

In situ Monitoring of Cement Gel Growth Dynamics. The Use of a Miniaturized Permanent Halbach Magnet for Precise ^1H NMR Studies

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The most critical parameter that affects important cement paste properties, such as strength, shrinkage, creep, and permeability, is its pore structure [1]. Pores in hydrated cement form an extremely complicated network, with a very broad size distribution, ranging from nanometers to millimeters [2], which changes with the chemical composition, relative humidity, temperature, and applied load. Here, without recourse to drying methods, we monitor the evolution of the pore structure during the progressive hydration and setting of three white cement pastes with different hydration kinetics. By combining ^1H NMR spin-lattice relaxation T_1 and diffusion measurements performed in a portable 0.29 Tesla Halbach magnet, it is possible to distinguish among gel and capillary pores, and study the growth dynamics of cement gel (T_1 measurements), and the associated shrinkage of the capillary pore system (diffusion measurements). In this way, aspects of the hydration kinetics are unveiled, which are difficult to observe with other techniques.

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[2] Jennings H. M., Bullard J. W., Thomas J. J., Andrade J. E., Chen J. J., Scherer G. W., Journal of Advanced Concrete Technology, 6, 5 (2008).