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USE OF THERMAL ANALYSIS FOR THE STUDY OF THE CEMENT PASTE REACTIONS DURING THE HYDRATION

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ABSTRACTS

New method was developed for studying the hydration reaction of cement respectively of other binder. This method named HTA was realised in Derivatograph apparatus. With the aid of obtained thermographic curves and their changes the properties and the behaviour of binder can be determined and the results of the other methods completed.

INTRODUCTION

Most of the recent investigations concern the problem of the hydration process. However, the knowledge about cement setting and hardening are not yet complete. We now chiefly the methods how to influence or how to speed up this process, e.g. with the temperature, water/cement ratio, fineness of cement etc. The relations between these independent variables and formed microstructure of hardened cement have been , in some case, determined quantitatively, but this is not enough (1)(2). That is why new methods are being developed which would provide further information as the below mentioned kind of thermal analysis.

With thermographic methods (DTA, TG, CDTA, DSC, ETA) (3) a specimen is examined, in which certain phase changes occured and which are identified and quantified. With HTA method, we investigate the behaviour of specimen in the initial stage of hydration. In this case we follow the reaction of cement from the instant of its mixing with water or, in other words, the cement reactivity, which is of particular significance for its evaluation.

RESULTS AND DISCUSSION

The HTA method can be briefly described as follows:

Weigh the tested cement precisely (approximately 10g) and mix with certain amount of water (e.g. water/cement ratio w = 0,3). Mix thoroughly this cement paste and allow it at rest for a short

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time. Then weigh precisely approximately 3 g paste directly into a crucible and place into the apparatus. In our case Derivatograph was used. In addition to the DTA curves the thermogravimetric curves TG were obtained as well. The thermal regime used must respect the reactions taking place in the specimen so that they might be plotted in the recorder. The test was stopped at 150 up to 170 °C. The specimen can be analyzed furter on and additional data about the reactions can be noticed (4).

In this case the following specimens were analyzed: Portland cement PC, Portland cement with admixtures, slag Portland cement SPC, alumina cement AC, clinker minerals and plaster of Paris. The HTA curves are shown in the figure.

As evident, the HTA curves have various course. Some signs on the curves associated with endothermic reaction of water evaporation (free or adsorbed), are alike in all specimens. Exothermic reactions associated with the formation of hydrated products interrupt the course of endothermic reaction, since the reaction heat exceeds that of needed for the evaporation of free water, what is manifested by typical peaks.

CONCLUSIONS

With respect to limited extent of the contribution the course of individual curves and their changes with temperature and time cannot be discussed in more details. It can be stated that the course of HTA curves depends on:

- kind of binder, Portland or alumina cement, plaster (lime can not be used),
- phase composition and fineness, i.e. on its microstructural composition,
- admixtures and additives,
- water/cement ratio,
- rate of heating. The preincubation and incubation periods of cement hydration (S_I and S_{II}) shorten due to the influence of temperature.

Since both the kind of binder and its microstructural composition can be different, we can, with the aid of HTA method, complete the results of other methods and contribute to complex evaluation of binder, e.g. cement, quality.

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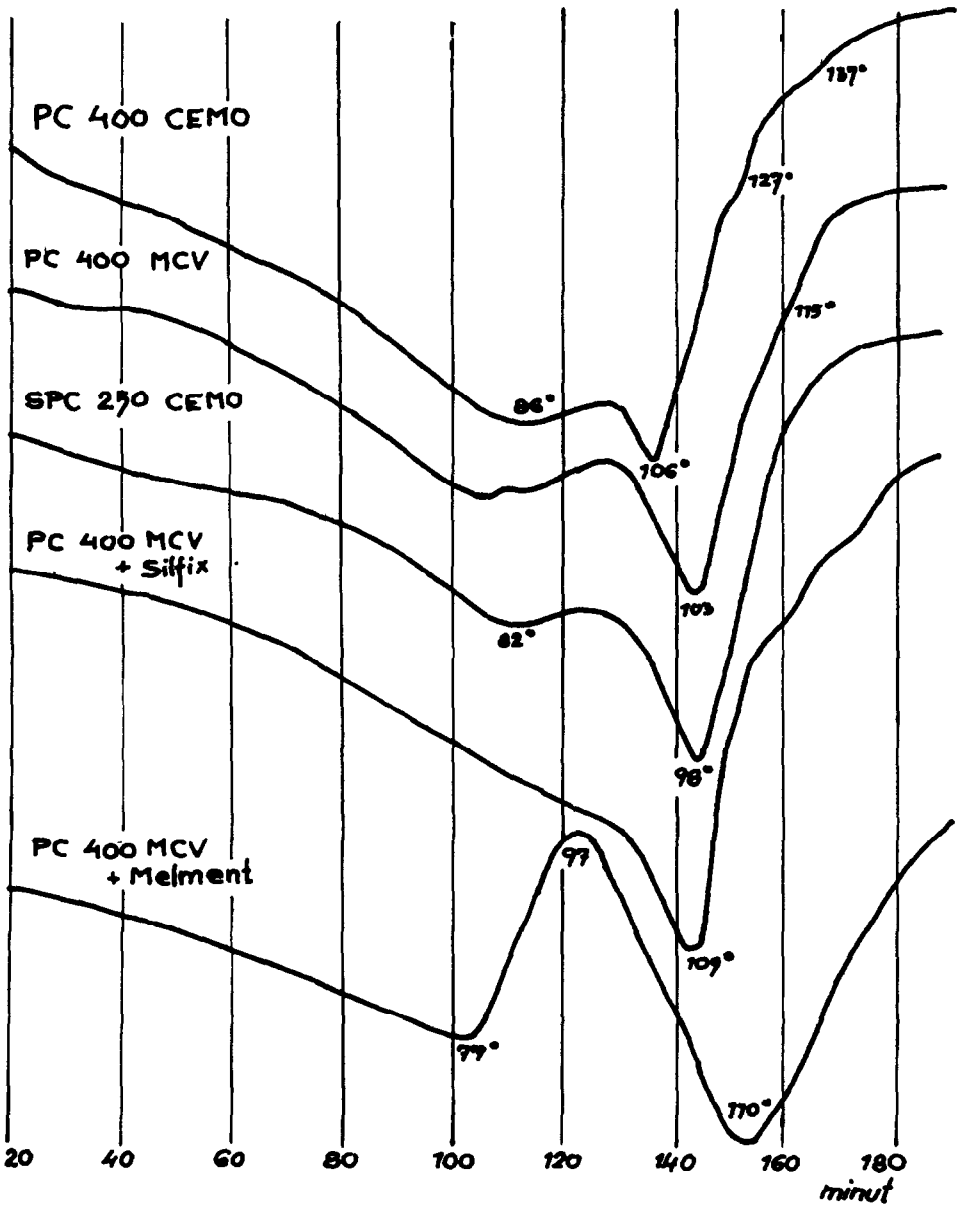

