BASF IRON ORE BINDER TECHNOLOGY: EFFECTS ON PELLET SIZING*

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Abstract

Pellet sizing plays a key role in the productivity of the entire pelletization and subsequent induration processes, whereas uneven pellet sizing can increase the circulating load of the balling circuit inducing operational instability leading to production loses. The present work focuses in comparing the agglomeration kinetics, expressed as the number of pellets produced in a determined target size range, of different organic binder-bentonite binder systems. The batch experimental results show that the binder system has a great influence in the resulting pellet sizing, which could lead to advantages in terms of balling circuit efficiency and eventually operational de-bottlenecking.

Keywords: Organic binders; Agglomeration kinetics; Pellet sizing.

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1 INTRODUCTION

Agglomeration of finely grained minerals and dusts is widely employed in the mining industry. The addition of binders is often critical to prevent break down of the agglomerates during processing. In the specific case of iron ore pelletization, pellet sizing plays a key role in the productivity of the entire pelletization and subsequent induration processes.

Resulting pellet sizing is determined by the adhesion and cohesion of particles, which is mainly influenced by ore moisture, ore particle size distribution and amount of bentonite added [1]. Other variables like ore type equipment sizing and processing conditions are irrelevant whereas the adhesion and cohesion forces drive a self-preserving, pseudo-time-independent size distribution of the agglomerates to be produced [2]. The chemistry of the water making up the moisture of the system influences the adhesion forces in the wet state which also determine the speed at which particles coalesce during the agglomeration process. Moreover, surface charge of the different particles in the system (iron ore, gangue minerals, bentonite and organic binders) will also influence the resulting mechanical properties of the produced pellets [3].

Utilization of organic binders can help to improve the mechanical properties of the pellets in the wet state, as reported elsewhere. However, its utilization is not widely accepted by iron ore pelletization operations beyond a limited number of cases. One of the reasons reported in the literature for this is “fresh feed material sticking easily on green balls during pelletizing” [4]. This phenomenon is related to a poor rheological profile of the organic binder, which causes an uncontrolled growth of the pellets. In the same publication, it is stated that organic binders have a low thermal stability and lose their intended effects during drying and preheating, leading to low thermal shock temperatures and weak pre-heated and fired pellets [4].

Therefore, the ideal organic binder would produce a rheological profile that allow a controlled layering of fine iron ore particles as the main mechanism of growth during pelletization at lower temperatures and, on the other hand, induce a high adhesive force during pellet preheating at the first stages of the induration machine, minimizing dust formation and increasing pellet strength.

As reported in a previous publication at the ABM Week 2017 [5], during recent years, BASF developed a new chemistry that can improve significantly the performance of polymer-bentonite systems in iron ore pelletization applications. In the present work, it is analyzed how the new product (based on novel chemistry) compare to a traditional HPAM copolymer in terms of thermo-dependent viscosity as well as its impact on pellet sizing in an iron ore pelletization experiment.

2 MATERIAL AND METHODS

Materials

A sample of magnetite ore containing 63,7 wt% Fe, 4,5 wt% silica and 0,14 wt% alumina as well as 9,7 wt% moisture was used in this work. The bentonite used presented the following composition: 1,2%Ca, 1,9%Na, 9,3%Al and 29%Si. Polymer samples used were Standard HPAM (Alcotac™ FE 16, conventional partially hydrolyzed polyacrylamide) and Alcotac™ CS (proprietary acrylic type ter-polymer with unique viscosity profile) both from BASF, Germany.

Rheological Measurements

The polymer component of both binders in study was dissolved in synthetic sea water (3.5% wt. NaCl) at a concentration of 1500ppm. Viscosity vs temperature data was tabulated using an Anton Paar rheometer model MCR-502 with cup and bob setup.

