A ^{1}H NMR PFG study of the capillary porosity of cement

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Abstract

Pulsed field gradient (PFG) NMR diffusometry[1,2] is a well established method for measuring the self diffusion coefficient, *D*, of small molecules in liquids. The diffusion-time dependence of *D* yields information about the confining microstructure[3]. We report one- and two-dimensional ^{1}H PFG studies of water in white cement paste, with water to cement ratio 0.4,cured under water for periods up to one year. Magnetic susceptibility gradients are usually considered to impact cement PFG experiments negatively. However, using a 13 interval pulse sequence[4], we show that the effects of these gradients are small in white cement. To analyse the data, we extend application of a well known expression for restricted diffusion in pores[3] to the case of a log-normal distribution of pore sizes for which the relaxation times T_1 and T_2 are pore size dependent.

In mature samples with diffusion time > 6 ms, the signal arises almost exclusively from the small fraction of residual capillary water. A global analysis of data for a 1 year old paste for different combinations of diffusion time from 6 to 50 ms and of the RF pulse gaps τ_2 and τ_1 all for gradient pulses of 2 ms has been made. The volume mean pore size and dimensionless distribution width are $r_0 = 4.2$ μm and $\sigma = 0.51$ respectively. The size distribution is similar to that in a 7 day old paste, confirming that hydrates and gel porosity do not form in the capillary porosity once the latter has been substantially created. Two dimensional correlation experiments have found no evidence for capillary pore anisotropy in cement.

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