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THE INFLUENCE OF ETHANOLAMINES ON THE SURFACE PROPERTIES OF PORTLAND CEMENT PASTES

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ABSTRACT

The effect of ethanolamines-monoethanolamine (MEA), diethanolamine (DEA) and triethanolamine (TEA) -on the pore-size distribution of the white Portland cement pastes (white PC) has been investigated. The cement pastes with and without admixtures were cured at various hydration times ranging from 1 day to 90 days. Cumulative pore areas and total pore volumes of the samples obtained from nitrogen desorption isotherms were presented along with pore-size distributions calculated using the method of Dollimore and Heal. © *1997 Elsevier Science Ltd*

Introduction

In the first paper of this series data on the setting times, $Ca(OH)_2$ contents, flexural and compressive strengths, specific surface area measurements of the white Portland cement pastes with and without ethanolamines were given. It was found that TEA is the most effective set retarder among these admixtures of MEA and DEA, but it produced low strength development at early and late stages of white PC hydration (1). Within this paper data on the effect of additional factors on the surface properties of the white Portland cement pastes are reported.

Experimental

The pastes were prepared with 0.4 water-cement ratio and cured from 1 day to 90 days. The composition and preparation of the pastes were described in the first paper of this series (1).

The cumulative pore areas and the total pore volumes of the cement pastes with and without ethanolamines were determined by nitrogen adsorption-desorption isotherms. The pore-size distribution method by Dollimore and Heal were used in the analyses (2-4). The calculations were realized by using the desorption data and open-ended cylindrical and non-intersecting pore model (5).

TABLE 1

The Cumulative Pore Areas of Cement Pastes, m^2/g

Cement Pastes		1 d.	3 d.	7 d.	28 d.	90 d.
Contro l		13.7	25.1	32.2	87.8	111.8
MEA	0.1%	13.0	26.4	31.2	87.0	112.5
	0.5%	13.0	24.7	29.9	69.5	104.1
	1%	14.1	26.0	29.3	85.0	113.1
DEA	0.1%	14.7	25.7	31.6	92.5	109.2
	0.5%	14	26.3	32.0	90.7	105.4
	1%	8.2	21.1	27.3	77.7	99.6
TEA	0.1%	12.9	25.5	29.7	92.5	108.5
	0.5%	11.7	26.1	30.5	77.1	108.0
	1%	7.3	14.5	19.7	63.6	93.9

Results and Discussion

Cumulative Pore Areas and Total Pore Volumes. The cumulative pore areas of cement pastes with and without admixtures are given in Table 1 and 2 respectively. The cumulative pore areas increased and total pore volumes decreased with hydration time for all the samples as expected. At the low addition rates, the admixtures did not significantly change the cumulative pore areas and the total pore volumes of the cement samples. For different hydration situations, the distributions of the pore volumes of the control cement paste and the paste containing MEA are very similar and the highest cumulative pore area and the lowest total pore volume values obtained with control sample and paste with 0.1% MEA. Within high admixture concentrations, the lower cumulative pore area and higher total pore volume values obtained due to retarding of the hydration.

Pore-Size Distribution Curves. Figures 1-4 show the pore-size distributions of the cement pastes with 1% MEA, DEA and TEA at various hydration times.

TABLE 2

The Total Pore Volumes of Cement Pastes, ml/g

Cement Pastes		1 d.	3 d.	7 d.	28 d.	90 d.
Control		0.214	0.200	0.102	0.082	0.075
MEA	0.1%	0.215	0.198	0.102	0.082	0.075
	0.5%	0.215	0.203	0.104	0.098	0.079
	1%	0.213	0.198	0.104	0.083	0.073
DEA	0.1%	0.212	0.199	0.102	0.078	0.077
	0.5%	0.213	0.198	0.102	0.079	0.077
	1%	0.301	0.206	0.107	0.090	0.079
TEA	0.1%	0.215	0.199	0.104	0.078	0.077
	0.5%	0.234	0.198	0.103	0.090	0.078
	1%	0.334	0.212	0.139	0.106	0.081