Pellet Sizing

The magnetite ore having 9,7% moisture was blended with a powdered pre-mix of binder formulation i.e. Bentonite alone or Bentonite plus organic binder, using a mixer machine brand Eirich model EL1, for three minutes. The resultant intimate mixture was subjected to pelletization by using an inclined pelletizing disk of 60 cm diameter, rotating at a speed of 33 rpm. The produced pellets were classified by their size distribution using sieves corresponding to 1/2in (12.5mm), 7/16in (11.2mm) and 3/8in (9.5mm).

3 RESULTS AND DISCUSSION

Themo-Rheological Measurements

The resulting rheological measurements comparing the two polymer solutions, can be seen in Figure 1. Here, the viscosity of the polymer solution was measured at a fixed shear rate of $7 s^{-1}$ while varying the temperature in 10°C increments up to 90°C.

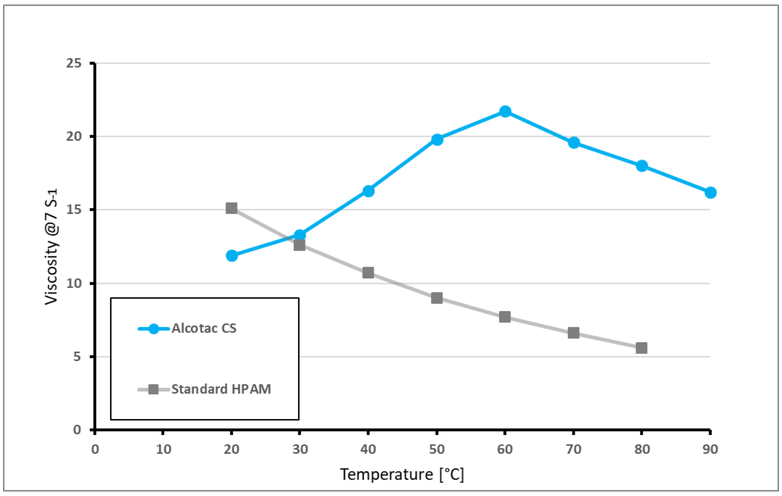

Figure 1. Thermo-rheological profile of both polymer solutions.

The thermo-rheological profile of the Standard HPAM polymer solution shows the classical drop in the viscosity associated to high molecular weight linear co-polymers. The continuous reduction in viscosity as temperature increases, can be explained by the physical disengagement of the once entangled long chain molecules in solution at lower temperatures, and eventually a collapsing gel structure [6]. In the other hand, the polymer in

Alcotac™ CS exhibits a strong thermo-thickening behavior, showing an increased the viscosity than the Standard HPAM but only at temperatures above 30°C for the condition analyzed in this experiment. This effect is the result of an exceptional molecular engineering process.

All the above translates into a smoother, predominantly layered agglomeration mechanism during pelletization as well as a massive increase in the pellet strength as it dries.

Pellet Sizing

The pelletization results compare three conditions: only bentonite and the combined use of bentonite at a reduced dosage rate (50%) in combination with organic binders. The results can be seen in Figures 2 and 3. For each experiment representing a single dot, the sizing of the resulting pellets is compared in terms of the number of pellets in % having a size no larger than 1/2in (12.5mm) or smaller than 3/8in (9.5mm). This fraction is defined as the target size. The band of 50-60% pellets in the target size is the expected value for batch experiments using bentonite alone at a rate of 0.7% for this ore.

