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The retarded character of $C_3A$ hydration during its initial stages.


Three different conditions are distinguished for a retarded character of the reaction of $C_3A$ with water in its initial stages:

a) Retardation in the presence of amounts of sulphate ions large enough to lead to ettringite formation during the early stages;

b) Retardation in the presence of amounts of sulphate ions too small to lead to ettringite formation;

c) Retardation in the absence of sulphate ions.

When during a reaction starting with ettringite formation, the sulphate ions become exhausted, the hydration rate does not simply show a succession of the phenomena observed for the cases a, b and c mentioned: apparently, the presence of hydrate crystals previously formed influences the reaction course.

This is illustrated by the hydration of $C_3A$ in pastes with $CaSO_4\cdot 2H_2O$, water, and $SiO_2$. Here, after sulphate consumption by initial ettringite formation, the reaction does not show the violent revival expected for a reaction of $C_3A$ in the presence of small amounts of $SO_4^{2-}$; instead, only an insignificant heat evolution rate peak is observed, which is influenced in a remarkable way by variations in the quantity of $SiO_2$ added: larger amounts of $SiO_2$ lead to a quicker transition to a strongly retarded reaction stage.

The following mechanism can account for these phenomena: when the sulphate concentration in the aqueous phase becomes too low for ettringite formation, the $C_3A$ reacts with part of the ettringite formed previously, forming calcium aluminate monosulphate hydrate and $C_4AH_{19}$. The amount of monosulphate formed depends on the availability of ettringite for attack by the $C_3A$; it is larger in the presence of small amounts of $SiO_2$, since the $SiO_2$ favours precipitation of ettringite far from the $C_3A$, either by offering precipitation sites for the ettringite, or by ensuring a better contact between $C_3A$ and solution during mixing. If only a small amount of mono-
sulphate is formed, \( \text{C}_3\text{AH}_6 \) precipitation predominates. However, then "CaO" and "\( \text{Al}_2\text{O}_3 \)" enter the solution, by the reaction of \( \text{C}_3\text{A} \), in a molar ratio 3:1, whereas they are withdrawn from it in a larger ratio (the latter would be 4:1 if only \( \text{C}_4\text{AH}_6 \) would be formed). This leads to the aqueous phase in the vicinity of the \( \text{C}_3\text{A} \) being low in "CaO", high in "\( \text{Al}_2\text{O}_3 \)" content, causing hydrous alumina precipitation which effectively retards the hydration of \( \text{C}_3\text{A} \).

This investigation will be described in more detail in a forthcoming paper in Cement and Concrete Research.

Heat evolution rate vs. time in pastes \( \text{C}_3\text{A} + \text{CaSO}_4 \cdot 2 \text{H}_2\text{O} + \text{SiO}_2 + \text{H}_2\text{O} \), weight ratios 1.50 : 1.43 : \( z \) : 5.00, with \( z \) indicated for each experiment separately.