupola produced *spiegeleisen* with the following compositions: 16.98% Mn; 5.02% C; 75.64% Fe; 0.87% Si; 0.072% P; 0.028% S; while reduction process by using induction furnace produced *spiegeleisen* with the following compositions: 9.36% Mn; 4.85% C; 86.03% Fe; 0.21% Si; 0.01% P; 0.02% S.

Key Words: *manganese;ore;reduction;furnace;pyrometallurgy;spiegeleisen*

1. INTRODUCTION

One of minerals should be processed for creating additional value is manganese ore. Manganese is one of mineral mine products with extra ordinary usefulness. This commodity belongs to 12 minerals on the earth crust which are unsubstitutable in the world steel industry. Ferro Manganese and Silico Manganese are two manganese forms widely used in steel industry. Manganese is also used in producing dry battery, ceramic, glass, and chemistry. The majority manganese product (90 %) is nowadays consumed by steel industry. This fact implies that manganese supply and demand depend on steel supply and demand (Soda, 2014). For iron steel industry, manganese ores are processed into ferromanganese; an iron mix with high Mn content which is made by heating mixture of MnO_2 and Fe_2O_3 with carbon (coal/cokes) by using blast furnace or submerged arc furnace. The result is a product similar pig iron but containing high manganese called as *spiegeleisen*. Table 1 showed grade levels of *spiegeleisen* according to ASTM A 98-50 standard. At each percentage, carbon is limited maximally 6.5%, phosphorus is 0.25%, and sulfur is 0.05%. Produced properly by either blast furnace or electric furnace, *spiegeleisen* is used for mixing material in steel, such as plain steel carbon, low alloy steel, and manganese steel as *deoxidizer* and cleaner during purification of steel making (Johnstone,1954).

Low grade manganese ore processing has been widely conducted (Kivinen et al, 2010; Swamy et al, 1998; Isnugroho K and Birawidha CB, 2011; and Rao, et al 1998), but direct processing with composite pellet method has seldom been conducted. The objective of this research was to process low grade manganese ore by using composite pellet method followed by pyrometallurgy reduction process.

Table 1. Spiegeleisen, ASTM Spesification A 98-50

		A	B	C
Manganese	%	16-19	19-21	25-28
Silicon, max	%	1-2	2-3	3,5-4,5

2. EXPERIMENT

The raw material came from Pringsewu district of Lampung province. Coal and bentonite were used as mixture in pellet composite making. The outline of research process was conducted by the following steps. Grinding raw material was conducted with laboratory jaw crusher and hammer mill. Stirring process was conducted by using mixer and then followed with pelletizing process by using rotary disc pelletizer. Pellet composite making was conducted with particle of raw material with size between -80 + 100 mesh with the composition of 85% low grade manganese ore, 10% coal, and 5% bentonite. Size of produced pellet composite was between 2.5 and 4 mm. the green pellet (the new produced pellet) was let aside on the open air for 72 hours and then dried in 110-120ºC. After pellet was formed, pre-reduction process was conducted by using shaft furnace with coke fuel in 1200°C.

The next step was smelting/reduction by using hot blast cupola and induction furnace. The process by using hot blast cupola was started by initial furnace heating by using 150 kg cokes. 150 kg cast scrap, 50 kg coke, and 15 kg lime were entered. After furnace condition was stable, cast scrap use was reduced into 10%, 20%, 30%, 40% and 60% from total weight of feeder. The hot blast cupola had 450 mm diameter and 2154 mm height. Smelting by using induction furnace in temperature between 1400°C and 1600ºC was conducted by adding

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reduced pellet of 10%, 20%, and 30% of total feeder weight. Induction furnace to use was inducthotherm type with 500 kg capacity. Analysis processes were conducted with equipment including AAS (Atomic Absorption Spectrophotometer) Shimadzu AA 7000, oven, and shieve shaker.

3. RESULTS AND DISCUSSION

Analysis results of raw material coming from Pringsewu district of Lampung province show compositions as it is presented in Table 2. Table 2 shows that Pringsewu manganese ore belongs to manganiferous ore category, with manganese content followed with 14.87% Fe content.

Table 2. Result of Manganese Ore

Parameter	% of Weight
MnO_2	32,270
SiO_2	5,680
Al_2O_3	2,451
Fe_2O_3	14,870
P_2O_5	0,571
SO_3	0,021
MgO	0,150

It might be that there are volcanic frozen stones containing of iron around the mining location. Mining area is located between Barisan hill and mountain clusters of South Sumatera where the cluster were formed because of volcanic stone sediment (Mufakhir, et al., 2014).

