

**STUDY OF TEMPERATURE DEPENDENCE ON MERCURY SOLUBILITY  
IN CONDENSATE/CRUDE OIL: PART II CYCLIC ALIPHATIC AND  
AROMATIC HYDROCARBONS**

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**ABSTRACT**

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Mercury is one of the contaminants in geological hydrocarbons and causes the serious problems in processing. Temperature is among the most important factors affecting the mercury solubility in petroleum. To better understand its behavior, this study focused on determining the mercury solubility of elemental mercury in each hydrocarbon categorized by cyclic aliphatic (cyclohexane and methylcyclohexane) and aromatic hydrocarbons (toluene, *o*-xylene and ethylbenzene) at increasing temperature in the range of 5 to 40 °C. The study also included decreasing the temperature within the same range to examine the hysteresis. Apart from single solvent systems, the actual crude oil simulated by mixtures of hydrocarbon types was also studied. The mercury analyzer (NIC, SP-3D) consisted of a two-step gold amalgamation and atomic absorption spectrometry was used to determine the mercury solubility. The detection limit of NIC is 5 ppb. For each hydrocarbon, it was found that the solubility varied from 180 to 2500 ppb, depending on types of hydrocarbons. The mercury solubility of simulated crude oil varied from 240 to 1500 ppb, and lied close to that of *n*-decane, and became high at higher temperature. For the hysteresis study, the mercury solubility showed the hysteresis in aromatic hydrocarbons and the simulated crude oil. Solubility of mercury in ethylbenzene showed an abnormal behavior, possibly due to formation of organomercury compound which requires further investigation.

## บทคัดย่อ

ปิยะ กิตติชัยชนะ : การศึกษาการละลายของปรอทในคอนเดนเซทและน้ำมันดิบที่ขึ้นอยู่กับอุณหภูมิ ตอนที่ 2: สารไฮโดรคาร์บอนโครงสร้างแบบวงอะลิฟาติกส์และอะโรแมติกส์ (Study of Temperature Dependence on Mercury Solubility in Condensate and Crude Oil: Part II Cyclic Aliphatic and Aromatic Hydrocarbons) อ.ที่ปรึกษา : รศ. ดร. จินตนา สายวรรณ, รศ. กัญจนา บุญเกียรติ และดร. ศิริพร จงภาควิณี 75 หน้า ISBN 974-993-748-1

ปรอทเป็นโลหะปนเปื้อนชนิดหนึ่งในปิโตรเลียมและก่อให้เกิดปัญหาในกระบวนการผลิตที่เกี่ยวข้องกับปิโตรเลียม โดยอุณหภูมิเป็นปัจจัยสำคัญต่อการละลายของปรอทในปิโตรเลียม ในการศึกษาเน้นการศึกษาการละลายของธาตุปรอทในสารไฮโดรคาร์บอน เพื่อให้เข้าใจพฤติกรรมละลายในจำพวกสารไฮโดรคาร์บอนโครงสร้างแบบวงอะลิฟาติกส์ (ไซโคลเฮกเซนและเมทิลไซโคลเฮกเซน) และอะโรแมติกส์ (โทลูอิน, ออโทไซลีนและเอทิลเบนซีน) ที่ช่วงอุณหภูมิ 5 ถึง 40 องศาเซลเซียส ทั้งการละลายด้วยการเพิ่มอุณหภูมิและลดอุณหภูมิในช่วงเดียวกัน ด้วยเพื่อที่จะตรวจสอบ ฮิสเทอรีซิส นอกจากนี้ ได้ศึกษาการละลายของธาตุปรอทในสารผสมไฮโดรคาร์บอนหรือน้ำมันดิบจำลองโดยใช้เครื่องมือที่ใช้วิเคราะห์ปรอท เอ็นไอซี รุ่น เอสพี-3 ดี ซึ่งใช้เทคนิคการเกิดอะมัลกัมกับทอง 2 ชั้นคอนและเทคนิคอะตอมมิกแอบซอร์ปชันสเปกโตรเมทรี วัดค่าการละลายของปรอท ที่ขีดจำกัดของการวัดคือ 5 ส่วนในพันล้านส่วน จากการศึกษาพบว่าการละลายของปรอทในสารไฮโดรคาร์บอนนั้น อยู่ในช่วง 180 ถึง 2500 ส่วนในพันล้านส่วน ซึ่งขึ้นอยู่กับประเภทของสารไฮโดรคาร์บอน และการละลายในน้ำมันดิบจำลองมีค่าการละลายอยู่ในช่วง 240 ถึง 1500 ส่วนในพันล้านส่วนและใกล้เคียงกับค่าการละลายในนอร์มัลเคเคนและมีค่าสูงขึ้นที่อุณหภูมิสูง ส่วนการศึกษาฮิสเทอรีซิสนั้น พบว่า การละลายในสารอะโรแมติกส์และน้ำมันดิบจำลองเกิด ฮิสเทอรีซิส ส่วนการละลายปรอทใน เอทิลเบนซีน แสดงพฤติกรรมละลายที่ผิดปกติ มีความเป็นไปได้ที่จะเกิดสารปรอทอินทรีย์ซึ่งต้องมีการศึกษาเพิ่มเติมต่อไป

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4.22 Comparison of mercury solubility at decreasing temperature at the temperature range of 5-40°C

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## LIST OF SYMBOLS

$\delta$	The solubility parameter (MPa) <sup>1/2</sup>
$\Delta U$	The molar internal energy of vaporization (J/Mol)
$V$	The molar volume (cm <sup>3</sup> /mol)
$\delta_t$	The total solubility parameter
$\delta_d$	The dispersive component solubility parameter
$\delta_p$	The polar component solubility parameter
$\delta_h$	The hydrogen bonding component parameter
$\bar{\delta}$	The effective solubility parameter
${}^i\delta$	The solubility parameter of component i
${}^j\delta$	The solubility parameter of solute j
${}^i\phi$	The molar volume fraction of component i in total j component
${}^iV$	The molar volume of component i (cm <sup>3</sup> /mol)
${}^jV$	The molar volume of component j (cm <sup>3</sup> /mol)
${}^ix$	The mole fraction of component i
${}^jx_s$	The mole fraction solubility of j in i
R	Gas constant (cm <sup>3</sup> MPa/mol K)
T	Absolute temperature (K)