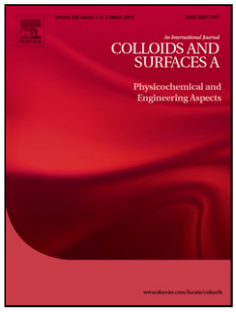

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Experimental Investigation of the Inhibitory Behavior of Metal Oxides Nanoparticles on Asphaltene Precipitation

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Graphical abstract

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Highlight

- Metal oxide nanoparticles inhibited asphaltene precipitation to a large extent.
- Nanoparticles with acidic chemical nature had greater effect on stability of asphaltenes.
- Asphaltene precipitated amount reduced in presence of nanoparticles.
- Increased in amount of nanoparticles led to enhance in asphaltene's stability.
- Increased in asphaltene concentration reduced the strength of nanoparticles.

ABSTRACT: Asphaltene deposition is one of the problematic aspect of petroleum industry, which imposes serious operational damage and cost. Adhering to reservoir rocks and consequently obstruction of their pores, blockage of pipelines, and make fouling in process equipment such as pumps is part of serious difficulties which are occurred by deposition of asphaltene. Many investigations have been performed to inhibit asphaltene deposition using inhibitors, which not only show high efficiency in suppressing asphaltene precipitation but also they are compatible with the environment. In accordance to this purpose, in this research, the effect of Fe_3O_4, NiO and γ-Al_2O_3 metal oxide nanoparticles was experimentally investigated on the synthetic oil in order to mitigate the risk associated with asphaltene deposition and postpone the onset of asphaltene precipitation. It was concluded that the aforementioned metal oxide nanoparticles were effective on suppressing the onset point and reducing the amount of precipitated asphaltene. The best results were obtained for γ-Al_2O_3 nanoparticles with 0.1 wt. % which it was attributed to its acidity chemical nature as well as high ratio of specific surface area. The NiO metal oxide nanoparticles exhibited a good operation though not to the same extent as γ-Al_2O_3.The poor results were related to Fe_3O_4 metal oxide nanoparticles with 0.01 wt. %. It was concluded that the metal oxide nanoparticles with more Bronsted acid sites in their structures were more capable to have a polar interaction with asphaltenes and consequently could suppress the precipitation process.

Keywords: asphaltene precipitation; asphaltene inhibitor; metal oxide nanoparticles; indirect technique;

1. Introduction

Asphaltenes are well-known as the most polar and heaviest fraction of the crude oils. Their structures are very complicated and contained tens of aromatic's rings along with heteroatoms like oxygen, nitrogen and sulfur[2]. According to the solubility, they are known as the components that can be dissolved in aromatics fluids, such as toluene and are insoluble in normal paraffins such as n-heptane[1, 3]. Under customary conditions (i.e. constant pressure, temperature and concentration), asphaltenes are in thermodynamic equilibrium with maltens in crude oil. With the variation of each of the thermodynamic parameters such as temperature, pressure and components of crude oil, the thermodynamic equilibrium is disordered and leads to asphaltene inconstancy[4-6]. This instability causes precipitation and then deposition of asphaltenes. Separation of asphaltenes from the crude phase and formation of fouling, can generate operational problems throughout the oil industries. The deposition of asphaltenes can obstacle the pores of reservoir's rock and ceased the production operation[7, 8]. Moreover,