

The Effect of Binder Type on the Properties of Briquette and Pellet Produced from the Magnetite Concentrate of Gol-E-Gohar Iron-Ore

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Abstract

Binders are of prime importance in the agglomeration of iron ore concentrates. In this research, strength and density of briquette produced from the magnetite concentrate of Gol-E-Gohar were investigated using different binders at various applied pressures. The results showed that peridor was the most effective binder relative to bentonite and lime. For all types of binders, the increase in binder content increased the strength and decreased the density of briquette. The increase in the applied pressure during the preparation of briquette also increased strength and density, but this occurred at different rates when different types of binders were used.

Keywords: Bentonite, Iron-ore concentrate, briquette, Peridor.

1. Introduction

In the past two decades, production and consumption of iron and its alloys have had a significant increase, accounting for 93% of global metallic and alloy products. Iron is an important metal because of its abundance in earth's crust and its wide range of various characteristics. Iron is often in the form of oxide ores in the earth's crust, the most important of which are hematite and magnetite. Low grades iron ores are crushed, milled, and concentrated at the mines. Concentrates are fine (powder) and they cannot be used in the furnaces. So they must be agglomerated into pellet or briquette of desirable mechanical, chemical and thermal characteristics. For agglomeration, different types and amounts of binder are used. Bentonite is one of the usual binders mostly used for pelletizing of iron ore concentrates^{1,2}. The main disadvantage of bentonite is in entering acid compounds to the pellets³; these compounds lead to problems during reduction process such as higher energy consumption⁴. On the other hand, some organic binders have been introduced with superior properties. These binders provide higher mechanical strength in spite of less consumption in comparison with mineral binders. Organic binders also evaporate during firing of agglomerates, thereby increasing purity and porosity of pellets. Among disadvantages, their high cost and environmental problems can be mentioned^{5,6}. However, the final properties of agglomerates not

only depend on the binder type but also, on the nature of the iron ore concentrate. Each iron ore concentrate may have different behaviors when agglomerated with a particular binder. Pelletising of iron ore concentrate in the rotating disc or drum has the same mechanism as briquetting. A large pressure (the weight of pellet on a single point) is applied on each particle (as pellet is rotating in the disc) and it is punched to the pellet nuclei⁷. So, pellet with high density is produced.

In this research, the effect of different types and contents of binder on the strength and density of briquette produced from Gol-E-Gohar iron ore concentrates was investigated.

2. Experimental Procedure

The magnetic concentrate of Gol-E-Gohar iron-ore was used; 80% of its particles were less than 45 micrometer in size. Chemical composition of the concentrate is shown in Table 1. The concentrate was mixed with different contents of various binders. Three different amounts of bentonite and lime, including 0.5, 1 and 2 %, and peridor, including 0.25 and 0.5 %, were used. Mixing process was conducted in a pilot scale pelletizing disc for 5 min at the speed of 20 rpm. About 9% water was manually added to dry concentrate mixes. Briquetting was conducted in a cylindrical die with the diameter of 14 mm under various pressures of 4400, 8800 and 13200 psi. The prepared samples were dried in open air for 2 days and subsequently, placed in an oven at 110 °C for 3 h to be dried completely. Before the strength measurement, density of the briquettes was measured. Finally, the dry strength of the samples was measured by a universal press machine. In order to enhance the accuracy of the results, the average of 8 data in different conditions was reported.

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Table 1. Chemical composition of magnetite concentrate of Gol-E-Gohar iron ore.

Composition	FeO	CaO	SiO ₂	MgO	Al ₂ O ₃	P ₂ O ₅	S	Fe _{total}
Wt. %	0.74	0.45	1.58	1.76	0.25	0.45	0.88	66.9

3. Results and Discussion

Figure 1 shows the effect of the amounts of bentonite and the briquetting applied pressure on CCS (Cold Compaction Strength). The strength of the samples was increased with the increase in briquetting pressure and the percentage of binder. Strength was increased from 3.1 to 8.4 kg per pellet via increasing the binder from 0.5 to 2 % at the pressure of 13200 psi. The effect of applied briquetting pressure on CCS was more pronounced when 2 wt% bentonite was used.

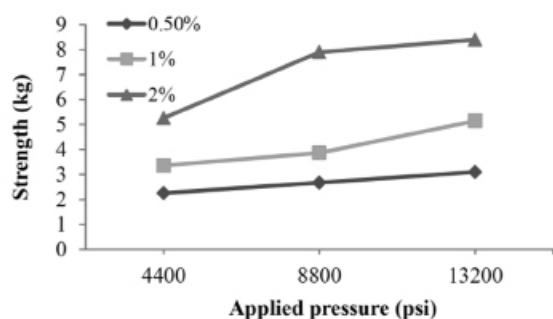


Fig. 1. CCS via the briquetting applied pressure for different amounts of bentonite binder.

Figure 2 shows the effect of different amounts of lime binder and applied pressure on CCS of the briquette. As for bentonite, the same pattern could be seen when lime was used as the binder. The increase in the CCS occurred by increasing the amount of binder or applied pressure. In contrast to bentonite, which is acidic, lime is a base useful in steelmaking. However, as can be seen in figure 1 & 2, a higher CCS was obtained with bentonite.