In the pre-reduction process of 1200ºC, Mn content level increased in the composite pellet, as it is shown in Figure 1. Figure 1 shows that Mn increases along with pre-reduction temperature increase, but the increase is relatively small compared to Mn level content in the used raw material. This is because Mn reduction starts to occur in stable manner at above of 1150°C. Beside temperature, there are other factors with strong effects to reduction process; the reduction time and CO_2 gas content during the process (Gao, et al., 2012).

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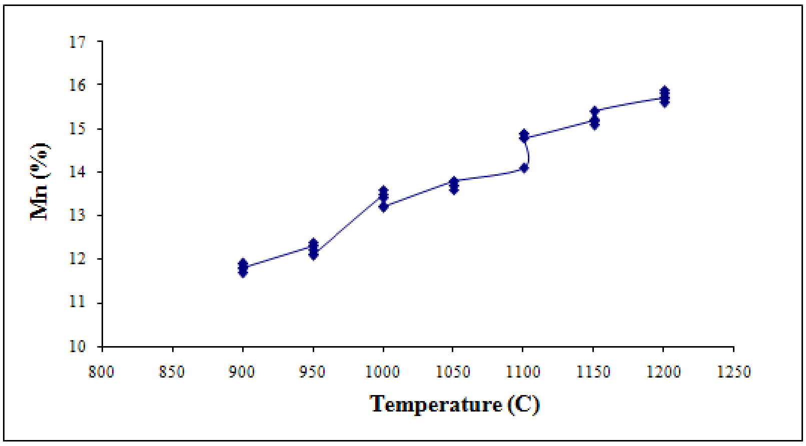

Gambar 1. Pre-Reduction Temperature

Pellet composite smelting/reduction observation was conducted to temperature of the process and the liquid tapping. Tapping of metal liquid was conducted in each 30 minutes. Tapping process I-VII without addition of pellet composite did not have any problem. Process temperature in the center was able to reach 1630°C. Recognizing this condition, reduced pellet composite was added three times with pellet percentage of 10%, 20%, 30%, and 40% in each addition. During the process, the furnace temperature was about 1559-1622ºC. Tapping with pre-reduced pellet composite of 10%-40% did not undergo any problem, but problem occurred when pellet composite addition was 50%. In just one charging with 50% pellet composite, tapping underwent many slags which made tapping was difficult. The next charging caused burning at upper position of the furnace. This condition represented metal oxide freezing at the heart of the furnace while tapping process underwent difficulties. If this condition was imposed to proceed, then more freezing at the heart would occur. Is was concluded that 50% pre-reduced pellet composite addition would be difficult to conduct in hot blast cupola. Smelting result by using hot blast cupola is presented in Table 3.

Smelting by using induction furnace was conducted by adding pre-reduction pellet composite of 10%, 20%, and 30% in induction furnace with process temperature of 1400^0C – 1600^0C. Pre-reduced pellet addition process in the furnace underwent problem in three layers; the lowest layer was in form of hot metal, middle layer was slags, and upper layer was carbon coming from the pellet. This carbon came from pellets which were not perfectly reduced so that inside them there were some carbon element which were not yet burnt. This condition would interfere at the process of liquid metal tapping. If a large quantity of unreduced iron oxide is introduced into a high carbon bath at high temperature, there is a vigorous carbon boil that could be extremely dangerous (Duta et al, 2004). The smelting result by using hot blast cupola is presented in Table 3.

Table 3. Product Composition

Parameter	Product from Hot Blast Cupola (%)	Product from Induction Furnace (%)
Mn	16,980	9,360
C	5,020	4,850
Fe	75,64	86,03
Si	0,870	0,210
S	0,028	0,020
P	0,072	0,010

Table 3 shows that product from hot blast cupola process belongs to grade A spiegeleisen according to standard of ASTM A 98-50, while product from induction furnace did not yet comply with standard of ASTM A 98-50. However, the product can be used as raw materials in making mixing cast iron with manganese content, such as hammer mill hammers, and components of asphalt mixing machine.

4. CONCLUSIONS

An initial process of low grade manganese ore from Pringsewu district of Lampung province, Indonesia, had been conducted by using pellet composite method. Pre-reduction process was conducted by using shaft furnace. The resulted product is temperature increase because of increase of Mn level content in the ores. Subsequently, Pellet composite was smelted/reduced into hot metal y using hot blast cupola and induction furnaces. Process in hot blast cupola was able to produce *spiegeleisen* product which complied ASTM A 98-50 grade A, while product from process in induction furnace was not able to comply ASTM A 98-50 grade A.

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