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EFFECT OF MICA ON WATER ABSORPTION OF ACRYLAMIDE – ITACONIC  
ACID SUPERABSORBENT NANOCOMPOSITES

Miss Daungtawan Fongfung

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

Faculty of Science

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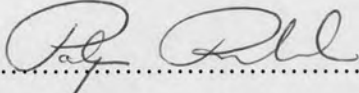
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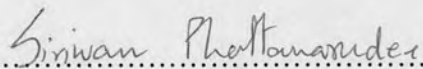
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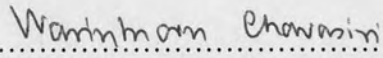
  
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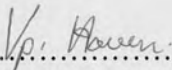
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การสังเคราะห์ซูเปอร์แอบซอร์เบนต์พอลิเมอร์ และ นาโนคอมโพสิตของโคพอลิเมอร์  
 อะครีลาไมด์-กรดอิตาโคนิกโดยกระบวนการพอลิเมอไรเซชันแบบสารละลายของอะครีลาไมด์ มี  
 กรดอิตา-โคนิกเป็นโคมอนอเมอร์และ ไมกาเป็นตัวเติมอนินทรีย์ ตัวริเริ่มปฏิกิริยาเป็นแอมโมเนียม  
 เพอร์ซัลเฟตและ เอ็น, เอ็น, เอ็น', เอ็น'-เทตระเมทิลเอทิลีนไดอะมีน, สารเชื่อมขวาง เอ็น, เอ็น'-เม  
 ทิลีนบิสอะครีลาไมด์, โดยทำการศึกษาผลของความเข้มข้นของกรดอิตาโคนิก ปริมาณไมกา  
 ปริมาณสารเชื่อมขวาง และอุณหภูมิที่ใช้ในการทำปฏิกิริยา ต่อสมบัติในการดูดน้ำของโคพอลิเมอร์  
 ที่สังเคราะห์ได้ ศึกษาผลของปริมาณของสารตัวเติมไมกาในคอมโพสิตที่ได้ต่อความสามารถในการ  
 ดูดซึมน้ำภายใต้แรงกด และศึกษาการดูดน้ำของนาโนคอมโพสิตที่ได้ในปีสภาวะเทียม ทำการ  
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 กล้องจุลทรรศน์ลำอิเล็กตรอนแบบส่องกราดและแบบส่งผ่าน ศึกษาสมบัติเชิงกลด้วยการดึงแบบ  
 ของรังสีเอกซ์ และศึกษาสมบัติทางความร้อนด้วยเทอร์มอลกราวิเมตรี นอกจากนี้ได้ตรวจสอบ  
 สมบัติวิสโคอิลาสติกของเจลบวมน้ำของคอมโพสิตที่สังเคราะห์ได้ จากผลการทดลองพบว่าสายโซ่  
 พอลิเมอร์แทรกอยู่ในช่องว่างระหว่างชั้นซิลิเกตของไมกาเกิดเป็นจุดเชื่อมขวางในโครงสร้างของ  
 โคพอลิเมอร์เพิ่มขึ้น จากการศึกษาสมบัติการดูดซึมน้ำของโคพอลิเมอร์ที่สังเคราะห์ได้พบว่าโคพอ-  
 ลิเมอร์อะครีลาไมด์-กรดอิตาโคนิกที่มีกรดอิตาโคนิกร้อยละ 5 โดยโมล, เอ็น, เอ็น'-เมทิลีน-  
 บิสอะครีลาไมด์ร้อยละ 0.2 โดยโมล, แอมโมเนียมเพอร์ซัลเฟตร้อยละ 0.3 โดยโมล และ เอ็น, เอ็น,  
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 รอบต่อนาที ที่ 50 องศาเซลเซียส ซูเปอร์แอบซอร์เบนต์พอลิเมอร์มีความสามารถในการดูดซึมน้ำได้  
 มากที่สุดถึง  $640 \pm 7$  เท่าของน้ำหนักแห้ง และ ดูดน้ำได้  $79 \pm 3$  เท่าของน้ำหนักแห้งในปีสภาวะเทียม  
 ส่วนซูเปอร์แอบซอร์เบนต์พอลิเมอร์นาโนคอม-โพสิตที่เติมไมการ้อยละ 5 โดยน้ำหนัก ดูดซึมน้ำ  
 ได้ถึง  $748 \pm 5$  เท่าของน้ำหนักพอลิเมอร์แห้ง พร้อมมีความแข็งแรงของเจลมากขึ้น ทนความร้อน  
 เพิ่มขึ้น และสามารถดูดซึมน้ำได้  $76 \pm 2$  เท่าของน้ำหนักแห้งในปีสภาวะเทียม

สาขาวิชาปิโตรเคมีและวิทยาศาสตร์พอลิเมอร์

ปีการศึกษา 2549

ลายมือชื่อนิสิต *ดวงตะวัน เพ็ญฟูง*.....

