**Mg based nanotechnologies to control clay swelling in coal seam gas wells**

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**Introduction**

Coal seam gas (CSG) wells in the Surat Basin are typically open-hole completions across multiple thin coal seams interlayered with mudstones that are rich in smectite clays (Towler et al. 2016). The swelling of smectite clays on contact with drilling fluids and water produced from coal seams leads to rock breakage that can negatively impact gas production. The conventional method to control clay swelling is KCl brine, but that treatment remains effective for only short production times.

**Aims**

Our project aims to develop clay swelling inhibitors that last longer than KCl brine. We evaluated the effectiveness of (i) six types of nanoparticles (Al2O3, ZnO, ZrO2, Fe2O3, SiO2, MgO) and (ii) various other sources of Mg cations to control swelling of a model bentonite clay.



**Fig. 1** Swelling index of clay treated with 1%wt solutions of Mg salts, MgO and Mg(OH)2. Lines show the raw bentonite in DI water (SI=3.2), formation water (SI=3.8) and nano MgO in 4%wt KCl (SI=2.0).

**Methods**

The bentonite clay was from AMCOL mine in Miles, Queensland. We evaluated swelling inhibition treatments in visual swelling experiments (ASTM D5890-11 (Pham & Nguyen, 2014)) with the measured swelling index, *SI*, calculated using$SI={\left(h\_{t}-h\_{i}\right)}/{h\_{i}}$, where *ht* and *hi* are the final and initial heights of the clay bed. Another second experiment on mudstone samples was performed in a flow-cell with circulating model formation water. The clay before and after treatment was characterised by XRD, XPS, and TGA to understand clay swelling inhibition mechanism with MgO nanoparticles.

**Results and Discussion**

The most effective nanoparticles to control swelling were SiO2 and MgO, and these were more effective than 4%wt KCl treatment. However, MgO nanoparticles showed no great advantages compared to soluble magnesium salts or Mg(OH)2 powder (Fig. 1). Based on the XRD, XPS, and TGA studies we propose that the reasons why MgO NPs and Mg(OH)2 were most effective at long term clay swelling inhibition could be:

1. Mg(OH)2 can adsorb physically on the surface of bentonite clay and this species is difficult to remove from the surface. And,
2. The adsorption of Mg(OH)2 on to the clay surface can interfere the penetration of water in the clay structure leading to swelling inhibition.

**Conclusions**

Our results suggest there is no great benefit to use nanoparticles instead of
Mg(OH)2. We conclude its unlikely these nanoparticle treatments would be cost-effective or practical for use in CSG wells. Further work in our lab has identified alternate techniques to deliver Mg and a base to the clay-rich layers and transform swelling smectite clays to non-swelling chlorite structures.

**References**

Towler, B., Firouzi, M. et al. 2016. An overview of the coal seam gas developments in Queensland. *Journal of Natural Gas Science and Engineering* 31, 249-271.

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