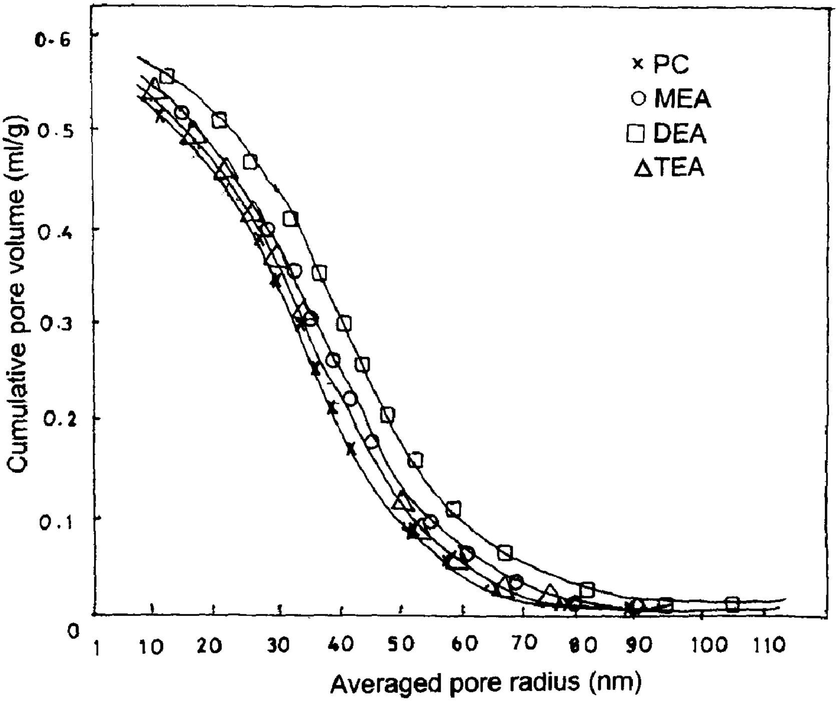

FIG. 1.
The pore-size distribution curves of the cement pastes at 1 day.

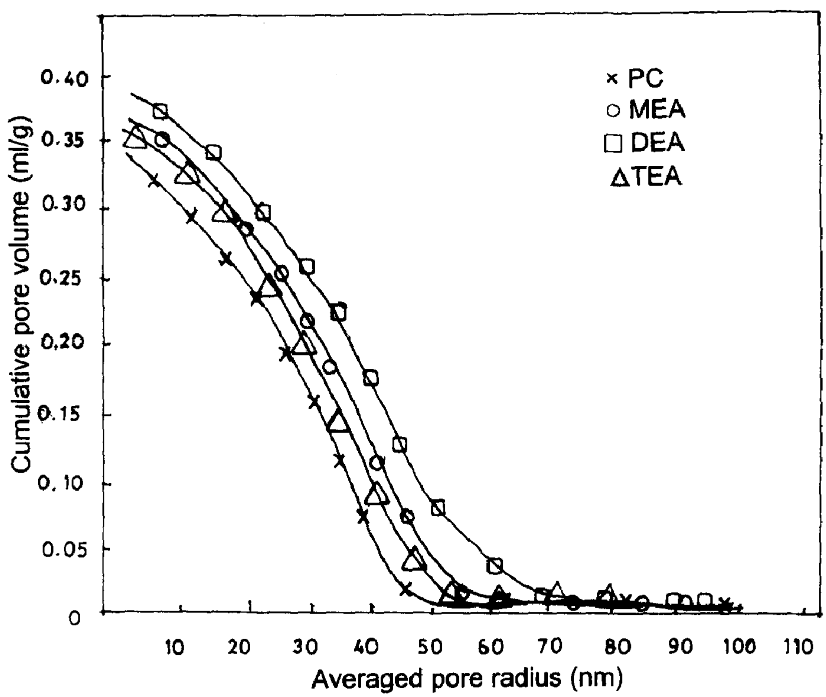

FIG. 2.
The pore-size distribution curves of the cement pastes at 7 days.

