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SYNTHESIS OF ZINC OXIDE NANOPARTICLES FOR WAX DEPOSITION CONTROL AND OIL UPGRADING: EFFECT OF DRYING TEMPERATURE

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ABSTRACT

Wax deposition becomes a major problem in the transportation of crude oil. During the transportation and production also they encounter problem due to the characteristic of the crude oil which was high specific gravity and high viscosity. Therefore, to encounter the problems occurred, nanotechnology had been introduced by performing synthesis of zinc oxide (ZnO) nanoparticles using sol-gel method. To obtain an efficient result in overcome the problems, an optimum drying temperature during the synthesized was investigated since it gave different sizes of nanoparticles. Hence, synthesized of ZnO nanoparticles using sol-gel method were performed and the drying temperature was varied from 80ºC to 200ºC to identify which temperature gave smaller size of nanoparticles as the smaller size gave better reduction in viscosity. By varying the drying temperature during the synthesized of ZnO nanoparticles also can show its effect to the surface morphology. Then, the crystalline phase and size of the ZnO nanoparticles were determined using X-ray Diffraction (XRD) and the surface morphology by using Field Emission Scanning Electron Microscopy (FE-SEM). While for the elemental composition determined using energy dispersive X-ray spectroscopy (EDX) shows that the nanoparticles contain Zinc (Zn) and Oxygen (O) only. As for the oil upgrading, the ZnO nanoparticles had been used as the viscosity reducer at different sizes, different shear rate and temperature using electronic rheometer and it shows that the smaller size of nanoparticles which is 10.87nm gave the highest viscosity reduction with range 50%. Also, for wax deposition, the smaller size of ZnO nanoparticles gave the higher percentage of ZnO efficiency and reduces more wax compared to bigger size with efficiency 78%. Therefore, the oil upgrading can be done by the addition of ZnO nanoparticles and the 200ºC of drying temperature gave the greatest effect.

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INTRODUCTION

1.1 RESEARCH BACKGROUND

Crude oil is a complex mixture of hydrocarbons which consist of asphaltenes, waxes, resins, aromatics and naphthenics. Out of these mixtures, one of them which is wax deposition is a major problem in oil productions and transportations facilities where give many problems towards the production such as decrease the production rates (Behbahani, Akbar, Beigi, Taheri, & Ghanbari, 2015). According to the statistical analysis of 69 different oil fields in 19 countries, 59 oil fields in 18 countries shows that wax deposition problem is a serious matter and it is found that the paraffinic waxes tend to precipitate when the temperature is below wax appearance temperature (WAT) during the crude oil production, transportation and storage (Li, Zhu, Liu, & Zhai, 2013). They also start to precipitate once the stability of the colloidal suspension, where the asphaltene tend to remain in, is destabilized which caused by the changes in pressure and temperature (Ahmed, Flow Assurance, 2007).

These wax precipitation will increase fluid viscosity and prevent the fluid from flowing through equipment and pipelines, thus reduce the effective flow cross-section of pipeline, increase delivery pressure and also cause the plugging (Li et al., 2013). Therefore, different prevention and removing wax methods have been approach to improve the situation and divided into three categories such as thermal, chemical, and mechanical treatment techniques (Thota & Onyeanuna, 2016). For the thermal technique, hot oiling is the most popular methods of deposit wax removal in flow lines and downhole where hot oil heated to a temperature above melting point for wax and then pumped into the well which normally through annular space (Thota & Onyeanuna, 2016).

However, this technique cannot be used in subsea flow lines because of extremely high cost of heating the oil and can cause permeability damage if the melted wax flow into the formation (Thota & Onyeanuna, 2016). While for chemical technique, the use of chemical inhibitors has being in demand due to number of chemicals with paraffin inhibition properties (Coto, Martos, Espada, Robustillo, & Peña, 2014). Despite the inhibition properties, the inhibitors are not showing the same