NERC Centre for Doctoral Training in Oil & Gas (2017 start)

Project Title: Alternative anti-biofouling strategies: selecting the path of least resistance

Host institution: University of Strathclyde

Supervisor 1: Prof Vernon Phoenix

Supervisor 2: Prof Bob Kalin

Additional Supervisor (s): Dr Charles Knapp

Project description: Microbial activity in hydraulic fracturing (fracking) operations cause bio-clogging, hinder gas extraction, produce harmful hydrogen sulphide, and contribute to the corrosion of fracking equipment. As such, biocides are added to fluids to control microbial activity. Problematically, the composition of the fracking fluid, including the biocide, will ensure that over time the system selects for bacteria that flourish under these conditions. As a result, high concentrations of biocide are required to control these persistent organisms. This is a concern due to the potentially harmful impact of biocides in the environment.

This proposal aims to explore innovative strategies aimed to reduce (or eliminate) the need for biocide in fracking fluids. To begin with, the student will explore 2 key concepts. 1) based on successes in clinical settings, the student will examine the strategy of cycling antimicrobial agents (injecting different antimicrobials one after the other). This is inspired by strategies in the biomedical arena where cycling different antimicrobials has prevented the build-up of resistant strains of organisms, allowing less antimicrobials to be used. 2) advancing upon this, the student will look to work with the organisms (pro-biotics), rather than against them. By controlling the biogeochemical environment and its redox potential (through adjustment of fluid chemistry or addition of bio-stimulants) the student will explore how this can be used to control the organisms that grow, thus preventing the occurrence of problematic species.

The broad aim to reduce the need for antimicrobial agents ensures there is flexibility in the project for the student to develop their own ideas and drive their research programme. The student will explore the effectiveness of these approaches by monitoring microbial growth, community population and function, biofilm formation and bio-clogging. This will be achieved using state-of-the-art genomics, GC-MS analysis of microbial metabolites and electron and fluorescent microscopies. Experiments will be performed using our RCH Hassler Core holder facility to generate relevant high pressures and temperatures. By the end of the scholarship, we aim to provide new guidelines on controlling microbial communities to reduce the environmental impact of fracking. The project does not require access to third party or industry data for which approvals are required.

CDT Research theme(s): Effective production of unconventional hydrocarbons; Environmental Impact and Regulation

Research context: The student will work in the department's (£6M) state-of-the-art Environmental Chemistry and Microbiology Laboratories. The department has significant expertise in microbiology, fracking research and groundwater geochemistry ensuring the student will undertake their work with colleagues who can provide a highly supportive environment. Each PhD student is allocated their own personal work space (desk/computer) for the duration of their funding.

Research costs: Isocratic pump and plumbing (£5k) for high pressure rig. Consumables and sequencing costs for genomics (£4k), GC-MS analysis of metabolites (£3k), Microscopies (£1k). General laboratory consumables (£2k). Conferences & travel (£5k)

Career routes: The scholar will develop a strong grounding in environmental microbiology and biogeochemistry relevant to conventional and unconventional oil and gas (e.g. biofouling, bio-corrosion and souring), but also highly applicable to employment in any area of environmental remediation and assessment, relevant to regulatory authorities and environmental consultancies.