Emerging Petroleum-Oriented Nanotechnologies for Reservoir Engineering

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The paper describes experimental/theoretical research aimed at modification of petroleum technologies by accounting for molecular processes in nanocolloids of petroleum and industrial fluids.

This research principally differs from other works as (for the first time with respect to petroleum resources) it utilizes nanotechnological methods, approaches and models devised for other industrial applications (e.g. for microelectronics and biotechnology). The specifics of petroleum were accounted for by development of new experimental techniques, particularly sensitive to properties of petroleum nanocolloids.

Our experiments have shown that in course of traditional technological operations, macroscopic properties of petroleum media (viscosity, density, pour point, etc.) may exhibit abrupt changes caused by currently uncontrolled microscopic phase transitions in nanocolloids. E.g., petroleum fluids may practically solidify at RT as a result of a short-time temperature increase by 5-10^{0}C, petroleum emulsions' stability abruptly increases after variation of water cuts merely by 3-5%. Contrary to conventional assumptions, the current properties of petroleum nanocolloids (and, hence, the current properties of petroleum fluids) are not defined solely by current technological parameters. Of equal/decisive importance are the details of a preceding history of reservoir development. In particular, our experiments provided phase diagrams of petroleum nanocolloids, which show critical parameters, highly unfavorable for industrial processing of petroleum.

We conclude, that proper recovery technologies, which do not unfavorably upset the state of petroleum nanocolloids, should: 1) include re-optimization of a network of injection/producing wells at any particular reservoir; 2) include real-time control of current reservoir parameters; 3) account for specific "histories" of reservoir's temperature/pressure fields as well as for the "history" of composition variations in recovered petroleum. Moreover, emerging petroleum-oriented nanotechnologies are ecologically favorable as they do not require "strong" treatments of petroleum, such as employment of aggressive chemical substances, of active microbiological species or of high-intensity force fields.