UNIVERSITI TEKNOLOGI MARA

# SYNTHESIS ZINC OXIDE NANOPARTICLES FOR OIL UPGRADING AND WAX DEPOSITION CONTROL: EFFECT ON CALCINATION TEMPERATURE

FATIN SYAHIRAH BINTI MOHAMED FUAD

B.Eng (Hons.) Oil & Gas

July 2018

# ABSTRACT

Deposition waxes in the heavy crude oil was a major problem with the enormous impact on production, transportation and economic growth in petroleum industry. Deposition of waxes started to precipitate at lower temperature along the pipeline because wax solubility is decreased. Many tools and chemical was developed to remove wax build up on the internal wall of the pipeline such as pigging. However, there was a potential risk in the usage of pigging due to detailed selection of the correct pig for each pipeline and larger time consuming is required. Therefore, Zinc Oxide (ZnO) nanotechnology was used to study the effect on addition ZnO in the heavy crude oil. In this study, ZnO nanoparticles were synthesized by using Sol-gel method to study the effect on oil upgrading and deposition control by varying the calcination temperature from 300°C to 900°C. Basically the calcined ZnO nanoparticles were characterized using X-ray diffraction (XRD), Field Emission Scanning Electron microscope (FESEM), and Energy-dispersive X-ray spectroscopy (EDX) in order to comprehend its structure, size, shape and morphology. XRD results approve the formation of hexagonal wurtzite structure of the ZnO nanoparticles. Decrease in crystallite size from 15.59 nm to 12.84 nm is observed with increasing calcination temperature. However, the crystallite size tends to increase from 12.84 nm to 41.58 nm with increasing calcination temperature. The degree viscosity reduction (DVR %) of heavy crude oil was observed to increase by 41.7% with decreasing ZnO nanoparticles size from 30.11 nm to 12.84 nm. The optimum calcination temperature was observed at 400°C. Wax deposition decrease by 32.40% after addition of ZnO nanoparticles into heavy crude oil.

# ACKNOWLEDGEMENT

Firstly, I wish to thank God for giving me the opportunity to embark on my degree and for completing this long and challenging journey successfully. My gratitude and thanks go to my supervisor, Madam Siti Nurliyana bt Che Mohamed Hussein for the support, patience and ideas in assisting me with this project. I would like to express my gratitude to the staff of the Faculty of Chemical Engineering for providing the facilities, knowledge and assistance.

My appreciation also goes to my colleagues and friends for helping me with this project.

Finally, this thesis is dedicated to the loving memory of my very dear late father and mother for the vision and determination to educate me. This piece of victory is dedicated to both of you.

# TABLE OF CONTENT

# CHAPTER ONE
# INTRODUCTION

## 1.1 Research Background

Crude oil was the main of resource energy our worldwide industry. It has been used in many variations of uses in our daily life and for energy carriers such as gasoline and diesel. Wax deposition always becomes a major problem to the flow assurance for oil and gas production and transportation. Wax deposition may be caused by various factors, for instance reduction of temperature along the pipeline and pressure drop at subsea pipeline. Those conditions made wax precipitation more favourable to produce. Serious wax deposition needs extra attention since it may cause harm especially in deep-water oil production such as abandonment of pipeline or production facilities and blockage in pipeline which tend to prevent crude oil to flow in the pipeline. There were many advanced technology and chemical inhibitor for wax deposition control that rapidly developed in this industry such as pigging and polymeric wax inhibitors. However, the application of pigging and inhibitors sometimes give a lot of disadvantages. Hence, it has become a major attention nowadays to reduce or control wax precipitate from the heavy crude oil, to avoid its bad effect on oil transportation and production.

The composition of heavy crude oil was the main reason of major contribution for wax deposition in the heavy crude oil. Wax produced from the heavy crude oil consists of long chain of saturated hydrocarbons such as n-paraffins(Onyeanuna 2017) which it can be either straight or branched hydrocarbon chains. This wax also referred as macrocrystalline wax which practically leads to wax paraffin problems in heavy crude oil. Basically, wax start to form insoluble crystal in the heavy crude oil when temperature of the crude oil decrease below the low-molecular-weight hydrocarbon vaporize. Moreover, wax appearance temperature (WAT) defined as temperature where the first wax crystal begins to precipitate out from the heavy crude oil and it also known as cloud point(Vazquez and Mansoori 2000).

Insoluble crystal was started to deposit around the pipeline and caused the problem to production and transportation. However, paraffin wax deposition was not only affected the deep-water oil production, but also caused the viscosity of the heavy