

**OILY WASTEWATER TREATMENT BY CONTINUOUS FROTH  
FLOTATION**



**Sunisa Watcharasing**

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**By:** Sunisa Watcharasing  
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**Thesis Advisors:** Assoc.Prof. Sumaeth Chavadej  
Prof. John F. Scamehorn

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Accepted by the Petroleum and Petrochemical College, Chulalongkorn University, in partial fulfilment of the requirements for the Degree of Doctor of Philosophy.

.....*Nantaya Yanumet*..... College Director  
(Assoc. Prof. Nantaya Yanumet)

**Thesis Committee:**

*Sumaeth Chavadej*  
(Assoc. Prof. Sumaeth Chavadej)

*John Scamehorn*  
(Prof. John F. Scamehorn)

.....*Thirasak Rirksomboon*.....  
(Assoc. Prof. Thirasak Rirksomboon)

*B. Kitiyanan*  
(Asst. Prof. Boonyarach Kitiyanan)

*Anchaleeporn W. Lothongkum*  
(Assoc. Prof. Anchaleeporn Waritswat Lothongkum )

## บทคัดย่อ

สุนิสา วัชรสิงห์ : กระบวนการบำบัดน้ำเสียที่มีน้ำมันโดยระบบทำให้ลอยแบบต่อเนื่อง (Oily Wastewater Treatment by Continuous Froth Flotation) อ. ที่ปรึกษา: รศ. ดร. สุเมธ ชวเดช และ ศ. ดร. จอห์น เอฟ สเคอร์มีฮอร์น 135 หน้า

ในงานวิจัยนี้ได้พัฒนากระบวนการทำให้ลอยแบบต่อเนื่องเพื่อกำจัดน้ำมันที่ปนเปื้อนอยู่ในน้ำเสียอุตสาหกรรม สารลดแรงตึงผิวชนิดยีสต์ ( $C_{14-15}(PO)_5SO_4Na$ ) ถูกนำมาทำให้เกิดไมโครอิมัลชันกับน้ำมันดีเซล ในกระบวนการทำให้ลอยแบบต่อเนื่อง โดยได้พิจารณาศึกษาถึงปัจจัยต่างๆ ได้แก่ ความเข้มข้นของสารลดแรงตึงผิว ความเข้มข้นของโซเดียมคลอไรด์ สัดส่วนโดยปริมาตรของน้ำมันต่อน้ำในน้ำเสีย ความสูงของฟอง อัตราการเป่าอากาศ และเวลาที่เก็บกัก โดยหาความสัมพันธ์แรงตึงผิวและลักษณะสมบัติของฟองกับประสิทธิภาพการแยกน้ำมันพบว่าระบบ  $C_{14-15}(PO)_5SO_4Na$  อย่างเดียวไม่สามารถได้ค่าแรงตึงผิวที่ต่ำที่สุดและการเกิดฟองที่ดีพร้อมกันได้ ดังนั้นจึงมีการเติมสารลดแรงตึงผิวโซเดียมโดเดซิลซัลเฟต (SDS) เพื่อช่วยเพิ่มความเสถียรของฟอง โดยกระบวนการทำให้ลอยแบบต่อเนื่องมีประสิทธิภาพการแยกน้ำมันดีเซลสูงสุดร้อยละ 96 ที่ความเข้มข้นของ  $C_{14-15}(PO)_5SO_4Na$  ร้อยละ 0.1 โดยมวล, ความเข้มข้นของ SDS ร้อยละ 0.5 โดยมวล และความเข้มข้นของเกลือร้อยละ 4 โดยมวล เพื่อเพิ่มความเสถียรของฟองของระบบสารลดแรงตึงผิว  $C_{14-15}(PO)_5SO_4Na$  ตัวเดียวโดยไม่ต้องมีการเติมสารลดแรงตึงผิวโซเดียมโดเดซิลซัลเฟต ได้นำคอลลอยคอลล์แก๊สแอฟรอน (CGA) ซึ่งมีความเสถียรค่อนข้างสูงมาทดลองกับกระบวนการทำให้ลอยแบบกะ โดยทำการศึกษาปัจจัยของความเค็ม ความเข้มข้นสารลดแรงตึงผิว ความเร็วในการปั่นและระยะเวลาในการกวน เพื่อหาสภาวะที่เหมาะสมที่มีผลต่อการสร้าง CGA ซึ่งได้นำไปทดลองต่อในส่วนของการทำให้ลอย จากผลการทดลองพบว่า การใช้คอลลอยคอลล์แก๊สแอฟรอนสามารถส่งเสริมประสิทธิภาพการแยกของกระบวนการทำให้ลอยได้ ประสิทธิภาพการกำจัดน้ำมันสูงที่สุดเท่ากับร้อยละ 97 ที่อัตราการเป่าอากาศ 0.30 ลิตรต่อนาทีโดยสารละลายที่ป้อนเข้าเป็นแบบสภาวะที่ยังไม่เกิดสมดุลของระบบ และสภาวะของคอลลอยคอลล์แก๊สแอฟรอนที่ความเข้มข้น  $C_{14-15}(PO)_5SO_4Na$  ร้อยละ 0.1 โดยมวล, ความเข้มข้นของเกลือร้อยละ 3 โดยมวล, ความเร็วในการกวน 5,000 รอบต่อนาที และระยะเวลาในการกวน 5 นาที

## ABSTRACT

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In this work, continuous froth flotation was developed to remove emulsified oil from industrial wastewater. Branched alcohol propoxylate sulfate sodium salt ( $C_{14-15}(PO)_5SO_4Na$ ), an extended surfactant, was used to form microemulsions with diesel oil. In the continuous froth flotation operation, the effects of operational parameters, including surfactant concentration, salinity, oil-to-water ratio, foam height, air flow rate and hydraulic retention time (HRT) were investigated to correlate the oil removal efficiency with interfacial tension (IFT) and foam characteristics. For the  $C_{14-15}(PO)_5SO_4Na$  system, it was not possible to obtain both ultralow IFT and good foaming. Hence, sodium dodecyl sulfate (SDS) was added to enhance the foam stability. A maximum diesel oil removal of 96% was accomplished by this continuous froth flotation at 0.1 wt.%  $C_{14-15}(PO)_5SO_4Na$ , 0.5 wt.% SDS, and 4 wt.% NaCl. In order to improve the foam stability of the sole  $C_{14-15}(PO)_5SO_4Na$  system without added SDS, colloidal gas aphron (CGA), which exhibits relatively high stability, was employed in a batch froth flotation unit. The effects of salinity, surfactant concentration, stirring speed, and stirring time were investigated for determining the optimum conditions of the CGA formation, which were further used for the froth flotation experiments. From the results, the use of CGA enhanced the separation performance of froth flotation. The highest diesel removal of 97% was achieved at an air flow rate of 0.30 l/min with the feed solution prepared under non-equilibrium and CGA conditions of 0.1 wt.%  $C_{14-15}(PO)_5SO_4Na$ , 3 wt.% NaCl with a stirring speed of 5,000 rpm and a stirring time of 5 min.

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