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INVESTIGATION OF THE RELATIVE RESISTANCE OF HYDRATION PRODUCTS OF CEMENT AGAINST CORROSION DUE TO AGGRESSIVE CO_2 WATER

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ABSTRACT

The resistance of hydration products of cement against water with aggressive CO_2, which causes the corrosion of concrete was investigated by means of thermal analysis and other methods. A relatively small resistance of these products against the studied aggressive medium was found.

INTRODUCTION

Water containing aggressive carbon dioxide cause the corrosion of concrete. Its chemism and mechanism are essentially known and are connected with gradual hydrolytical decomposition of the hydration products of cement in the concrete and with gradual degradation of physico-mechanical properties of concrete.

Hitherto a relative resistance of particular hydration products of cement against the action of aggressive CO_2 is not reliably known yet though information about this resistance represent one of the assumptions for the correct evaluation of service life and for the choise of protective measures of concrete structures exposed to action of aggressive CO_2 waters. In the framework of large research program of corrosion the research of relative resistance of particular typos of hydration products against the aggressive CO_2 water was performed, too.

EXPERIMENTAL

The relative resistance of particular types of hydration products against aggressive CO_2 water was investigated by observing changes of their phase and chemical composition due to action of aggressive CO_2 in diluted water suspensions, to which gaseous CO_2 was fed under sufficient overpressure.

Fine- grained specimens of hardened pastes, mortars and concretes were selected according to their hydration products.

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The initial composition of used specimens is shown in Table 1.

At certain periods the dried substrates of the suspensions - i.e. the specimens of their solid phases- were studied by thermal and x- ray diffraction analysis and chemical analysis, using derivatograph type OD 102 /made by MOM Budapest/,x-ray diffractograph Philips with generator PW 1730 as well as current chemical analytical methods.

Table 1 Phase composition of specimens in their initial state

Specimen No.	Type of specimen	Phase composition /X-ray diffr.phase analysis/
1	hardened paste of Portland cement	C_3AH_6, C_4AH_{13}, ettringite, calcite, Ca $/OH/_2$, $C_3A.CaCO_3.nH_2O$,
2	gas concrete	tobermorite, C_3AH_6, gypsum, calcite
3	gas silicate	tobermorite, xonotlite hydrogarnet, fly ash, calcite, SiO_2
4	hardened paste of activated kaolin and Ca $/OH/_2$	gehlenitehydrate, calcite, activated kaolin

RESULTS AND DISCUSSION

The results of investigation of changes of the composition of specimens, exposed to the action of aggressive CO_2 are given in Table 2, DTA curves of these specimens are shown in Fig.1 .

According to the results of the thermal analysis the content of bound water in hydration products was decreasing- except the specimen No.3 - gas silicate, whereas the content of $CaCO_3$ was increasing in the investigated specimens with the time of action of the aggressive CO_2 water.The observed decrease of the content

Tab.2 Results of investigation of changes of specimens composition

Specimen No.	Time of action of aggr. CO_2 /day/	Thermal analysis /%/		Chem. anal. /%/	X-ray diffraction phase analysis			
					Relative values of intensity of basic diffr.lines			
		Water bound in hydrat. products	CaO bound in $CaCO_{33}$	Total CaO cont.	Hydration products			Calcite
1	0	12,26	9,97	62,12	8/E/	6/AH/	15/AC/	75
	20	7,70	33,87	59,45	0	0	10	100
2	0	7,45	3,14	23,85	35/T/	5/A6/	-	50
	20	4,93	12,97	15,29	0	0	-	100
3	0	8,26	5,81	25,18	15/X/	15/H/	-	50
	20	9,10	11,48	21,19	0	0	-	100
4	0	20,58	2,52	28,15	100/G/	-	-	30
	20	12,84	13,63	20,80	0	-	-	100

Abbrev.: E- ettringite, AH-C_4AH_{13}, AC-$C_3A.CaCO_3.nH_2O$, T-tobermorite, A6-C_3AH_6, X- xonotlite, H- hydrogarnet, G- gehlenite hydrate

of bound water in the specimens was evidently due to the decomposition of hydration products in these specimens caused by the aggressive CO_2 water.

As follows from Fig.1 the decomposition of hydration products in the given specimens became evident on their DTA curves, too.In comparison with DTA curves of original specimens their DTA curves as early as after 2 days of action of aggressive solution has proved a decrease or even vanishing of the peaks of the hydration products and at the same time an increase of the endothermic peak at 830°C- 895°C corresponding to calcite.

The results of chemical and x-ray diffraction phase analysis the fact and information concerning the decomposition of hydration products stored in aggressive CO_2 water following from the results of thermal analysis fully confirm- by the found drop of the total CaO contents in the studied specimens as well as by the found gradual decrease of intensity and oven full vanishing of diffraction lines belonging to hydration products.

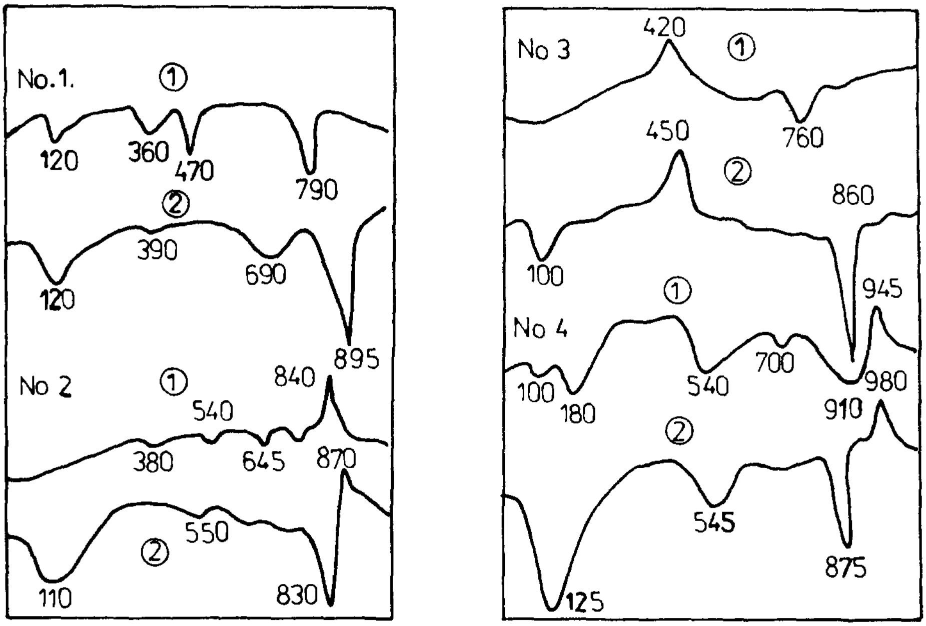

Fig.1 DTA curves of specimens in their initial state ① and after 2 days of action of water containing aggressive CO_2 ②

CONCLUSIONS

The obtained results show that the studied hydration products namely tobermorite, xonotlite, C_3AH_6, C_4AH_{13}, ettringite, gehlenite hydrate and hydrogarnet phase occuring in concretes and analogous composites are relatively quickly decomposed by the action of the aggressive CO_2 water. This consequence is significant from the point of view of possibility of the securing of the functional service-life of concrete structures subjected to action of aggressive CO_2 waters.

REFERENCES

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