ลายมือชื่ออาจารย์ที่ปรึกษา *สุดา เกียรติกำจรวงศ์*.....

ลายมือชื่ออาจารย์ที่ปรึกษาร่วม *สิริวรรณ พัฒนาฤดี*.....

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 KEY WORD : SUPERABSORBENT NANOCOMPOSITES / MICA / WATER  
 ABSORBENCY / INTERCALATION

DAUNGTAWAN FOUNGFUNG: EFFECT OF MICA ON WATER ABSORPTION  
 OF ACRYLAMIDE – ITACONIC ACID SUPERABSORBENT NANOCOMPOSITES.  
 THESIS ADVISOR : PROF. SUDA KIATKAMJORNWONG, Ph.D., THESIS  
 COADVISOR : SIRIWAN PHATTANARUDEE, Ph.D., 116 pp.

The superabsorbent polymer and its nanocomposite of acrylamide (AM)/itaconic acid (IA) were synthesized by solution polymerization in the aqueous solution of AM with IA as a comonomer and mica used as an inorganic additive in the polymerization process. This reaction was initiated by an initiator couple of ammonium persulfate and *N,N,N',N'*-tetramethylethylenediamine (TEMED). The *N,N'*-methylenebisacrylamide crosslinker was used in the polymerization. The influences of the concentrations of IA, crosslinker, mica content, and reaction temperature on the water absorption of the superabsorbent polymer systems were examined. In addition, the effects of the mica content on water absorbency under load of the synthesized copolymers and composites at 0.28 and 0.70 psi were examined. The water absorbency of the synthesized copolymers in artificial urine was also investigated. The functional groups of synthesized copolymers and composites were investigated by Fourier Transform Infrared Spectroscopy, and thermal properties were characterized by thermal gravimetric analysis. The structure and surface morphology were investigated by scanning electron microscopy, transmission electron microscopy and X-ray diffraction. Moreover, the viscoelastic properties of the swollen gel were investigated. The results showed that the polymer chains intercalated into the silicate layer in the mica and created more network junctions in the polymer structure. The synthesized copolymer gives the highest water absorbency of  $640 \pm 7$  times its dry weight at the AM-to-IA ratio of 95:5 and 5% mica, and can absorb up to  $79 \pm 3$  times its dry weight in artificial urine. The mica addition results in higher water absorption of  $748 \pm 5$  and  $76 \pm 2$  times its dry weight in artificial urine with increased gel strength and enhanced thermal stability of the synthesized superabsorbent nanocomposites. Such composites were obtained from the polymerization condition of AM/IA 95/5, 5% wt of mica, 0.2% mole of N-MBA, 0.3% mole of APS, 1.2% mole of TEMED (0.2 ml) and a reaction temperature of 50°C. This superabsorbent nanocomposite has intercalation layers in mica with increasing gel strength, higher water absorption and thermal stability.

Field of Study Petrochemistry and Polymer Science  
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**LIST OF ABBREVIATIONS**

AM	: acrylamide
IA	: Itaconic acid
N-MBA	: <i>N, N'</i> -methylenebisacrylamide
APS	: ammonium persulfate
TEMED	: <i>N, N, N', N'</i> -tetramethylethylenediamine
°C	: degrees Celsius
min	: minute
rpm	: rounds per minute
% mol	: percent by mole
% wt.	: percent by weight
r	: reactivity ratio
M	: molecular weight
b.p.	: boiling point
m.p.	: melting point
D	: density
g	: gram
FTIR	: Fourier Transform Infrared Spectroscopy
KBr	: potassium bromide
SEM	: Scanning Electron Microscopy
TEM	: Transmission Electron Microscopy
TGA	: Thermal gravimetric analysis
nm	: nanometer
h	: hour

$Q$	: the water absorbency
$\text{g g}^{-1}$	: gram per gram
psi	: pound per square inch
SAPs	: superabsorbent polymers
$Q$	: maximum swelling ratio
$i$	: electronic charge on the polymer structure per polymer unit
$v_u$	: polymer repeating unit volume
$S^*$	: ionic strength of solution
$\chi_1$	: interaction parameter of polymer with solvent
$V_1$	: molar volume of solvent, in a real network
$V_0$	: un-swollen polymer volume
$v_e$	: effective number of chains
WAXD	: wide angle X-ray diffraction
$k_d$	: the rate constant for initiator decomposition
$k_p$	: the rate constant for the propagation step
$k_t$	: the rate constant for the termination
$G'$	: storage modulus
$G''$	: loss modulus
$G^*$	: complex shear modulus
mA	: milliampere
mg	: milligram
M	: molar
AUL	: absorbency under load
$\omega$	: Angular frequency
KGy	: kilogay

LVE	: linear viscoelastic
KV	: kilovolt
$\mu\text{m}$	: micrometer
$\text{\AA}$	: angstrom
$\text{rad s}^{-1}$	: radian per second
ml	: millilitre