DOLOMITE FILLER AS SUPPLEMENTARY CEMENTITIOUS MATERIAL IN COLD-AGGLOMERATED BRIQUETTING

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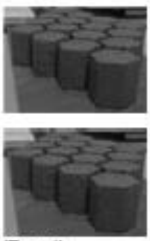
BACKGROUND

A wide variety of by-products such as dusts, scraps, and mill scale are generated during the production of iron and steel. The by-products need to be processed before being used as burden material in the blast furnace. Briquetting is a commonly used technology to recycle by-products in steel plants. Portland cement (PC) has generally been used as a bonding agent in the cold-bond agglomeration process.

The use of cement in the agglomeration process has some identified disadvantages, which could be reduced by an alternative material. The side-effects include higher slag formation, moisture content and increased reduction rate, in addition to costs and environmental aspects. Briquette degradation and strength loss at a relatively low temperature (ca. 700°C) is one problem caused by the decomposition of CSH. Cement also requires additional water which evaporates at high temperatures causing a temperature imbalance impacting blast furnace quality. In addition, cement in briquettes produces additional slag, which requires extra energy.1Also, a higher proportion of cement is associated with the decreased reduction rate and swelling in briquettes. It has been stated that swelling could be decreased by substituting cement.

THE AIM OF THE STUDY

was to examine an alternative binder material for PC in the briquette recipe used at the SSAB steel plant in Raahe. The plant uses the vibration method in briquetting. The size of one hexagonal briquette is ca. 60 x 60 mm, and the weight is ca. 500 g (Figure 1). The used briquette production mix contains ground granulated blast furnace slag (BFS) and rapid hardening PC as binders. Dolomite filler was chosen for closer investigation as a potential partial substitute for PC due to its known ability to partially substitute cement, its low cost, and favorable chemical composition.



(Figure 1).

METHOD

The briquetting method, curing conditions and other briquette mix components, excluding binders, were standardized in the trial mixes; only PC and substitute binder dosages in addition to water dosages varied. No admixtures were used in the mixes expect for trial mixes studying the effect of superplasticizer. Rapid hardening cement and the blast furnace slag (BFS) KJ400 (BET 400m2/kg) were used. The cement had good initial and final strength: 1d/20 MPa and 28d/53 MPa. The used superplasticizer (SP) was based on polycarboxylates containing chlorides ≤ 0.1 % and alkalis ≤ 2.0 %. In total, the test program comprised 2 reference mixes and 5 trial mixes with various dolomite and superplasticizer combinations (Table 1).

Table 1: Test mixes with moisture content (wt%).

Code	PC	BFS	DoL	Tot. binder	SP	Tot. water	water/ binder
R1	60	40	0	11.6	0	9.85	0.849
R2	70	30	0	12.0	0	10.24	0.853
M1	42	40	18	12.0	0	9.76	0.813
M2	42	40	18	12.0	2.9	9.98	0.832
M3	42	40	18	12.0	2.9	9.39	0.783
M4	48	40	12	11.9	2.9	9.02	0.758
M5	25	50	25	12.0	2.9	8.07	0.672

The possibility of substituting PC with dolomite filler and/or superplasticizer was tested at the briquette laboratory (Figure 2a-d).

Figures 2a-d. Briquette preparation equipment.

The mixes were prepared using a 10 l Hobart mixer and compressed with a briquetting machine, Teksam VU600/6B. The machine pressed 16 briquettes at the same time. The briquette moulds were filled manually. The machine used vibration before pressing at 100 bar for 5 seconds. One batch (16 briquettes) was prepared using each test recipe.

RESULTS

The principal target total moisture content of the mixes was approximately 10.0 %. Total moisture content was measured by a moisture analyzer. The measured total moisture content varied between 8.07 and 10.24 % in the mixes being highest in the reference mix R2. Additionally, output hydrates were calculated for the test mixes (Figure 3).

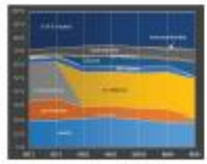


Figure 3. The output hydrates for the test mixes.

The height of the fresh briquettes was measured after removal from the machine. The briquettes were stored at the temperature of 35°C for two days before tumble strength testing. The usability of dolomite filler to substitute cement depends on strength development and wear resistance achieved within 2 days after casting. Figures 4-7 summarizes the tumbler indexes (TI), heights and densities of the fresh test briquettes after 2, 7, and 28 days, and correlations between them.

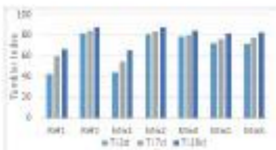


Figure 4. Tumbler indexes after 2d, 7d and 28d

Figure 5. Tumbler indexes and heights

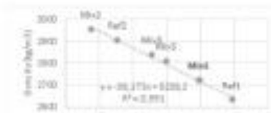


Figure 6. Briquette heights and densities.

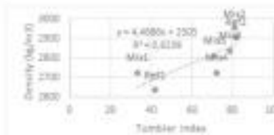


Figure 7. Tumbler indexes and densities.

CONCLUSIONS

On the basis of the studies carried out, it could be concluded that:

- Comparing to R1 (PC 60 % and BFS 40 % of binder), all the test mixes a ready had a higher tumbler index after 2 days, indicating the potential to r place at least 30 % of PC with dolomite filler and superplasticizer.
- Compared to R2 (PC 70 % and BFS 30 % of binder), M2 provided corresponding tumbler indexes by replacing 25 % PC with dolomite filler and superplasticizer.
- Fine dolomite filler did not reduce initial strength development compared to the reference mixes.
- The use of superplasticizer with dolomite filler enabled water reduction ca. 20 %, increased density and tumbler index values.
- Superplasticizer did not indicate any negative reducing effects on strength development or wear resistance.

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