Ultrasonically Driven Flow in Porous Media for Tertiary Oil Recovery – An Experimental Study

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Munib and Angela Masri Institute of Energy and Natural Resources

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Abstract

Primary and secondary oil recovery methods used in oil field operations can leave behind as much as 40% to 70% of the original oil in place unattained. Ideas on the use of ultrasonic methods for tertiary recovery have been circulated for some time, particularly since ultrasonic waves can spontaneously result from natural phenomena such as earthquakes, and these have been linked to improved oil yields. The exact underlying physics behind the positive impact of ultrasound are not definitive, but a number of activities have been implicated such as cavitation, acoustic streaming, rock fracturing, and heat generation, to name a few. Yet, the common denominator in all these activities is the passage of a traveling sound pressure wave (length scale 1~10 cm) in a porous medium (rock formation), with the capillary pores (length scale 10~100 um) containing a viscous fluid (oil) or films/droplets thereof. In this proposal, we are interested in experimentally studying the physics of the stimulative effect in capillary tubes, characteristic of the fundamental micro-scale in petroleum formations, from ultrasonic excitation. In the proposed work laser flow visualization of the flow through engineered pores will be conducted. The pores (micro channels) will be manufactured from an optically clear, castable, high strength RTV rubber using a fine wire etching process and/or wire drawing process from the cured cast. Optical laser imaging for quantitative flow visualization (particle image velocimetry, PIV, and laser induced fluorescence) will provide insight into the ultrasonically induced mass transfer process through the porous medium and the underlying multiphase physical interactions. This work would add to the basic petroleum knowledge bank for eventual use in improving tertiary oil recovery methods, and it fits well within the Masri Institute priority area of oil exploration and recovery.