

The retarded character of C3A hydration during its initial stages

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The retarded character of C_3A hydration during its initial stages.

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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.

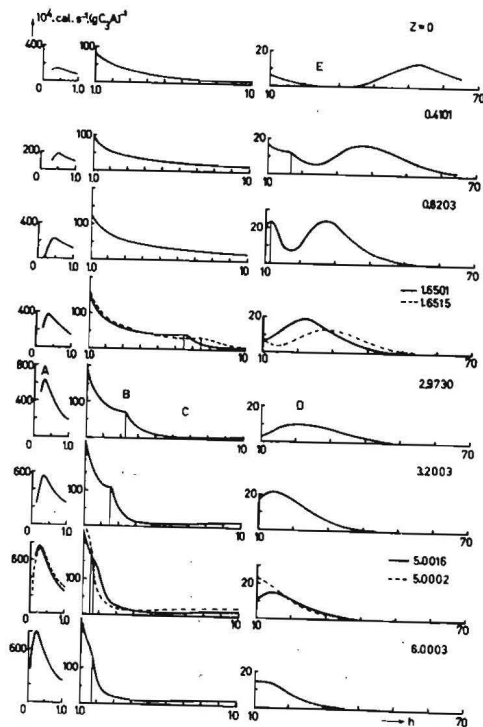
When during a reaction starting with ettringite formation, the sulphate ions become exhausted, the hydration rate does not simply show a succession of the phenomena observed for the cases a, b and c mentioned: apparently, the presence of hydrate crystals previously formed influences the reaction course.

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, C_4AH_{19} precipitation predominates. However, then "CaO" and " Al_2O_3 " enter the solution, by the reaction of C_3A , in a molar ratio 3:1, whereas they are withdrawn from it in a larger ratio (the latter would be 4:1 if only C_4AH_{19} would be formed). This leads to the aqueous phase in the vicinity of the C_3A being low in "CaO", high in " Al_2O_3 " content, causing hydrous alumina precipitation which effectively retards the hydration of C_3A .

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



Heat evolution rate vs. time in pastes $C_3A + CaSO_4 \cdot 2 H_2O + SiO_2 + H_2O$, weight ratios 1.50 : 1.43 : z : 5.00, with z indicated for each experiment separately.