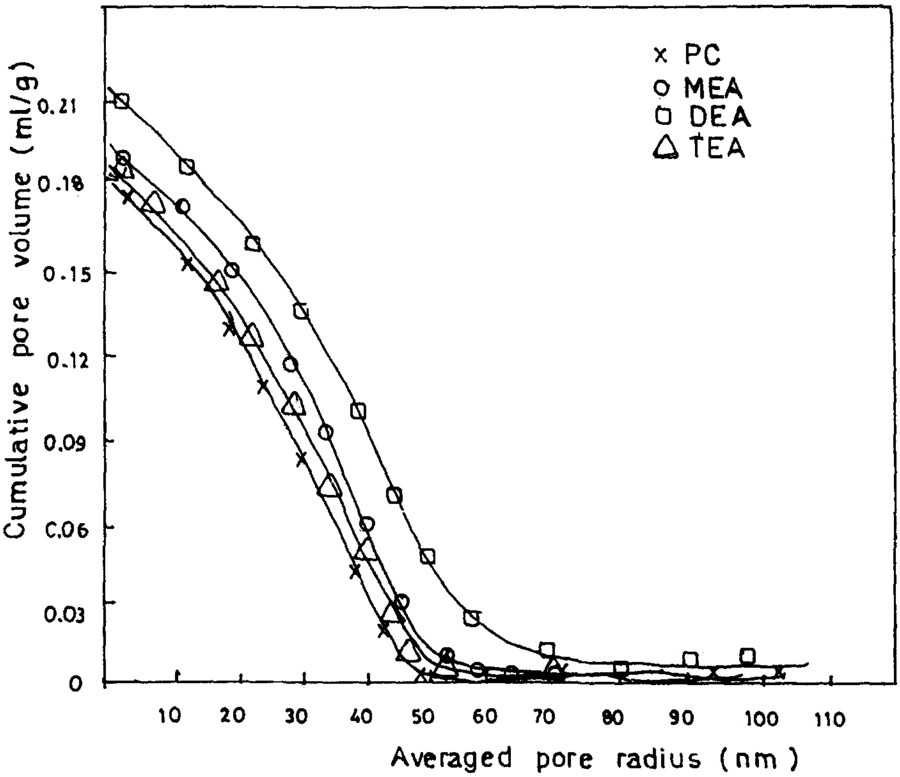

FIG. 3.
The pore-size distribution curves of the cement pastes at 28 days.

The study produced too many pore-size distributions to be reproduced. However, with the exception of the samples prepared with 1% admixtures, all samples type had essentially the same pore-size distributions at the same hydration rates.

The pore-size distributions of the pastes with admixtures have the same general shape as the control cement paste. However, the cement pastes with DEA and TEA are more porous and they have more large size pores according to the control samples. The cement paste with MEA has a structure that is more closer to the control cement paste than those of the cement pastes with DEA and TEA.

Conclusions

The presence of MEA did not modify the pore structure of the hydrated cement pastes significantly. The influence of the ethanolamines increases from MEA to TEA. TEA acts as a retarder of hydration probably owing to the formation of a surface complex on the hydrating surface (1, 6, 7). In the presence of TEA the C_3S and C_2S hydration occur with some changes in the morphology and microstructure of the hydration products (8, 9). DEA and TEA were noticed to cause a reduction in $Ca(OH)_2$ content and an increase in the CaO/SiO_2 ratio in

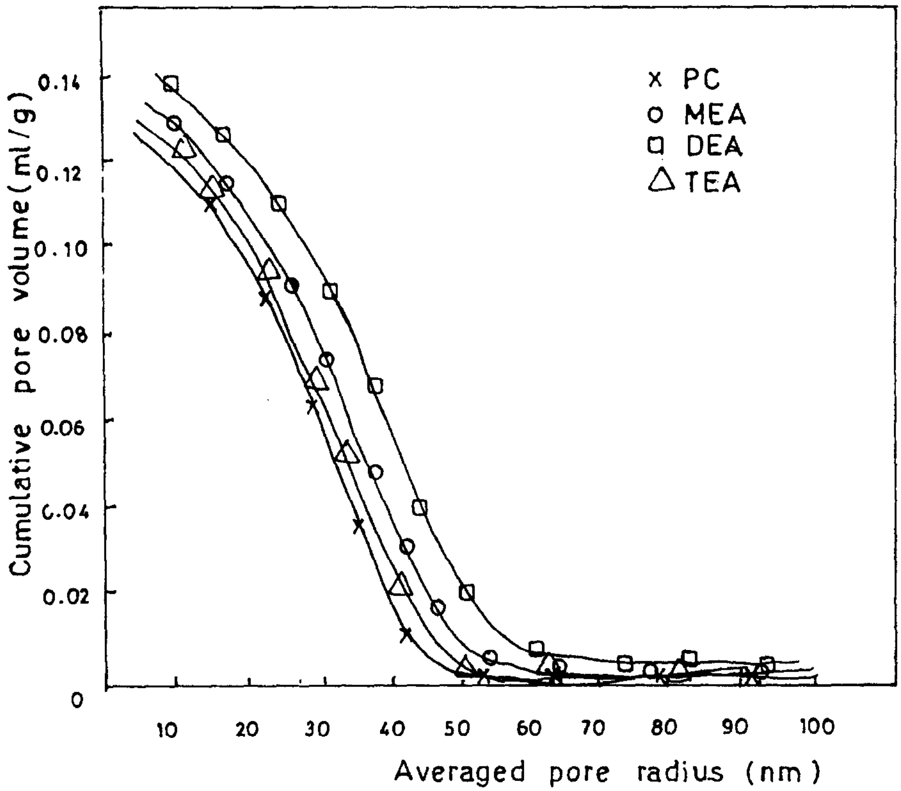

FIG. 4.
The pore-size distribution curves of the cement pastes at 90 days.

CSH gel (1, 10). They can alter the CSH gel microstructure and promote the cumulative pore volumes of the larger pores.

Because of retarding effects of the admixtures the hydration degrees of the cement pastes with DEA and TEA may not reach the hydration degree of the control cement paste at equal hydration times. It can be the cause of an increase in the cumulative pore volumes of the larger pores.

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