INFLUENCE OF SURFACE AREA IN THE FLOWABILITY BEHAVIOUR OF SELF-FLOW REFRACTORY CASTABLES

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Abstract: *Aluminium oxide (alumina) exhibits a high melting point (2050ºC), high hardness and excellent abrasion resistance, what makes it one of the most common raw materials for self flow refractory castables (SFRC) for monolithic linings. However, besides the properties of its ingredients, the success of the refractory lining depends on its easy installation (good flowability). The objective of this work was to evaluate the dependence between the flowability index (FI) of the fresh concrete and the specific surface area (SSA) of its particles. The castable mixtures were formed by three different size classes of commercial tabular alumina (aggregate) ([0,2-0,6mm], [0,5-1mm] and [1-3mm]), added to an optimized constant alumina matrix of three fine size classes ("-230" and "-500" mesh tabular alumina, and CT3000SG reactive alumina). The proportion of matrix to aggregate was varied (eight different mixtures, table1), controlled by the SSA value.*

MOTIVATION:

SFRC shared allow:

- ❑ High flowability
- ❑ High temperature
- ❑ Easy application
- ❑ Low water contents
- ❑ High mechanical resistance

LEGEND:

1 – The comercial tabular alumina;
2 – Wet sieves;
3 – Suspension of class of "-500" mesh;
4 – Mortar mixer;
5 – Casting the paste in the slump flow;
6 – Dispersal paste;
7 – Metallic moulds and the test pieces;
8 – Test pieces in sintering process.

The mixture of powders that constitute the matrix optimized in previous authors research (Figure 2) and aggregate was done in a mortar mixer, as described in the Portuguese patent #103432 (2008) .

The mixtures have a specific surface area (SSA) between 1,983 to 2,573 m^2/g. It is necessary ensuring this value next to 2,0 m^2/g in order to get mixtures that reach the self-flow turning point with a minimum water content.

The evolution of the (FI) is shown in the Figure 1. The results demonstrate that there is a clearly dependence between the FI and the SSA. This relation can be described, with great accuracy (elevated value of R^2=0,9839) by the quadratic polynomial equation (Eq.1).

$$FI = 276{,}74 \times (SSA)^2 + 1486{,}6\ (SSA) - 1855{,}1 \qquad (Eq.1)$$

Mixtures	Matrix [wt%]	Aggregate [wt%]	SSA [m^2/g]	IF [%]	Relative Error [%]
M1	38,5	61,5	1,983	9,049	0,990
M2	40,0	60,0	2,060	26,190	0,203
M3	42,0	58,0	2,163	65,646	0,001
M4	42,5	57,5	2,188	75,170	0,032
M5	45,0	55,0	2,317	94,218	0,091
M6	46,0	54,0	2,368	121,769	0,074
M7	47,5	52,5	2,445	128,571	0,026
M8	50,0	50,0	2,573	134,969	0,021

Table 1: Properties of the analysed mixtures

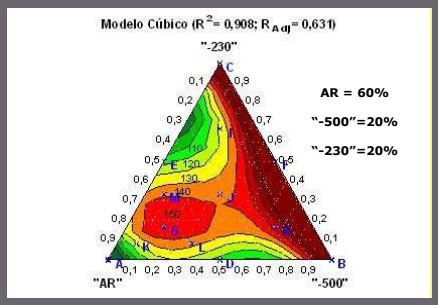

Figure 2: Matrix optimized

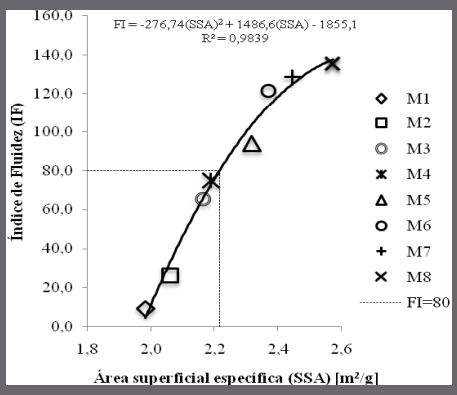

Figure 1:Evolution of flowability index (FI) as a function of specific surface area (SSA) of the mixture

CONCLUSIONS:

❑ The FI increases with the increase of fine particles content (larger SSA), but for SSA values higher than 2,4m^2/g, it requires a higher increment in SSA, to get a small increase in FI, with the consequent increase in castable cost.

❑ To guarantee the FI corresponding to a self-flow behaviour (FI> 80%), it is necessary that the refractory castable has a SSA higher than 2,215 m^2/g, as given by equation (1), and this corresponds to (table 1) a mininum 45 (wt%) of matrix in the mixture.

❑ In this research it was possible to estimate the value of the flowability index (FI) in function of the specific area (SSA) of the eight mixtures analysed.

These results are very important to optimize the composition of the self-flow alumina refractory castable for monolithic applications.

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