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SYNTHESIS AND PERFORMANCE OF ACRYLAMIDE-BASED  
ALUMINIUM FLOCCULANT

Miss Praon Nanakorn

A Thesis Submitted in Partial Fulfillment of the Requirements  
for the Degree of Master of Science Program in Petrochemistry and Polymer Science

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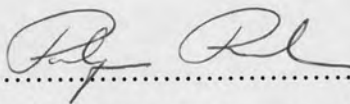
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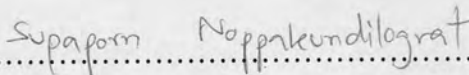
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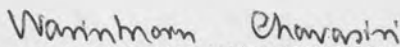
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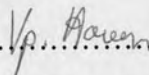
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การสังเคราะห์สารก่อการจับกลุ่มของอะลูมิเนียมไฮดรอกไซด์-พอลิ(อะคริลาไมด์-โค-กรดอะคริลิก) หรือ AHAMAA จากปฏิกิริยาพอลิเมอไรเซชันแบบเชื่อมขวางในสารละลายโดยมีอะลูมิเนียมเป็นสารก่อการจับก้อน ซึ่งมีอะคริลาไมด์และกรดอะคริลิกเป็นมอนอเมอร์ สารเชื่อมขวาง เอ็น, เอ็น'-เมทิลีนบิสอะคริลาไมด์ และแอมโมเนียมเพอร์ซัลเฟต กับ เอ็น, เอ็น, เอ็น', เอ็น'-เทตระเมทิลเอทิลีนไดเอมีน เป็นสารริเริ่มปฏิกิริยาและสารริเริ่มปฏิกิริยาร่วม ใช้ความเร็วรอบกวน 250 รอบต่อนาที อุณหภูมิ 40-50 องศาเซลเซียส เวลา 1 ชั่วโมง คั่งน้ำออกจากผลิตภัณฑ์ที่ได้โดยการตกตะกอนด้วยเอซีโตน แล้วอบให้แห้งที่อุณหภูมิ 50 องศาเซลเซียส เป็นเวลา 24 ชั่วโมง แล้วบด ศึกษาค่าการดูดซึมน้ำ ประสิทธิภาพในการกำจัดสีย้อมประเภทไครเร็กซ์ และการลดความขุ่นของพอลิ(อะคริลาไมด์-โค-กรดอะคริลิก) และ AHAMAA ในน้ำเสียสังเคราะห์ของสารแขวนลอยดินขาวเคโอลิน ผลการทดลองพบว่า ในทุก ๆ ภาวะของการสังเคราะห์ ค่าการดูดซึมน้ำของพอลิ(อะคริลาไมด์-โค-กรดอะคริลิก) สูงกว่า AHAMAA เสมอ และค่าการดูดซึมน้ำสัมพันธ์กับค่า storage modulus โดยค่า storage modulus ของ AHAMAA ที่สูงกว่า พอลิ(อะคริลาไมด์-โค-กรดอะคริลิก) ซึ่งสอดคล้องกับค่าการดูดซึมน้ำที่ต่ำกว่า เมื่อพิจารณาประสิทธิภาพในการกำจัดสีย้อมพบว่า AHAMAA มีประสิทธิภาพในการกำจัดสีย้อม Congo red ดีกว่าพอลิ(อะคริลาไมด์-โค-กรดอะคริลิก) เมื่อใช้กรดอะคริลิก, สารเชื่อมขวาง, สารริเริ่มปฏิกิริยา และสารริเริ่มปฏิกิริยาร่วม มีความเข้มข้น  $4 \times 10^{-3}$ ,  $2.3 \times 10^{-4}$ ,  $1.6 \times 10^{-4}$  และ  $12 \times 10^{-4}$  โมล ตามลำดับ AHAMAA สามารถกำจัดสีย้อมโดยเกิดการดูดซับแบบ Freundlich isotherm ในขณะที่พอลิ(อะคริลาไมด์-โค-กรดอะคริลิก) เกิดการดูดซับสีย้อมเข้าสู่รูพรุนในโครงสร้างของพอลิเมอร์ ในกรณีของสีย้อม direct blue 71 พบว่า ในทุก ๆ ภาวะการสังเคราะห์ของ AHAMAA สามารถกำจัดสีย้อมชนิดนี้ได้ โดยเกิดการดูดซับแบบ Freundlich isotherm ในขณะที่พอลิ(อะคริลาไมด์-โค-กรดอะคริลิก) ไม่สามารถกำจัดสีย้อมชนิดนี้ได้ นอกจากนี้ AHAMAA ยังมีประสิทธิภาพในการลดความขุ่นของน้ำเสียสังเคราะห์จากสารแขวนลอยดินขาวเคโอลินได้ดีกว่าพอลิ(อะคริลาไมด์-โค-กรดอะคริลิก).

