Elastic Waves: Applications of Elastic Wave Propagation in the Recovery of Depleted Oil Patches

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Currently, the average global efficiency of oil extraction is around 35%, leaving almost two thirds of the initial reserve unexploited. Using a theoretical modeling of a magnetostrictive actuator and a scaled down model, we tested the feasibility of using Mechanical Enhanced Oil Recovery (MEOR) techniques, focusing on elastic wave propagation to increase the rate at which we extract petrol form the ground. A theoretical model for a magnetostrictive actuator was developed, addressing it from three critical perspectives: optimal physical dimensions of the coil and core, premagnetization of the core and mechanically pre-stressing the core. The feasibility of this actuator was tested on a miniature scale, with a container of sand, a patch of raw petroleum and a piezoelectric crystal connected to an alternative current source for the wave generator. The study's findings reveal that for an length-to-diameter ratio of 5 for the coil, the coil must extend to at least 115% the length of the core to ensure that the magnetic field is at least 90% of its maximum value across the entire core length. Furthermore, a pre-stressing force between 500N and 600N was determined to be critical for achieving optimal core displacement. For the small-scale model, the application of vibrations from the piezoelectric crystal resulted in a significant increase in the displacement of the oil patch, jumping from 0.7 cm to 1.1 cm. This represents a 57% increase in relative displacement. The research showed the ideal dimensions and characteristics for a magnetostrictive actuator are and that the MEOR techniques for enhancing oil recovery are promising. Further research is needed to determine the results for a full-scale application of the project.

Awards Won:

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