On the Constitution of Sulfo-Aluminous Clinker

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According to Lafuma[1], sulfo-aluminous clinker is produced by burning the mixture of gypsum, bauxite, and calcium carbonate, and is used as an expansive agent for the manufacture of expansive cement.

He succeeded in identifying the minerals, free anhydrous calcium sulfate, calcium aluminates particularly $5CaO \cdot 3Al_2O_3$, and γ $2CaO \cdot SiO_2$ in the clinker, but he could not confirm the ternary compound, calcium-sulfo-aluminate.

In the course of previous studies[2] on the system CaO-Al_2O_3-$CaSO_4$, the author could conclusively establish the existence of a ternary compound of the composition $3CaO \cdot 3Al_2O_3 \cdot CaSO_4$ which gave the X-ray diffraction data as shown in Table I.

With the opinion that this ternary compound may be expected to exist in sulfo-aluminous clinker the author has carried out the following experiments.

1) Heating the mixture of bauxite, lime, and gypsum for 30 min. at 1350°C the clinker was prepared, which was similar in appearance as described by Lafuma.

2) A series of sulfo-aluminous clinkers with the mole ratios of Al_2O_3/SO_3, 8.2, 6.0, 3.5, 2.0 and 0.8, respectively, were prepared by heating the batches containing different amounts of gypsum under the same conditions as above.

The samples 1 and 2 were identified by the determination of their chemical composition, X-ray diffraction patterns (powder method), and quantitative X-ray analysis using standard substances.

The X-ray data and chemical composition of sample 1, and the chemical composition of sample 2 are given in Tables II, III and IV.

The results are summarized as follows:

a) The existence of $3CaO \cdot 3Al_2O_3 \cdot CaSO_4$ as the main constituent in sulfo-alminous clinker has definitely been established.

b) The amount of this ternary compound in clinkers estimated from the content of Al_2O_3 or $CaSO_4$ determined by the chemical

TABLE I. X-RAY DIFFRACTION DATA OF $3CaO \cdot 3Al_2O_3 \cdot CaSO_4$

d, Å	3.75	3.24	2.91	2.65	2.46	2.30	2.17	1.62	1.58
Int.	100	7	6	29	7	4	24	7	4

TABLE II. X-RAY DIFFRACTION DATA OF CLINKER

d, Å	3.75	3.49	3.25	2.91	2.85	2.79	2.71	2.65	2.46	2.34	2.17	1.63
Int.	100	59	10	—	12	20	4	30	11	—	37	13

TABLE III. CHEMICAL ANALYSIS OF CLINKER 1 (wt. %)

SiO_2	7.08	TiO_2	0.38	CaO	42.64
Al_2O_3	21.82	Fe_2O_3	5.38	SO_3	22.26

Content of $3CaO \cdot 3Al_2O_3 \cdot CaSO_4$; Calcd. 43.50. By X-ray analysis. 39.20.

1) H. Lafuma, *Proc. of the 3rd. International Symposium on the Chemistry of Cement, London* (1952).

2) N. Fukuda, submitted to *J. Chem. Soc. Japan, Ind. Chem. Sec.*, (*Kogyo Kagaku Zasshi*).

TABLE IV. CHEMICAL ANALYSIS OF CLINKERS 2 (wt. %)

Al_2O_3	35.30	34.27	30.84	28.41	21.80
SO_3	3.36	4.52	7.02	10.98	21.12
Al_2O_3/SO_3 mole ratio	8.2	6.0	3.5	2.0	0.8
$3CaO \cdot 3Al_2O_3\ CaSO_4$					
Calcd.	25.64	34.18	53.49	56.72	43.48
By X-ray analysis.	27.65	33.80	57.00	56.00	41.05

analysis is in fairly good agreement with the results of direct measurements by quantitative X-ray analysis. The author, furthermore, has found that the amount of this compound is in equivalent with Al_2O_3-content when $Al_2O_3/SO_3 < 3$, and with $CaSO_4$-content when $Al_2O_3/ > SO_3 > 3$.

c) As for the other constituents the existence of free anhydrous calcium sulfate was distinctly observed, while that of β $2CaO \cdot SiO_2$ was not so clear.

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