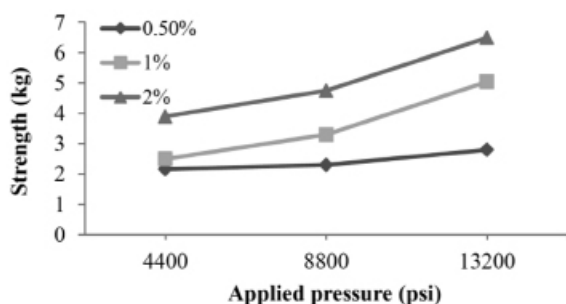


Fig. 2. CCS via the applied pressure for different amounts of lime binder.

Figure 3 shows the CCS of briquette when pridior

was used as the binder. Pridor is a trade name for a widely used organic substance. It is clear from Fig. 3 that CCS was increased with increasing the amount of binder from 0.25 to 0.5% at any pressure. The strength reached over 55 kg at the briquetting pressure of 13200 psi and the binder of 0.5wt%.

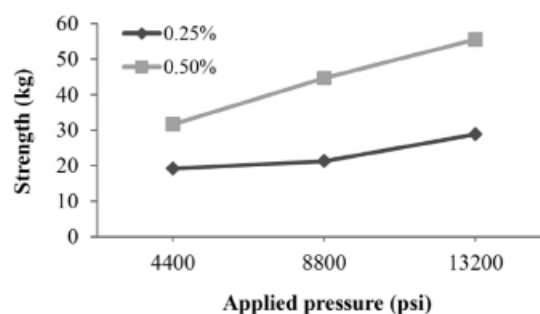


Fig.3. CCS via the applied pressure for different amounts of pridior binder.

Figure 4 to 6 show the effect of the applied pressure on the density of the samples via different amounts of binder. Figure 4 shows the effect of the amount of the applied pressure on briquettes prepared by different amounts of bentonite. As it is clear in this diagram, the increase in the amount of bentonite decreased the density of the samples; this is due to the fact that bentonite absorbs a high amount of water (5 times of its weight⁷) and so, high volume leads to the low density of briquette. It is observable from this diagram that the density of the samples was increased with increasing the pressure applied by the press. For example, the increase in pressure from 4400 to 13200 psi for 0.5% bentonite increased density from 3.3 to 3.56 g/cm³. The increase in density via more applied pressure caused the decrease in voids among the particles and consequently, porosity would be normally reduced.

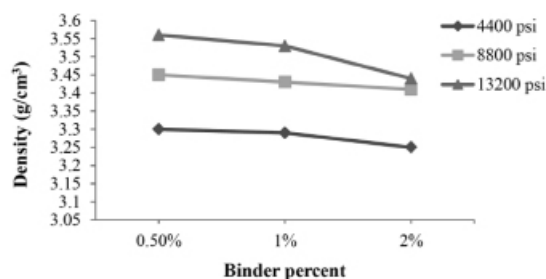


Fig. 4. Diagram of density of the briquette via different amounts of bentonite binder at different applied pressures

Figure 5 shows the effect of the applied pressure on the density of the samples prepared by different amounts of lime binder. This diagram shows that the increase in density was directly related to the increase in the pressure and the decrease in the amount of binder.

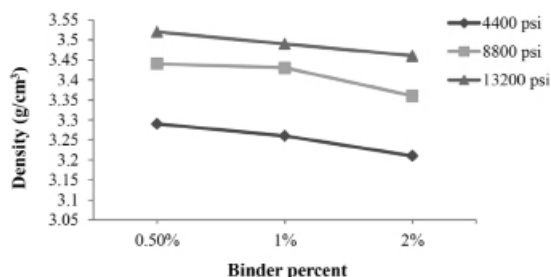


Fig. 5. Diagram of density of the briquette via different amounts of lime binder at different applied pressures.

Figure 6 shows the effect of the applied pressure on the density of the pellets prepared by two different amounts of peridor binder. As it is clear, like the two previous diagrams, the increase in pressure increased the density. On the other hand, a little increase in the amount of binder decreased the density of the produced briquette due to the low density of peridor in comparison with that of iron concentrate. For example, three times increase in pressure for 0.5% peridor binder increased density to 0.23 g/cm³.

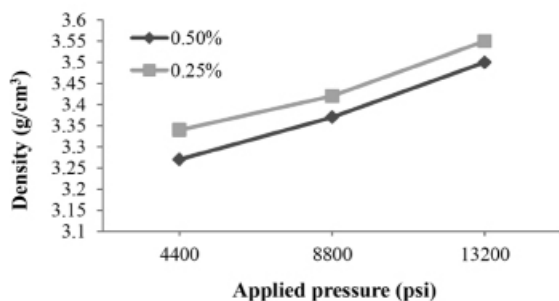


Fig. 6. Diagram of density of briquette via the applied pressure for different amounts of peridor binder.

4. Conclusion

1. Dry strength of the samples in research conditions varied with the increase in the amount of binder. Dry strength of the samples prepared by bentonite binder was higher than that of the samples prepared by lime binder, but applying much less peridor binder in the samples produced higher strength.
2. Increasing the amount of applied pressure increased the strength and density of the samples.
3. The increase in the amount of different binders decreased the density of the samples.

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