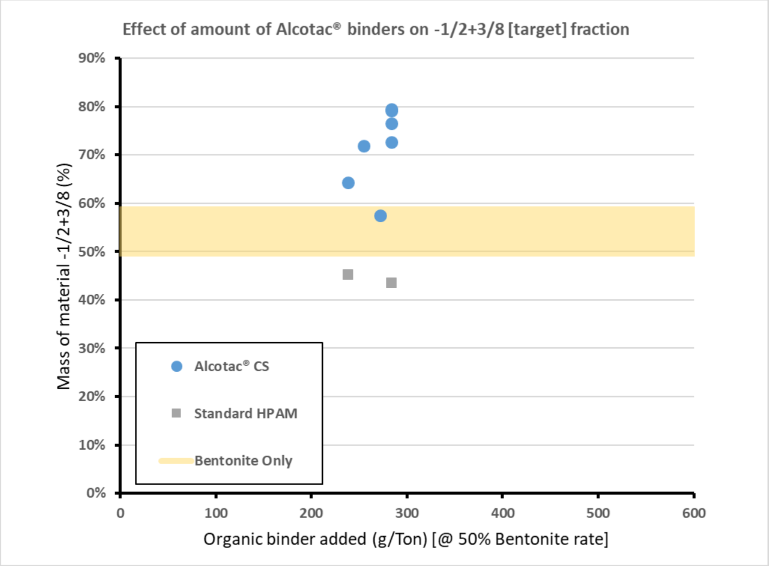

Figure 2. Pellet sizing as a function of pellets produced within the target size fraction.

As Figure 2 reveals, the combined use of a reduced amount of bentonite and Standard HPAM (0.35% bentonite plus ~250g/t organic binder) produce lower amounts of pellets in the target size than bentonite alone (at 0.7% rate). This could lead to an increase in the circulating load and potential instability of the balling circuit. On the contrary, except for 01 out of 06 repeated tests, the combined use of Alcotac™ CS and bentonite at the same dosage rates produce a significant increase (15-35%) of pellets in the target size when compared to Standard HPAM and 0 to 20% more than bentonite added at full rate of 0.7%.

The graph in Figure 3 below provides additional information about the pellet sizing in terms of the amount of oversized material (+1/2in or +12.5mm) produced during the experiments. This can be assumed to represent the load to the upper deck in the roller screen during a normal operation. In this case, the combined use of Alcotac™ CS and a reduced bentonite rate, produce a lower amount of rejects in the upper size limit than the other two conditions of about 2-25%. In practice, this effect can be interpreted as having a reduced load at the upper deck of the roller screen. A reduced amount of rejects in combination with a stable circuit operation, can translate into de-bottlenecking of the circuit, provided there is available capacity for doing so.

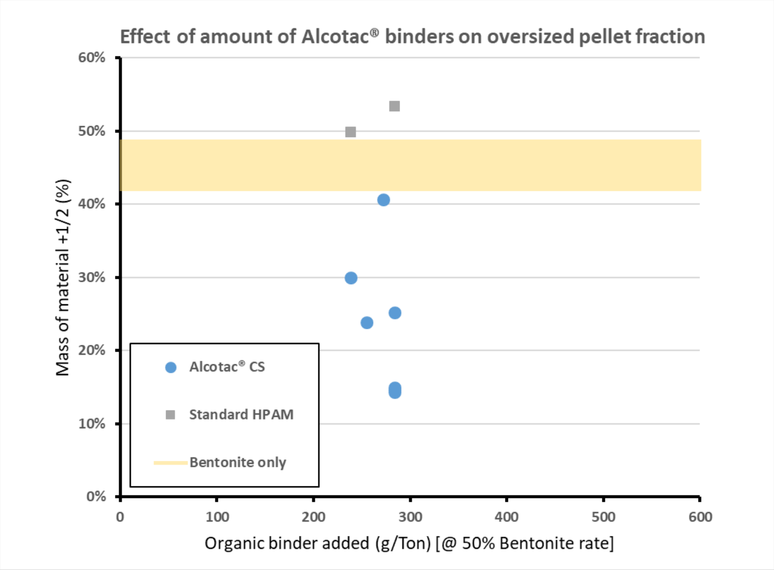

Figure 3. Pellet sizing as a function of the oversized pellet fraction.

4 CONCLUSION

Pellet sizing is greatly influenced by the addition of binders, through modification of the adhesion and cohesion events during agglomeration.

The rheological profile of the organic binder can have a significant impact in the resulting pellet sizing. Ideally, a layered pellet growth mechanism associated with a lower viscosity during agglomeration, will lead to a maximization of the circuit capacity. At the same time, however, the ideal organic binder is required to produce a higher viscosity to sustain the pellet mechanical integrity during pre-heating.

The novel binder from BASF Alcotac™ CS is capable of producing both effects.

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