

Monitoring magnesia cemented paste backfill using low field ^1H NMR relaxometry

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Abstract

When the mining industry extracts minerals vast volumes of waste material known as tailings are generated, with tailings-to-product volume ratio of 100:1 common and in extreme cases 1,000,000:1 [1]. For safe deposition of solids into underground mine openings cemented paste backfill (CPB) is often used. CPB is a heterogeneous material formulated using mine tailings (typically 70-85 wt% of total solids content), binder (up to 10 wt% of total solids content) and water. In this study, we utilise low-field ^1H nuclear magnetic resonance (NMR) relaxometry (T_2) to monitor the curing of magnesia CPB [2] over 28 days. Magnesia cements are of interest due to their rapid strengthening coupled with the capacity for CO_2 capture. Here we study the effect of magnesium oxychloride (MOC), or Sorel cement, formed by the combination of MgCl_2 and MgO . The results (see Fig 1) show $T_{2,\text{mean}}$ relaxation time of magnesia CPB samples compared with CPB samples prepared using ordinary Portland cement (OPC). The $T_{2,\text{mean}}$ evolution over time was compared with mechanical strength using uniaxial compressive strength (UCS) testing, and product formation was assessed using scanning electron microscopy (SEM). The results of the study showed that magnesia CPB exhibits T_2 relaxation evolution consistent with the more rapid curing of MOC. Furthermore, the relative importance of magnesia concentration and solution pH on the formation mechanism of MOC [3] was experimentally evidenced by the change in $T_{2,\text{mean}}$ when magnesia CPB was prepared using either 0.5 M or 3M MgCl_2 .

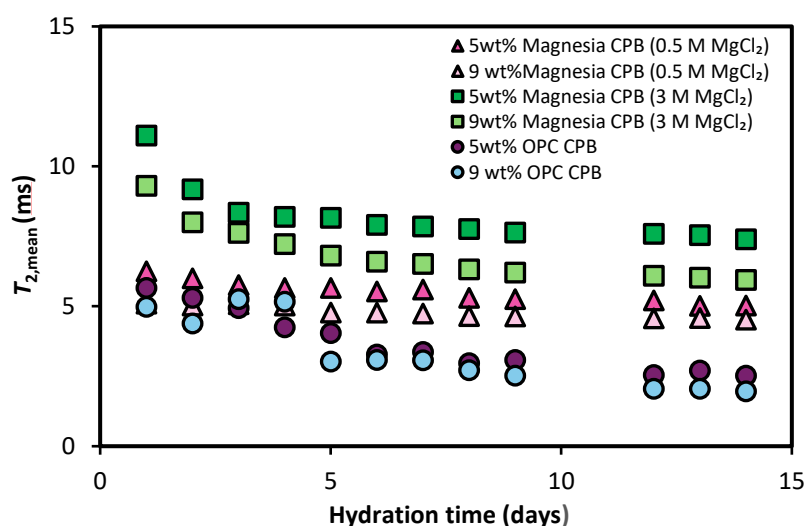


Fig. 1: Comparison of the measured $T_{2,\text{mean}}$ obtained from the modal peak as a function of hydration time for magnesia CPB samples prepared with 0.5 or 3 M MgCl_2 , and Ordinary Portland CPB samples. Samples were prepared using either 5wt% or 9wt% binder.

References:

[1] Dudeney et al., Int. J. Min. Reclam. Environ. (2013). [2] Walling and Provis, Chem. Rev. (2016), [3] Deng and Zhang, Cem. Concr. (1999).