Effect of Triethanolamine on Concrete Made up of PPC – A Review

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Abstract-*The present study investigates the working principle upon the accelerating-retarding effect of triethanolamine dosage on the initial setting time of concrete made up of portland pozzolana cement. The triethanolamine added in concrete will increase the strength of concrete such as compressive strength and flexural strength. This type of concrete gives more strength than the conventional concrete.*

Keywords-Triethanolamine, Concrete, Portland pozzolana cement

I. INTRODUCTION

The concrete in which common ingredients such as aggregate, water and sand cement are used is known as normal concrete. It is also known as normal weight concrete or normal strength concrete. It has a setting time of 30 - 90 minutes depending upon humidity, grain size of cement etc. At about 90 days almost 90% of strength is achieved. The slump varies from 1 to 4 inches. Density ranges from 140 to 175 pcf. It has weak tension but strong compression. Air content is about 1 to 2%. Normal concrete does not withstand severe conditions like freezing and thawing.

In the past several years, the use of organic admixtures to alter the physical and rheological properties of portland cement concrete has become common practice in the construction industry. However, the low concentrations typically used, and the organic nature of the admixtures, present problems to the analytical chemist who may be called upon to determine the amounts and types of admixtures originally added to the concrete.

Triethanolamine (TEA) is the main chemical used as cement additive with multi functions as grinding aid during cement comminution process and setting time regulator for cement hydrations. These couple of functions is the main advantage from using TEA in addition to the relatively small dosage as well as the alkali and chloride free features. A unique characteristic of TEA is that it can either accelerate or retard cement hydration toward initial setting time depending on the dosage used.

TEA is a surface-active substance which is absorbed on the surface of cement particle and cement hydrated product. TEA imparts the solution some metallic ions Fe3+and Al+3 thus increasing the activity of C4AF compound and inhibiting the formation of Fe(OH)3 and Al(OH)3 on surface of the cement particle. The action of silicate and aluminate phases within the cement particle. TEA also reduces to some extent the surface tension of water that enables the cement powder wetting as well as highly reactive cement compound.

Thus, the addition of TEA with mixing with water reduces setting time, increasing the drying shrinkage but diminishing the mechanical strength of mortar and concrete.

II. LITERATURE REVIEW

Yohannes L. Yaphary et al [1] performed experiments and molecular simulation for the discovery of working principle to explain the accelerating-retarding effects of TEA dosage on initial setting time of hydrated cement. TEA initially influences C3A hydration. In the presence of TEA, C3A hydration involves the formation of alumatrane as has been evaluated by molecular simulation and FTIR spectroscopy. Under this TEA influencing circumstance, the precipitate called TEA-ettringite are formed. The pace of TEA-ettringite formation is faster than normal ettringite. The level in intensity of TEA-ettringite formation is governed by TEA dosage and can influence the cement hydration to different extents prior the initial setting time. Acceleration of initial setting time of hydrated cement with considered low dosage of TEA has the acceleration period that starts earlier and with lower quantity of ettringite. These observations suggest the relatively small quantity of TEA-ettringite rapidly grows on C3A surface, which impedes the normal ettringite formation and allows the other phases of cement such as C3S to hydrate faster. Consequently, general process in cement hydration is accelerated hence initial setting time. In presence of relatively higher dosage of TEA, the amount of TEA is adequate to cause the fast network formation of TEA-ettringite that can generate initial setting time. Retardation in initial setting time from the use of TEA with considered medium dosage is caused by TEA-ettringite that adequately grows on the surfaces of C3A and other cement phases. As a

consequence, the subsequent cement hydration is impeded leading to the delayed initial setting time. The working principle discovered in this study regarding the accelerating-retarding effects on initial setting time is not merely applicable to TEA but also in general to others chemical accelerating the hydration of C3A. Furthermore, it is found that control upon hydration of C3A provides the means to regulate cement hydration toward initial setting time.

V. S. Ramachandran et al [2] have investigated in very small amounts triethanolamine has practically no effect on the setting, hydration, heat development and strength development of portland cement pastes. In amounts greater than 0.1 percent it has significant influence. TEA acts as a retarder in the hydration of the silicate phases and as an accelerator in the hydration of the aluminate phase. The mechanism of this action may be traced to a complex formed between TEA and the hydrating components of portland cement.

