AN ABSTRACT OF A THESIS

EARLY AGE NANO- AND MACRO-PORE STRUCTURE DEVELOPMENT FOR PURE AND SLAG BLENDED CEMENTS EXPOSED TO VARYING MOISTURE ENVIRONMENTS

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Master of Science in Chemical Engineering

The hydration of cement-based materials yields a complex structure with pore sizes ranging from approximately 2 nm to hundreds of microns in size. Previous methods to characterize the distribution of the finest end of this pore size spectrum have suffered from inherent flaws that prevent accurate understanding of its development. Thermoporometry, a technique designed for the measurement of pores nanometers in size, has been used to study pore size distributions in pure cements and slag blended cements exposed to varying moisture environments.

Differential scanning calorimetry was used to obtain the necessary solidification thermograms from which pore size distributions were determined using the principles of thermoporometry. Thermal gravimetric analysis was used to measure extents of reaction and levels of carbonation. Sample curing was varied by initial time spent in sealed conditions and by subsequent exposure to saturated limewater, 90% or 70% relative humidities. Hydration ages extended from one day to thirty-two days at 35 °C.

This work demonstrates the use of thermoporometry for the measurement of the distributions of the smallest pore sizes in cement systems. Changes in the behavior of the distribution of freezable water are observed for samples exposed to different moisture conditions and comparison are made between pure and slag blended cements. Observed phenomena can best be explained by considering the rate of formation of capillary pores, subsequent filling of capillaries by hydration product, and the role that self-desiccation plays in the hydration of cement. Hydration in sealed conditions shortens the time at which the capillary pores no longer exhibit freezable water as compared to samples hydrated in saturated conditions. It was also found that if cement materials are properly cured, they can continue to hydrate up to thirty two days after exposure to relative humidities as low as 70%. Resistance to carbonation was dramatically increased for samples allowed to cure in sealed conditions for more than one day. Lastly, the colligative freezing point depression associated with the pore solution chemistry of cement is shown to play an insignificant role in the determination of pore sizes from thermoporometry.

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