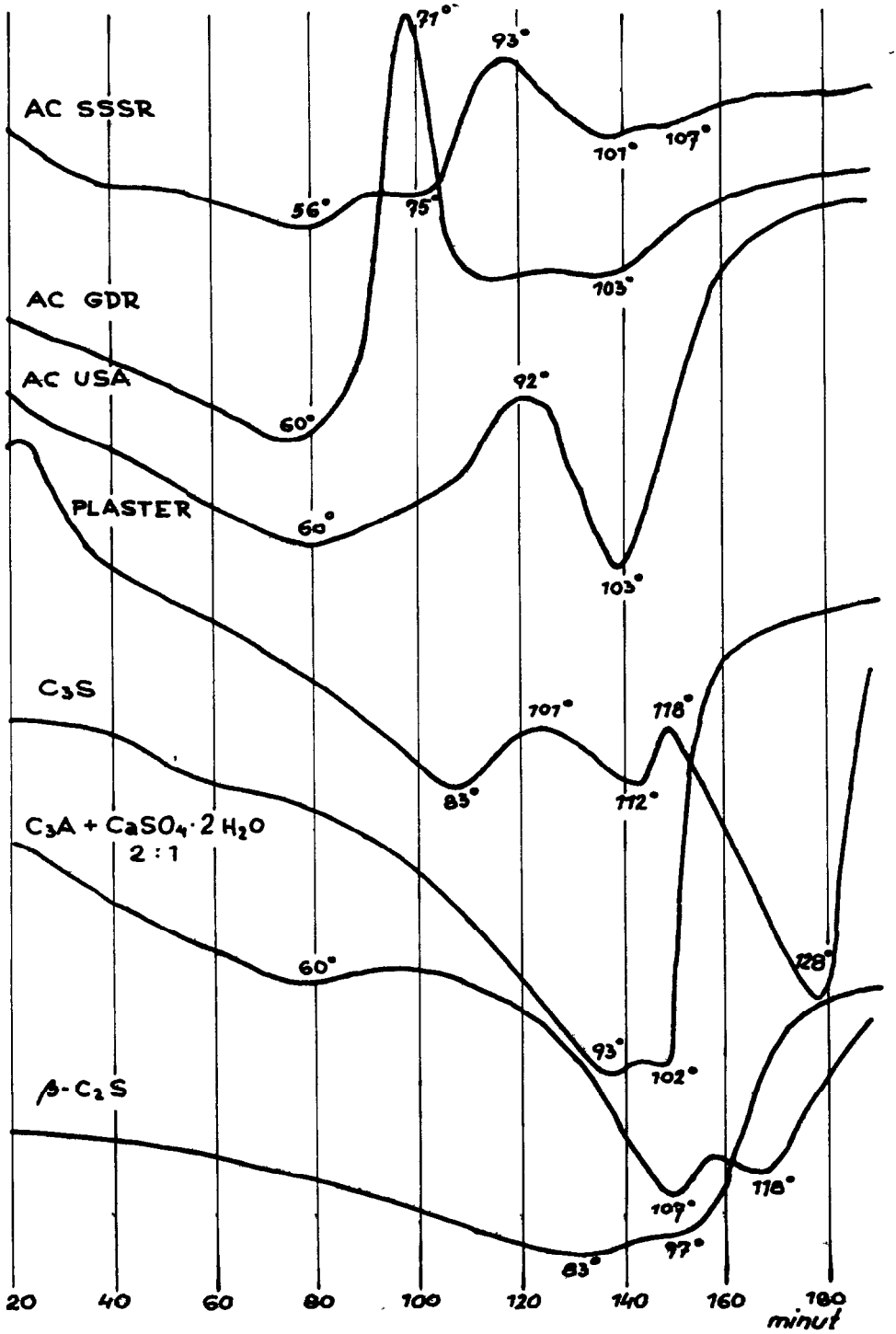
AC SSSR
AC GDR
AC USA
PLASTER
C3S
C3A + CaSO4·2 H2O
2 : 1
β-C2S
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93°
56°
75°
101°
107°
103°
60°
92°
60°
103°
83°
101°
118°
112°
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