



NERC Centre for Doctoral Training in Oil & Gas (2018 start)

Project Title: Enhancing in-situ extraction technologies for heavy and shale oils, for improved oil recovery factor and reduced environmental impact.

Host institution: University of Birmingham

Supervisor 1: Prof. Joe Wood

Supervisor 2: Prof. Sean Rigby

Additional Supervisor (s):

Project description: To supply future energy demand the extraction of heavy oil, bitumen, shale gas and shale oil must be exploited. However the recovery of such reserves must be performed in a way to minimise the environmental impact, such as production of greenhouse gases and polluted water. The project will be based upon research on upstream in-situ combustion methods such as Toe-to-Heel Air Injection and its catalytic add-on CAPRI, which are key to reducing the use of external natural gas and water otherwise required for techniques such as steam based extraction. Limitations of deploying existing catalysts downhole include extensive coking and deactivation, which hinders their effectiveness such that the produced oil would require more refinery treatment. The project aims to increase the oil recovery and decrease emissions of the downhole process via a combination of improved characterisation of transport and reaction of nanomaterials in the environment of the porous rock matrix of the well, and optimising the efficiency of the recovery process. Specific aims of the work will be to: 1. Utilise in-situ catalyst preparation techniques in collaboration with the University of Nottingham to study the formation of catalysts from metal solutions based on iron and manganese within rock cores, perform core analysis on model cores injected with catalyst. 2. Study the conversion of heavy oil under well conditions over the prepared catalysts to determine the yield of liquid, coke and gas composition of produced gases. 3. To optimise the in-well conditions and heating technologies to minimise the production of greenhouse gases and energy input requirements. 4. To make an economic and environmental assessment of the required energy and produced gases, study critical events to assess environmental damage risk and compare with alternative extraction technologies. 5. To utilise reservoir simulations in collaboration with Nottingham to determine how the technologies could be implemented in the field.

CDT Research theme(s): The research is highly relevant to the theme **Effective production of unconventional hydrocarbons**, since the developed in-situ recovery methods are key to realising untapped reserves of heavy oil and shale oil. Understanding how in-situ recovery methods can be applied in the field to ensure minimal environmental impact requires solutions engineered to work with the geology of the reservoir. The techniques could also be applicable to **extending the life of wells in the North Sea**. The project will cover **environmental impact assessment** of the developed technologies.

Research context: The Birmingham-Nottingham team have been working on heavy oil extraction using THAI-CAPRI for 10 years, but more recently two NERC students (Claydon and Parker) have been studying the translation of metals found in the reservoir into catalysts that can reduce the amount of refinery treatment needed. The student will join a lively team of collaborators, the NERC students will retain distinction in terms of their study of the upstream and environmental aspects of the process in the context of reservoir geology.

Research costs: The RTSG will cover essential costs such as chemicals, gases, travel and conference attendance. Rigs and major equipment required for the project are provided via research grants between the collaborators, for example the £700K project EP/N032985/1.

Career routes: The trained students will be multidisciplinary, with background in Chemical Engineering or Chemistry and extensive training through the NERC CDT in oil and gas, thus will be highly attractive to oil companies such as BP, Shell, engineering contractors and academia.

Submissions must conform to this single-sided A4 format. The Awards Committee reserves the right not to consider submissions that do not adhere to this condition.