

**INVESTIGATING PRECIPITATION KINETICS OF
ASPHALTENES FROM CRUDE OIL**



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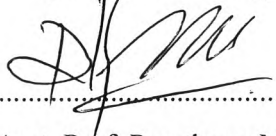
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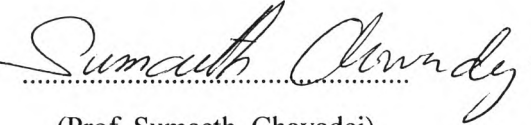
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ABSTRACT

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The precipitation of asphaltenes from crude oil can lead to serious problems in oil production and processing, such as plugged pipelines and process equipment. To better understand the properties responsible for asphaltene precipitation, this research focused on investigating precipitation behaviour of different crude oils. n-Heptane was used as a precipitant to induce asphaltene instability before fractionation. Several techniques of characterization were used to investigate the properties of precipitated asphaltenes precipitated at different times and precipitant concentrations. Small angle X-ray scattering (SAXS), nuclear magnetic resonance (^1H and ^{13}C NMR), elemental analyzer (EA) and inductively coupled plasma mass spectrometry (ICP-MS) were then used to assess the properties of asphaltenes for different cuts such as size of nanoaggregates, structural parameters (aromaticity and number of carbon per alkyl side chain), heteroatoms and metal contents, respectively. The results showed that the asphaltene precipitation rate for all crude oils investigated was controlled both by thermodynamics and diffusion process ($(\delta_{\text{asph}} - \delta_{\text{solution}})^2 / \mu_{\text{solution}}$). Except cut 1, the asphaltenes precipitated firstly had higher heteroatoms and metal contents but less number of carbons per alkyl side chain because more polar fractions could induce asphaltenes to precipitate easily. The nanoaggregate sizes and aromaticity for different cuts were similar. This understanding may help better predict the instability of asphaltenes under different operational conditions and develop proper remediation techniques.

บทคัดย่อ

เพ็ญญา มาศิริสุข: การสังเกตการตกตะกอนของแอสฟัลทีนจากน้ำมันดิบ (Investigating Precipitation Kinetics of Asphaltenes from Crude Oil) อาจารย์ที่ปรึกษา: ศ. ดร. เอช สก๊อตต ฟอกเลอร์ และ ผศ. ดร. ปมทอง มาลากุล ณ อยู่ชยา 70 หน้า

การตกตะกอนของแอสฟัลทีนจากน้ำมันดิบสามารถก่อให้เกิดปัญหาในกระบวนการผลิตน้ำมันดิบ เช่น การอุดตันของท่อและอุปกรณ์ในกระบวนการผลิต การวิจัยนี้จึงมุ่งเน้นการศึกษาพฤติกรรมของการตกตะกอนของน้ำมันดิบชนิดต่างๆ เพื่อให้เข้าใจคุณสมบัติของแอสฟัลทีนที่มีผลต่อการตกตะกอน โดยใช้ไนอร์มัลเฮปเทนเป็นสารตกตะกอนที่ชักนำการเกิดความไม่เสถียรของแอสฟัลทีนขึ้นเพื่อให้แอสฟัลทีนตกตะกอน เทคนิคการวิเคราะห์หลายเทคนิคถูกใช้เพื่อศึกษาคุณสมบัติของแอสฟัลทีนที่ตกตะกอนที่เวลาและความเข้มข้นของสารตกตะกอนแตกต่างกัน อาทิ เช่น เทคนิคการกระเจิงแสงรังสีเอ็กซ์, นิวเคลียร์แมกเนติกเรโซแนนซ์, การวิเคราะห์เคมีอินทรีย์ และอินดักทีป्ली คัปเปิลพลาสมา-แมสสเปกโตรเมตรี เพื่อศึกษาคุณสมบัติเช่น ขนาดของตะกอนแอสฟัลทีน, ความเป็นอะโรมาติก, จำนวนคาร์บอนในสายโซ่อัลคิล, ปริมาณเคมีอินทรีย์ และปริมาณโลหะในตะกอนแอสฟัลทีนตามลำดับ จากการทดลองพบว่า อัตราเร็วในการตกตะกอนของแอสฟัลทีนของน้ำมันดิบทุกชนิดถูกควบคุมโดยอุณหภูมิและกระบวนการแพร่ $((\delta_{\text{asph}} - \delta_{\text{solution}})^2 / \mu_{\text{solution}})$ ยกเว้นคัท 1 ตะกอนแอสฟัลทีนที่ตกตะกอนก่อนมีปริมาณเคมีอินทรีย์ และโลหะสูงกว่า แต่มีจำนวนคาร์บอนในสายโซ่อัลคิลต่ำกว่า เพราะว่าความมีขั้วที่สูงกว่าชักนำแอสฟัลทีนให้ตกตะกอนง่ายขึ้น และยังพบว่า ขนาดของตะกอนแอสฟัลทีนและความเป็นอะโรมาติกมีความคล้ายคลึงกันสำหรับแอสฟัลทีนที่ตกตะกอน ณ เวลาและความเข้มข้นของสารตกตะกอนแตกต่างกัน การวิจัยนี้อาจช่วยให้สามารถคาดการณ์เสถียรภาพของแอสฟัลทีนที่สภาวะที่แตกต่างกัน ได้ดีขึ้นและพัฒนาแนวทางการแก้ปัญหาได้ต่อไป

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