Ali Allahverdi et al [3] shows the experimental results confirm that TEA as a grinding aid is considerably more effective in ball mill than in vibrating disk mill when added at the same amount of 0.06 % by the weight of the cement. It increases the Blaine specific surface area of the mixtures of 95 % clinker and 5 % gypsum by 16 and 7.6 % in ball and vibrating disk mills, respectively, compared to the blank test. In both ball and vibrating disk mills, addition of TEA increases both initial and final setting times and decreases compressive strengths at 3-, 7- and 28-day curing ages. The effects, however, are more significant in ball mill compared to vibrating disk mill. This is mainly due to differences in the grinding mechanisms in the two mills. In the case of ball mill, slow grinding over quite longer time periods (40 times longer) provides enough time for effective distribution of grinding aid molecules on particles of the samples being ground. This effective distribution of grinding aid considerably enhances the effectiveness of TEA in ball mill compared to vibrating disk mill.

M. T. McCall et al [4] have investigated the Triethanolamine cannot be efficiently extracted from cement pastes after more than a few hours of hydration. Organic material, other than triethanolamine, is extracted from triethanolamine doped cement paste - - suggesting that TEA – cement reactions occur during hydration.

NecatiMenek et al [5] explain that TEA in cement matrix is converted into the TEA-Fe3 + complex by adding NaOH and Fe3 + solutions and analysed by using SWV techniques. Quantitative determination of TEA was realised by the voltammogram produced by the complex. Results show that the amount of adsorbed TEA in the cement paste increases with an increase in the amount of time and that the adsorption is approximately completed at 12 hours. After 12 hours the percentage of TEA adsorbed is approximately constant at different times of hydration for all specimens. For different amounts of TEA added to the cement paste, the amount of TEA adsorbed increases with an increase in the initial TEA concentration.

Zhang Yan-Rong et al [6] have investigated the addition of TEA in cement pastes leads to a notable reduction of the measured CH content by XRD and TGA at early ages in a hydrating cement paste. From the SEM observations, the morphology of CH crystals changes from large and parallel-stacked lamellar shape to smaller and distorted actinomorphic one due to the addition of TEA in the cement pastes. For the first time, the CH micro-crystals and even non-crystalline CH in HCPs in the presence of TEA were observed by TEM and electron diffraction techniques. Remarkable higher Ca/Si ratio of the C–S–H phase in the presence of TEA was found, which was also reported by other researchers and was supposed to originate from the CH micro-crystals embedded in the C–S–H phase during cement hydration. The pore solution analysis and NMR and UV results evidence the chelating effect between TEA and Ca2+ ions via the interaction between Ca2+ and the oxygen atoms in TEA molecule. It is supposed that by forming a complex of TEA-Ca2+, TEA can be introduced into the crystallization process of CH phase and thus significantly alters the morphology of CH crystals and even the content of the crystalline CH phase.

III. CONCLUSION

- Triethanolamine increases compressive strength of concrete.
- Accelerating-retarding effects of TEA on initial setting time of hydrated cement are examined.
- Flexural strength leads to increased concrete strength at early age made by TEA.
- Adding Triethanolamine decreases the mechanical strength as compared with Portland cement mortar. It also decreased the setting time and increases chemical shrinkage.
- Shortens the interval between initial and final setting time of the fresh mortar pastes. Increases the mortar density.

REFERENCES

[1] Yohannes L. Yaphary, Zechuan Yu, Raymond H.W. Lam, Denvid Lau. ”Effect of triethanolamine on cement hydration toward initial setting time” Construction and Building Materials 141 (2017) 94 –103 (ELSEVIER).

[2] V. S. Ramachandran. ”HYDRATION OF CEMENT -- ROLE OF TRIETHANOLAMINE” Cement And Concrete Research. Vol. 6, pp. 623-632.
[3] ALI ALLAHVERDI, ZEINAB BABASAFARI. ”EFFECTIVENESS OF TRIETHANOLAMINE ON GRINDABILITY AND PROPERTIES OF PORTLAND CEMENT IN LABORATORY BALL AND VIBRATING DISK MILLS” Cement Research Center, School of Chemical Engineering, Iran University of Science and Technology, Narmak 1684613114, Tehran, Iran. Ceramics – Silikáty 58 (2) 89-94 (2014).
[4] M. T. McCall and J. Mannone. “ANALYSIS OF CEMENT PASTES FOR TRIETHANOLAMINE” Cement And Concrete research. Vol. 5, pp. 489-496.
[5] NecatiMenek, ZerrinHeren. “Analysis of triethanolamine in white cement pastes by voltammetric methods” Cement and Concrete Research 29 (1999) 777–779.
[6] Zhang Yan-Rong, Kong Xiang-Ming, Lu Zi-Chen, Lu Zhen-Bao, Zhang Qing, Dong Bi-Qin, Xing Feng. “Influence of triethanolamine on the hydration product of portlandite in cement paste and the mechanism” Cement and Concrete Research 87 (2016) 64–76 (ELSEVIER).