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Full Length Article

Mechanistic and kinetic insight into catalytic oxidation process of heavy oil in in-situ combustion process using copper (II) stearate as oil soluble catalyst

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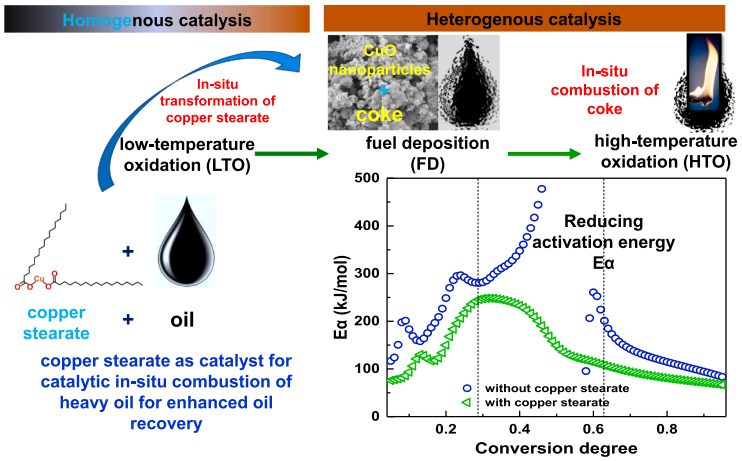
GRAPHICAL ABSTRACT



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ABSTRACT

In this study, copper (II) stearate was proposed as oil-soluble catalysts for catalyzing heavy oil oxidation in in-situ combustion (ISC) process to improve the efficiency of ISC for heavy oil recovery. Its catalytic mechanism and kinetics were deeply investigated by joint use of TG-FTIR, autoclave experiments, FESEM-EDX, and XPS, etc., together with isoconversional kinetic methods. We find that the addition of copper (II) stearate initiated both efficient homogenous and heterogenous catalytic oxidation/combustion process of heavy oil. In low-temperature range, copper (II) stearate (before its full decomposition) played a homogenous catalytic role in low temperature oxidation (LTO), and in high-temperature range, in-situ formed CuO nanoparticles (after the full decomposition of copper (II) stearate) played a heterogenous catalytic role in the formation and combustion process of fuel (coke-like residues) in fuel deposition (FD) and high temperature oxidation (HTO) stages. Specifically, the addition of copper (II) stearate significantly reduced the values of E_α of all reaction stages (LTO, FD, and HTO), especially at the later stage of LTO, FD and the beginning of HTO (the maximum values of E_α were decreased from about 500–600 KJ/mol to 300–400 KJ/mol), decreased the energy required to overcome reaction barriers,

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