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A Reply to a Discussion by John Bensted of the Paper "ALINITE-CHEMICAL COMPOSITION, SOLID SOLUTION AND HYDRATION BEHAVIOUR"*

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Besides basic investigations on the characterization of Alinite and the hydration behaviour of Alinite Cement [1, 2], this special cement has been produced since 1968 in a pilot plant of the „Research and Designing Institute for Building Materials" in Tashkent, Usbekistan. The production of Alinite Cement in a scale of about 100 000 t/a has been started in 1974 in a cement factory in Ahangaran/Usbekistan. This Alinite Cement has been produced by mixing OPC raw meal with calcium chloride, that results from a soda factory, in order to decrease the sintering temperature and therefore to save energy [3]. The mineral composition of this Alinite Cement can be described as follows:

Mineral	Simplified Formula	Content in wt.-%
Alinite	„C_3S*$CaCl_2$"	65
Belite	„ß-C_2S"	20
Mayenit	$C_{11}A_7$•$CaCl_2$	10
Brownmillerite	„C_4AF"	5

Tab. 1: Average Composition of technically produced Alinite cement

Bensted [4] pointed out, that the application of Alinite Cement is a problem, because of the danger of steel corrosion of the reinforcement. Nudelman*), has the opinion, that reinforcement corrosion is no problem, when the chloride content of the clinker is limited to 2.5 wt.-% [5]. Up to 2.5 wt.-% of Cl, all chloride is chemically bound within the mineral Alinite and no free $CaCl_2$ occures. On the areal of the Tashkent Research Centre several steel reinforced concrete plates, aged more than 10 years, can be investigated. The binder for manufacturing this plates has been Alinite Cement with a Cl-content below 2.5 wt.-% and till now, no steel corrosion occures. Despite, the question is, what happens with the chloride during the hydration of the clinker. The only proofed hydration phase, that contains chloride, is the „Friedel's Salt" (C_3A • $CaCl_2$ • 10 H_2O). Some Cl-binding capability of the C-S-H-phases can be emphasized. Detailed results on carbonatisation effects and therefore on Cl-release are at the time not available.

Nevertheless, Alinite Cement is no standardized product, according to the ENV 197 (Dez.

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*CCR 24(8) 1413-1422 (1994).

1992), where the Cl-contend is limited below 0.1 wt.-%. Therefore Alinite Cement will always be a binder for some special applications, where the chloride content is not a problem. In the last few years a lot of research work has been done an the possibility of producing Alinite Cement from chloride-rich waste material, e. g. reaction products from flue gas cleaning of municipal solid waste incinerators (MSWI) [6].

By mixing various industrial wastes it is possible, to produce cements and binders on the basis of Alinite. In a pilot plant 60 tons of Alinite Cement with the following composition and technical properties were produced [7, 8].

Compound	Content in wt.-%
salt from flue gas cleaning	49
fly ash from MSWI	35
lime flour	16

Tab. 2: Raw meal composition for Alinite Cement production from residues

Chemical Composition		Technical properties	
Constituent	wt.-%	Parameter	
SiO_2	20.2	Setting time	5-10 min
Fe_2O_3	2.6		
Al_2O_3	10.5	Compressive Strength	
Mn_2O_3	0.1	after	N/mm^2
Ca as CaO	55.0		
MgO	1.9	24 h	17
SO_3	3.2	7 d	23
K_2O	0.8	28 d	32
Na_2O	0.7		
Cl	5.6		

Tab. 3: Chemical composition and technical properties of Alinite Cement, made from flue gas cleaning residues.

This Alinite Cement can be used for special purposes as a substitute for OPC. Two application fields were worked out:

In mixtures for solidification of industrial waste material Alinite Cement is a suitable binder. In comparison to OPC the early compressive strength of the „Alinite Cement - stabilized mixtures" is much higher.

Another application is the usage in the coal mining industry. On the basis of Alinite Cement it is possible, to produce early-bearing mining mortars. Because of its rapid setting and hardening, Alinite Cement should be processed pneumatically and used as a shotcrete. Some characteristics of these mortars are given in [6].

For a more widespread application of Alinite Cement the setting time has to be extended by suitable retarders in order to make these mortars capable for hydraulic transport. Further investigations on the coarse of hydration and of the hydration products may extend the usage of Alinite Cement for other application fields.

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