

**SURFACTANT ADSORPTION ON SOLID SURFACES IN RELATION TO
WETTABILITY**

Thritima Sritapunya

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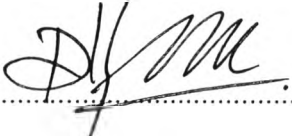
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By: Thritima Sritapunya
Program: Petrochemical Technology
Thesis Advisors: Prof. Sumaeth Chavadej
Prof. John F. Scamehorn
Prof. Brian P. Grady


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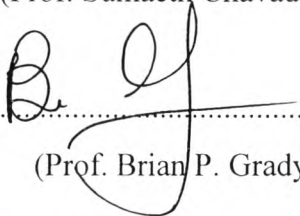

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Thesis Committee:

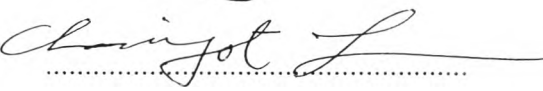

.....
(Asst. Prof. Pomthong Malakul)


.....
(Prof. Sumaeth Chavadej)


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


.....
(Prof. Brian P. Grady)


.....
(Assoc. Prof. Pramoch Rangsunvigit)


.....
(Prof. Chaiyot Tangsathitkulchai)

ABSTRACT

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The main propose of the first part of this research was to investigate the relation of surfactant adsorption and wettability on various hydrophobic surfaces. Surface tension was measured as a function of surfactant concentration for three cationic and three anionic surfactants. In addition, advancing contact angles and surfactant adsorptions on eight polymers were measured. Thus, a mathematical analysis was developed by using Zisman's equation to calculate the interfacial tensions at solid/vapor (γ_{SV}) and solid/pure water (γ°_{SL}), which are rarely directly measured. γ_{SV} was found to be 33.3 mN/m and to not depend on polymer structure. From the surfactant adsorption isotherms on polymer surfaces carried out by the solution depletion method with varying the solution pH, the surfactant adsorption increased with the surfactant tail length for both cationic and anionic surfactants below these CMCs. Whereas sodium octanoate (C8) adsorption was highest at plateau region due to less polarity of carboxylate group. The pH level only slightly affected the adsorption level. Finally, the fundamental mechanism of flotation deinking was studied by using a hydrophobic carbon black and a hydrophilic office paper. Sodium dodecyl sulphate (SDS) and C8 were chosen for adsorption in this study. The adsorption of C8 onto carbon black is higher than that of SDS, resulting to the wide use of C8 surfactant in flotation deinking operations. Moreover the calcium is used as the effective activator since it can improve surfactant adsorption on carbon black, while not enhancing surfactant adsorption on paper fiber that will be easily removed with carbon black in flotation process.

บทคัดย่อ

ธฤติมา ศรีตะปัญญะ: การดูดซับสารลดแรงตึงผิวบนพื้นผิวของของแข็งที่มีความสัมพันธ์ต่อความสามารถในการเปียก (Surfactant Adsorption on Solid Surfaces in Relation to Wettability) อ. ที่ปรึกษา: ศ. ดร. สุเมธ ชวเดช ศ. ดร. จอห์น เอฟ. สแกมเมอร์สัน และ ศ. ดร. ไบรอัน พี. แกรดี 134 หน้า

