Upgrading of Heavy Oil using Metal Nanoparticles by Catalytic Aquathermolysis: A Comprehensive Review

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Abstract

Heavy oil is known as the major energy of hydrocarbons in the 21st century as its reserves account for 40% of the total quantity of petroleum in the world. Extracting heavy oil is critical and challenging due to its high viscosity and low API gravity values, which results in large difficulties in production, extraction, and transportation. Thermal recovery techniques are the most common techniques implemented in heavy oil extraction, however, these techniques become uneconomical due to the mandatory requirement of adding proper diluents to the produced oil to gain enough mobility for transportation. Furthermore, the cost of pipelines troubleshooting due to asphaltene precipitation, also it is environmentally unfavorable due to high steam requirements.

In-Situ heavy oil upgrading by aquathermolysis has opened the way to overcome the aforementioned challenges. Aquathermolysis using nano-sized metal particles such as nickel, iron, and copper, has a dramatic effect on increasing heavy oil recovery. Aquathermolysis reactions result in irreversible lowering of heavy oil viscosity due to the change of its physical properties with a series of chemical reactions that dissociate C-S bond in the asphaltene. Consequently, leading to an increase in the light fractions of oil, and generation of H2S, CO2, H2, CO, CH4, and C2-C5 gases, that cause further reduction in the viscosity of oil.

This paper is to provide a comprehensive review of the conclusions of the most significant experimental work conducted to determine the most favorable nano-catalyst that will offer maximal viscosity reduction as well as the best material for asphaltene content reduction, in addition, the effect of different permeability values on recovery factor using constant concentration nanoparticle.