SYNTHESIS OF TRICALCIUM ALUMINATE FROM ALUMINIUM DROSS

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ABSTRACT

The present work examines the synthesis of **tricalcium aluminate** (for use as a synthetic slags) from the dross produced in the manufacture of metallic aluminium in Holding furnaces. Three types of input dross were used with Al_2O_3 contents ranging from 51 to 82 wt%. Calcium aluminates were formed via the **mechanical activation** (reactive milling) of different mixtures of dross and calcium carbonate, and **sintering at 1200ºC**. The variables affecting the process, especially the milling time and the Al_2O_3:CaO molar ratio, were studied. The final products were examined via DRX, SEM, TEM and Raman spectroscopy, and their chemical composition were compared with those of commercial synthetic slags.

1. MATERIALS

Three types of dross of different ages have been studied: Al-1: 3-7 years (30 wt%); Al-2: 7-10 years (20 wt%) and Al-3: 2013-2016 (50 wt%)

Chemical composition of aluminium dross (wt,%) (FRX)

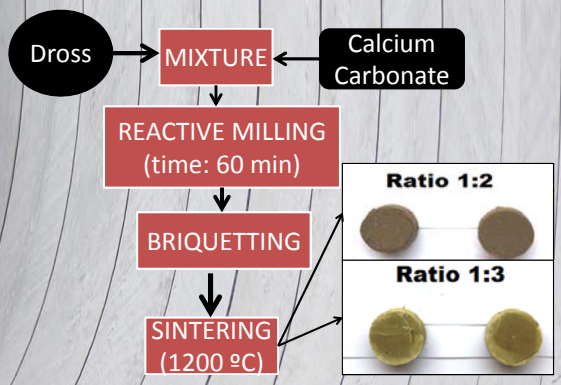
Compounds	Al-1	Al-2	Al-3
Al_2O_3	75.7	58.4	81.9
CaO	4.5	4.6	4.7
Fe_2O_3	3.7	4.5	1.8
MgO	3.2	2.0	3.3
SiO_2	3.0	5.2	4.6
CuO	0.1	0.4	0.1
ZnO	0.04	2.5	0.05
NiO	0.03	0.03	0.01
L.O.I	7.4	17.5	3.2

Mineralogical composition of aluminium dross (XRD and Rietveld cuantification)

Mineralogical Phase	Al-1	Al-2	Al-3
$Al_{1,99}Fe_{0,11}Mg_{0,9}O_4$	23.3	13.6	24.2
AlN	13.9	3.1	12.3
α-Al_2O_3	8.3	6.2	12.0
Al	11.4	3.8	14.4
$Al_{2,4}Mg_{0,4}O_4$	23.3	-	15.8
α-$Al(OH)_3$	5.9	3.4	2.1
$Al(OH)_3$	1.8	-	0.9
$Ca(OH)_2$	1.4	2.2	2.9
$CaCO_3$	8.7	10.3	6.4
SiO_2	0.8	1.0	0.4
$MgSiO_3$	0.8	-	4.5
$MgCO_3$	0.6	-	-
γ-AlO(OH)	-	50.4	-
γ-$Al(OH)_3$	-	5.9	-
$Ca_{14}Mg_2(SiO_4)_8$	-	-	3.6

High content in aluminum hydrates

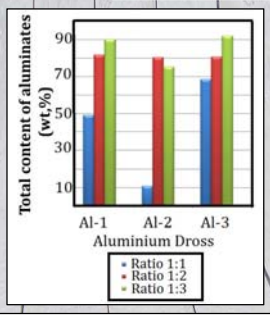
2. SYNTHESIS OF ALUMINATES

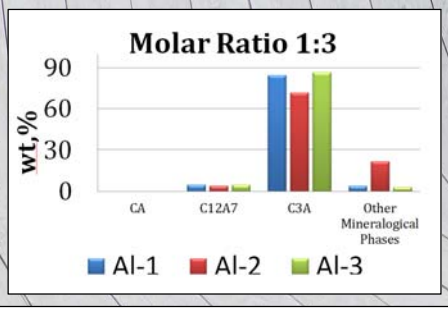


The A:C molar ratio was varied from 1: 1 to 1: 3 (A= Al_2O_3; C= CaO)

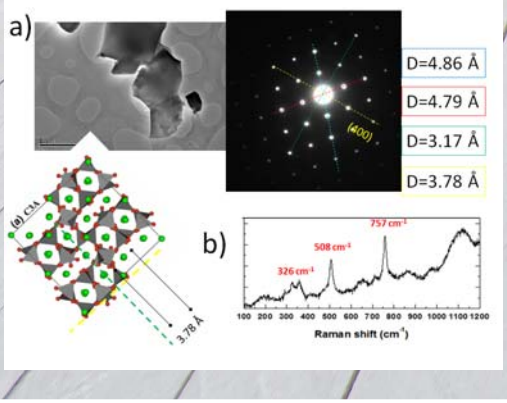
3. EXPERIMENTALS RESULTS

Mineralogical composition of sintered materials at 1200 ºC





C_3A characterization by a)TEM and b) Raman spectroscopy



The aluminate content increases with increasing molar ratio A:C. For a 1:3 molar ratio, the highest content of calcium aluminate was obtained for all dross studied. For this ratio, the majority aluminate is C_3A (**tricalcium aluminate**) whose content is 85% and 87% for dross Al-1 and Al-3 respectively, and 72% for dross Al-2

Mineralogical composition of commercial products (XRD and Rietveld quantification)

Mineralogical Phase	CP-1 (%)	CP-2 (%)	CP-3 (%)
Total Aluminates	68.3	56.6	**67.3**
Other phases	31.7	43.5	**19.0**
MgO	-	-	**13.8**

4. CONCLUSIONS

- It is possible to obtain aluminates from the dross by reactive milling and a sintering at 1200 ° C, using calcium carbonate as the precursor.
- The greatest aluminates contents are obtained from dross Al-3, the most recent, since it presents a lower content in aluminum hydrates.
- The aluminates obtained with a A:C ratio of 1:3 have high C_3A content (85% -87%), even higher than the commercial products studied.