Evaluation of the Wettability and Other Physical Properties of Particles of Iron Ore Concentrate that Consumed in the Pelletizing Plant of Mobarakeh Steel Company

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1. Introduction

Principally, the main contributing parameters to pellet ability are particle size, particle shape, moisture content, binder and wettability. For example, with increasing the wettability of concentrate particles, due to the presence of surface tension and capillary pressures, the proper of seeding and growthing of green pellet occur during the pelletizing process. One of the techniques for improvement the pellet ability of iron ore particles is adding organic binder instead of bentonite to raw materials. Furthermore, the optimal particle size distribution is another parameter that is controlling the pellet ability of iron concentrates. Usually, an optimum specific surface area (blain number) is found in the range of 1500-2000 cm^2/g, which is approximately equal to 75 to 90% of the particle size below 45 microns. Any disruption of these factors leads to increase the amount of recycling materials and the fluctuation in the size of green pellets producing. In this research, in addition to the study of contact angles measuring of variant iron ore concentrate by the different fluids, also investigated other physical properties of particles such as size and size distribution in the pelletizing plant of Mobarakeh Steel Co.

2. Experimental

To do this research, samples were taken from two iron ore mine of Chadormalu and Sangan. The color camera was used for measuring the contact angle of different liquids (distilled water, process water, soda, dolapix and carboximetilcelulose (CMC)). A scanning electron microscope (SEM), sieve screening and the particle size laser analyzer (PSA) were used to study the shape, size and distribution of particle size, respectively. The BET and Fisher tests were used to determine the pore distribution and specific surface area, respectively.

3. Results and Dissuasion

The results showed that the high-grade Chadoremlou iron ore had a higher wettability than low-grade (Figure 1). As the presence of gang in Chadormalu iron ore are caused that the contact angle of distilled water increased from 7 to 20 degrees. Despite that the lower amounts of gang exist in the Sangan iron ore, its contact angle was higher than low-grade of Chadormalu (Figure 2). This is related to genesis and neutrality in Sangan iron ore. The high wettability was measured for CMC organic binder solution which is close to distilled water (Figure 3). The hydrophilic groups in the chemical structure of the CMC organic binder increase the wettability, while the organic binder has a stronger adhesion force compared with distilled water.

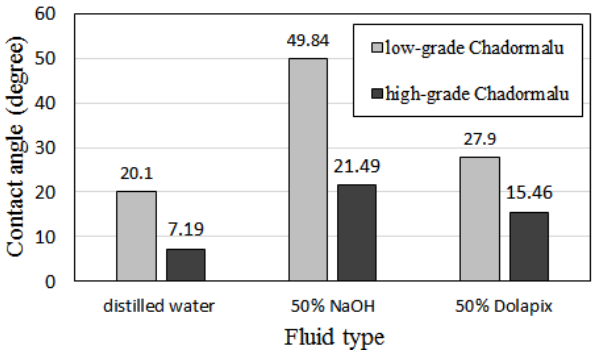

Fig. 1. Wettability of distilled water, soda and Dolapix with Chadormlou iron ore with different grades

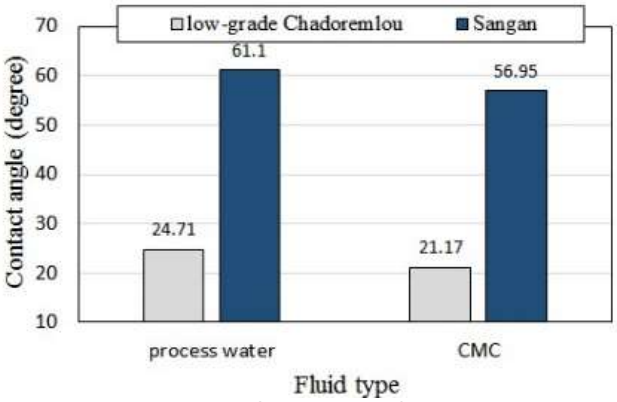

Fig. 2. The comparison of wettability of process water and CMC on Sangan and Chadormalu low grade iron ore

