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Application of ND: YAG laser to improve rock permeability and increase heavy oil recovery employing fuzzy logic

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The use of laser technology to recover heavy oil as well as to increase permeability, compared to the current techniques, without having any adverse effects on the reservoir productivity was examined in this research. This paper will present study results of the employment of pulsed (Q-switched) ND: YAG laser on impermeable heavy oil-bearing core samples which have been simulated as close as possible to the real reservoir conditions. It was observed that varying relaxation times of laser beams in this laser will yield positive and satisfactory results both for heavy oil flow as well as permeability. Optimum relaxation time to simultaneously experience the maximum permeability and heavy oil flow was achieved by examining a range of 8 relaxation times. Specifications of applied laser pulses and their associated beam properties, samples characteristics and dimensions and experiment environment in comparison with real reservoir conditions will be reported. Increasing the rock permeability in low permeable zones of the HC reservoirs by conventional methods will often cause formation damage and consequently will reduce the efficiency of recovery of the reservoirs. By applying the ND: YAG laser with the optimal beam relaxation time on samples from Burgan and Minagish reservoir samples, microfractures were produced and permeability increase of 10% - 180% was recorded due to induced high temperatures generated in the rock during lasing. This generated temperature also heavily affected the viscosity of the heavy oil resulting in an induced increase in fluid flow ranging from 7% - 12%. The twelve employed samples were selected from heavy-oil-bearing limestone reservoir rocks of Maaddud (9) and Minagish (3) within greater Burgan oil field. Relaxation times, lithological characteristics, depth at which samples were retrieved, RQD and PDPK were influencing factors to lasing outcomes, the effect of which, were normalized based on their contribution by employing fuzzy logic.

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Sustainable ways of oil refinery development via process integration

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Oil refining is an energy intensive production and depending on the degree of oil conversion, oil composition, the range and quality of products and other factors the reduced energy consumption by refineries is equivalent to 6–10% of refined oil. Reduction of energy resources in industry can be achieved by the wide implementation of modern energy saving technologies and the creation of highly efficient engineering complexes. Although this challenge is far from being new for the petrochemical industry, two factors appeared last time which attached special significance to energy saving and prompted the extension of the range of methods and devices used for this purpose. First, the rise in energy prices has encouraged more saving of energy to reduce total costs. Second, the rate of economic growth has significantly decreased and putting new plants into operation and implementation of new processes are difficult. Therefore, more and more attention has to be shifted towards increasing the efficiency of existing facilities. Heat Integration is a key tool for energy saving achieved by heat recovery in reprocessing industries. Energy saving has an important role in achieving a sustainable future development. Heat recovery at Process and Total Site levels provide a considerable potential for energy saving. Use of excess heat can give a way to reduce the use of primary energy and contribution to global CO₂ mitigation. Heat Integration is the main tool for industrial energy expertise, which provides the recommendation for decision makers during efficient retrofit, new concept design and strategy planning.

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