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How much polyacrylamide can be lost by adsorption during slick-water fracking operations?

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A typical fracking fluid used around the world would contain between 3 and 12 additives, sometimes up to 25 that are used for all manner of different reasons. In the UK, the first well to be fracked onshore in 2011 targeted the Bowland Shale in Lancashire and contained only two additives excluding sand proppant, an undisclosed salt and polyacrylamide (PAM). This basic fracking fluid is called a slick-water fluid. The polyacrylamide is used as a friction reducer. Friction reducers increase the viscosity of the fluid helping to confine the fluid pressure to attainable levels for the machinery involved. The presence of PAM also aids the addition and suspension of proppant, solid particles of sand or ceramic that hold the fractures open, and in turn reduces the turbulence downhole when fluid flows through small diameter fractures that are indicative slick-water operations. It is likely that PAM will be a major constituent of most fracturing fluids in the UK and so its affects downhole in relation to the shale and flowback fluid need to be investigated. To explore the behaviour of PAM in a shale fracking fluid, a series of batch experiments were performed. 13 samples (Bowland shale, overlying sandstone and underlying limestone) were collected from core samples and surface outcrops in the north of England. Initially adsorption experiments were performed on all chosen samples, and subsequently, an initial desorption experiment was performed on a sandstone and a shale to study how any adsorbed PAM would behave in a simulated post fracture flush.

• Adsorption isotherms were obtained for all 13 samples, 9 of which were shales, 3 sandstones and 1 limestone.
• Initial results show that in concentrations of PAM of 125 mg/L or less, up to 99% of PAM is adsorbed.
• In concentrations greater than 125 mg/L, no more than 45% of the polyacrylamide is removed by adsorption.
• All samples exhibit moderate to high levels of adsorption reminding us that we are dealing with a very adsorptive material.
• Initial desorption experiments suggest that of the PAM that is adsorbed, minimal amounts will desorb back into the flowback fluid during the flush stages of a hydraulic fracture.

These results imply that much of the PAM would be removed from the fluid, adsorbing to the shales and consequently diminishing its effectiveness in fracking operations. A lack of desorption during flushing operations means that the PAM is unlikely to be mobilised in to shallow aquifers.