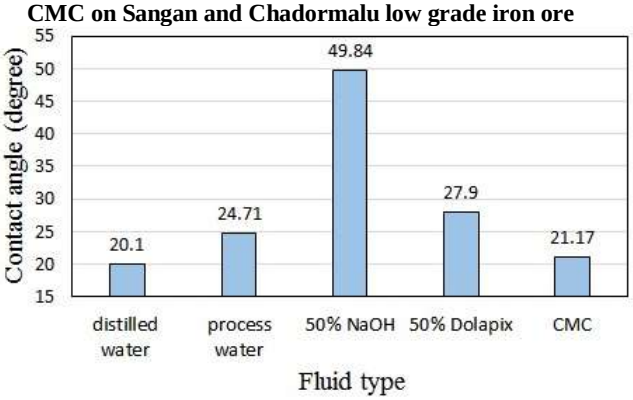

Fig. 3. The comparison of wettability angle of various fluids at contact with Chadormalu iron ore

The distribution of particle size of iron concentrate was evaluated by different methods such as sieve screening and laser analysis. The results showed that there is a significant difference between these methods. The maximum volume fraction of particle size was obtained in the range of 20 to 37μm via sieve screening test (Figure 4).

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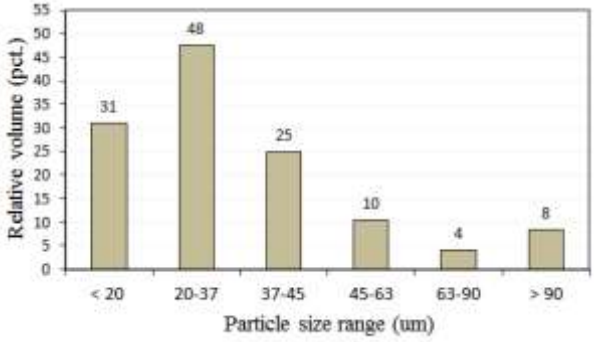
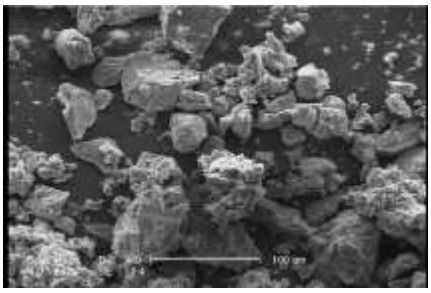
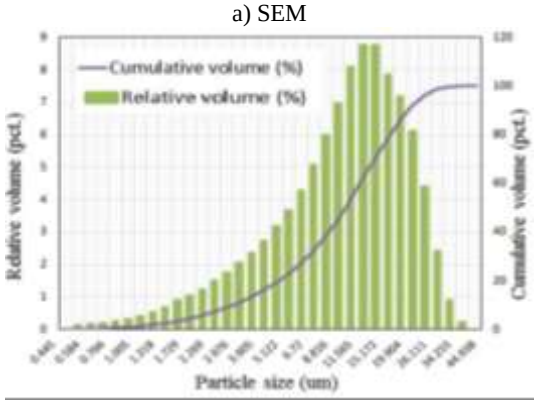


Fig. 4. Distribution of particle size obtained by sieve screening test

However, the SEM and PSA results showed that the highest of relative volume particle size is approximately 10 μm (Figure 5). Because of existing of ultra-fine particles, micro-agglomerates are created by electrostatic and magnetic forces. The presence of these micro-agglomerates have caused some differences at results of sieve and laser methods. Furthermore, the two connection mechanisms of the solid particles including static forces between solids and interlocking bands have increased by the very fine particles in the powder, so the micro-agglomerates cannot collapse during the sieve screening test. The results of BET experiment also revealed the reduction in porosity and roughness on the particle surfaces. However, the presences of micro-agglomerates with a size approximately 100 μm act like a big particle and cause to limit of the pelletizing process. For this purpose, using the high viscose of CMC can be used as a solution.



a) SEM



b) PSA

Fig. 5. SEM micrograph (a) and distribution particle size (b)

4. Conclusion

The high wettability was measured for high-grade Chadormalu iron ore when Carboxymethylcellulose organic binder solution was used. The presence of gang in Chadormalu iron ore credited that the contact angle of distilled water increased from 7 to 20 degrees. Despite that the lower amounts of gang exist in the Sangan iron ore but observed that the contact angle (61° for the water process) was higher than low-grade of Chadormalu (24° for water process. The results of sieve screening test showed that the maximum volume fraction particle size are in the range of 20 to 37μm, while the SEM and PSA results showed that the highest of volume fraction of particle size is approximately 10μm. The results of BET experiment also revealed that the reduction in porosity and roughness of particles surface.