จุดประสงค์หลักในส่วนแรกของงานวิจัยนี้คือ การศึกษาความสัมพันธ์ระหว่างการดูดซับสารลดแรงตึงผิวและความสามารถในการเปียกผิวบนของแข็งที่ไม่ชอบน้ำชนิดต่างๆ แรงตึงผิวถูกวัดเป็นฟังก์ชันกับความเข้มข้นของสารลดแรงตึงผิวชนิดขั้วบวก 3 ชนิดและขั้วลบ 3 ชนิด นอกจากนี้ มุมของการเปียกแบบก้าวหน้าและการดูดซับสารลดแรงตึงผิวบนพื้นผิวของพอลิเมอร์ที่มีความไม่ชอบน้ำแตกต่างกัน 8 ชนิด ยังได้ถูกวัดด้วย การวิเคราะห์เชิงคณิตศาสตร์จึงได้ถูกพัฒนาขึ้นโดยใช้สมการของ Zisman เพื่อคำนวณหาค่าแรงตึงผิวระหว่างผิวของแข็ง/อากาศ และระหว่างผิวของแข็ง/น้ำบริสุทธิ์ ซึ่งไม่สามารถวัดได้โดยตรง ซึ่ง ค่าแรงตึงผิวระหว่างผิวของแข็ง/อากาศพบว่ามีค่า 33.3 มิลลินิวตันต่อเมตร และค่านี้ไม่ขึ้นอยู่กับโครงสร้างของพอลิเมอร์ จากผลการดูดซับสารลดแรงตึงผิวบนพอลิเมอร์วัดโดยวิธี solution depletion ที่ค่าความเป็นกรด-ด่างต่างๆ พบว่าการดูดซับสารลดแรงตึงผิวบนผิวของพอลิเมอร์สูงขึ้นเมื่อสารลดแรงตึงผิวทั้งชนิดขั้วบวกและลบมีความยาวของส่วนหางยาวมากขึ้นที่ความเข้มข้นต่ำกว่า CMC ขณะที่โซเดียมออกตาโนเอต (C8) สามารถดูดซับได้สูงสุดในช่วงการดูดซับคงที่ เนื่องจากจากส่วนหัว (คาร์บอกซิลเลต) มีขั้วต่ำกว่า ส่วนระดับของความเป็นกรด-ด่างนั้นมีผลเพียงเล็กน้อยต่อการดูดซับ

ในส่วนสุดท้าย กลไกพื้นฐานของการกำจัดหมึกแบบลอยถูกศึกษาโดยการใช้ผงถ่านที่ไม่ชอบน้ำ และกระดาษสำนักงานที่ชอบน้ำ ซึ่งโซเดียมโดเดคซิลซัลเฟต (SDS) และ C8 ถูกเลือกใช้ในการศึกษาการดูดซับ การดูดซับของ C8 บนผิวของผงถ่านสูงกว่าการดูดซับของ SDS เป็นผลให้ C8 ถูกใช้อย่างกว้างขวางในกระบวนการกำจัดหมึกแบบลอย ยิ่งไปกว่านั้นแคลเซียมถูกใช้เป็นตัวกระตุ้นให้มีประสิทธิภาพเนื่องจากมันสามารถปรับปรุงการดูดซับของสารลดแรงตึงผิวบนผงถ่าน ขณะที่ไม่สามารถเพิ่มการดูดซับบนบนเส้นใยกระดาษได้ ซึ่งผงถ่านจะสามารถถูกกำจัดออกจากเส้นใยกระดาษได้โดยง่าย

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LIST OF SYMBOLS

Parameters	Symbols	Units
Avogadro's number	N_A	-
Contact angle	θ	Degree ($^\circ$)
Contact angle of water	θ°	Degree ($^\circ$)
Critical surface tension	γ_c	mN/m
Difference in this horizontal force between pure water and the surfactant solution for the solid/liquid interface	F_{SL}	mN/m
Difference in this horizontal force between pure water and the surfactant solution for the liquid/vapor interface	F_{LV}	mN/m
Fraction of the surfactant effect attributable to surface tension reduction	f_{LV}	mN/m
Gas constant	R	N·m/mole·K
Initial surfactant concentration	C_0	μM
Interfacial tension at solid/vapor interface	γ_{SV}	mN/m
Interfacial tension at solid/liquid interface	γ_{SL}	mN/m
Interfacial tension at liquid/vapor interface or Surface tension	γ_{LV}	mN/m
Interfacial tension at solid/vapor interface for pure water	γ°_{SV}	mN/m
Interfacial tension at solid/liquid interface for pure water	γ°_{SL}	mN/m
Interfacial tension at liquid/vapor interface or Surface tension for pure water	γ°_{LV}	mN/m
Occupied surface area	A	$\text{\AA}^2/\text{molecule}$
Slope of Zisman plot	β	-
Solubility product constant	K_{SP}	M^3
Specific surface area	a_s	m^2/g

Parameters	Symbols	Units
Spreading coefficient	S_{LS}	mN/m
Surface pressure at solid/liquid interface	Π_{SL}	mN/m
Surface pressure at liquid/vapor interface	Π_{LV}	mN/m
Surfactant adsorption at solid/liquid interface	Γ_{SL}	$\mu\text{mole}/\text{m}^2$
Surfactant adsorption at liquid/vapor interface	Γ_{LV}	$\mu\text{mole}/\text{m}^2$
Surfactant concentration	C_S	μM
Temperature	T	K
Volume of a surfactant solution	V	L
Weight of a powdered plastic sample	W_{plastic}	g