สาขาวิชา ปีโตรเคมีและวิทยาศาสตร์พอลิเมอร์ ลายมือชื่อนิสิต.....

ปีการศึกษา 2549

ลายมือชื่ออาจารย์ที่ปรึกษา.....

ลายมือชื่ออาจารย์ที่ปรึกษาร่วม.....



# # 4772363423: MAJOR PETROCHEMISTRY AND POLYMER SCIENCE

KEY WORD : SUPERABSORBENT POLYMERS / POLYMERIC FLOCCULANT /  
WATER ABSORBENCY / DYE REMOVAL

PRAON NANAKORN: SYNTHESIS AND PERFORMANCE OF ACRYLAMIDE-BASED ALUMINIUM FLOCCULANT. THESIS ADVISOR: PROF. SUDA KIATKAMJORNWONG, Ph.D., THESIS CO-ADVISOR: ASST. PROF. SUPAPORN NOPPAKUNDILOGRAT, Ph.D., 132 pp.

Polymeric flocculants of aluminium hydroxide-poly[acrylamide-co-(acrylic acid)], AHAMAA, were synthesized by solution crosslinking polymerization using aluminium hydroxide as a coagulant in the presence of acrylamide and acrylic acid as a comonomer pair, *N, N'*-methylenebisacrylamide (N-MBA) crosslink agent, ammonium persulphate (APS) and *N, N, N', N'*-tetramethylethylenediamine (TEMED) as an initiator and co-initiator pair, respectively. The reaction was stirred with a stirring speed of 250 rpm at 40-50°C for 1 h. The reaction products were dewatered by precipitation with acetone, dried in an oven at 50°C for 24 h and milled. The water absorbency, the direct dye removal efficiency and the turbidity reduction of a synthetic wastewater of suspending kaolin with a variety of poly[AM-co-(AA)] and AHAMAA were investigated. From the results, it was found that the water absorbency of poly[AM-co-(AA)] is always higher than AHAMAA for all synthesized polymers. The water absorbency can be related to the storage modulus of the polymers. The storage modulus of AHAMAA is higher than that of poly[AM-co-(AA)], in good agreement with its lower absorbency. The efficiency of Congo red removal by AHAMAA is better than that of poly[AM-co-(AA)] synthesized by  $4 \times 10^{-3}$ ,  $2.3 \times 10^{-4}$ ,  $1.6 \times 10^{-4}$  and  $12 \times 10^{-4}$  mol of the acrylic acid, crosslinking agent, initiator, and co-initiator, respectively. The AHAMAA can remove Congo red which obeys the Freundlich adsorption isotherm, whereas poly[AM-co-(AA)] can adsorb Congo red by the transportation of dye molecules into its hydrogel porous structure. In the case of direct blue 71, all the synthesized AHAMAAs can remove the dye and obey the Freundlich isotherm whereas poly[AM-co-(AA)] cannot remove it. The AHAMAA is far more effective to reduce turbidity of the kaolin suspending wastewater than poly[AM-co-(AA)].

Field of Study Petrochemistry and Polymer Science  
Academic Year 2006

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## ABBREVIATIONS

SAPs	superabsorbent polymers
AM	acrylamide monomer
AA	acrylic acid monomer
N-MBA	<i>N, N'</i> -methylenebisacrylamide
APS	ammonium persulfate
TEMED	<i>N, N, N', N'</i> -tetramethylethylenediamine
I	ionic strength ( $\text{mol-ion dm}^3$ )
$C_e$	equilibrium concentration
$K_F$	Freundlich constant ( $\text{l mg}^{-1}$ )
n	the exponent in Freundlich isotherm
$Q_{\text{max}}$	adsorption capacity ( $\text{mg g}^{-1}$ )
$K_L$ (or b)	Langmuir adsorption constant ( $\text{l mg}^{-1}$ )
JGB	Janus green B
CR	Congo red (direct red 28)
BR-5	Basic red 5
BV-3	Basic violet 3
BCB	Brilliant cresyl blue
DB 71	Direct blue 71
C.I.	Color Index
MW	molecular weight
M	concentration in molar
g	gram

rpm	round per minute
min	minute
h	hour
$\mu\text{l}$	microlitre
ppm	concentration in part per million
FTIR	Fourier Transform Infrared Spectrophotometer
NMR	Nuclear Magnetic Resonance Spectrometer
SEM	Scanning Electron Microscope
EDX	Energy Dispersive X-ray Spectrometer
ICP-AES	Inductive Couple Plasma Atomic Emission Spectrometer
$Q$	water absorbency
$\text{g g}^{-1}$	gram per gram
kV	kilo volt
$G'$	storage modulus
$G''$	loss modulus