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**PREPARATION OF POLYETHYLENE FILM
CONTAINING POROUS STRUCTURE**



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บทคัดย่อ

จินตวัฒน์ สงวนรักษา: การเตรียมฟิล์มโพลีเอทิลีนที่มีโครงสร้างเป็นรูพรุน (Preparation of Polyethylene Film Containing Porous Structure) อ. ที่ปรึกษา: ศ. ดร. ไชอิชิ โทคุระ (Prof. Sei-ichi Tokura) ดร. รัตนา รุจิรวนิช และ ดร. พิชญ์ ศุภผล 135 หน้า ISBN 974-13-0732-2

งานวิจัยนี้เป็นการศึกษาวิธีการเตรียมฟิล์มโพลีเอทิลีนที่มีโครงสร้างเป็นรูพรุนจากโพลีเอทิลีนความหนาแน่นต่ำ และเปี่ยมล้นสำหรับ โดยการนำโพลีเอทิลีนความหนาแน่นต่ำมาผสมกับเปี่ยมล้นสำหรับ ในอัตราส่วนแบ่ง 0, 2, 4, 6, 8, 10, และ 12 % โดยน้ำหนัก หลังจากนั้นนำไปขึ้นรูปเป็นแผ่นฟิล์มที่มีความหนา 50, 80, และ 100 ไมโครเมตร แล้วนำไปเข้ากระบวนการไฮโดรไลซิสด้วยกรดหรือเอนไซม์เพื่อให้เกิดโครงสร้างที่เป็นรูพรุน ในกระบวนการไฮโดรไลซิสด้วยกรด แผ่นฟิล์มจะถูกนำไปแช่ในสารละลายกรดไฮโดรคลอริก, กรดซัลฟิวริก, และกรดไนตริก ที่สภาวะต่างๆ ส่วนการไฮโดรไลซิสด้วยเอนไซม์จะใช้แอลฟาไมเลสในการย่อยสลายเปี่ยมล้นออกจากแผ่นฟิล์มเพื่อให้เกิดรูพรุน จากผลการวิจัยพบว่าในกระบวนการไฮโดรไลซิสด้วยกรด กรดไนตริกสามารถสลายเปี่ยมล้นออกจากแผ่นฟิล์มได้ดีที่สุด โดยสามารถสลายได้ถึงประมาณ 85% ที่ความเข้มข้น 5 นอร์มอลลิที และอุณหภูมิ 65 องศาเซลเซียส ในขณะที่กระบวนการไฮโดรไลซิสด้วยเอนไซม์สามารถสลายเปี่ยมล้นได้เพียง 35 % การวัดปริมาณเปี่ยมล้นที่ถูกละลายออกจากแผ่นฟิล์มมีความสอดคล้องกับภาพถ่ายจุลทรรศน์อิเล็กตรอน ซึ่งพบว่าฟิล์มที่สลายเปี่ยมล้นออกจากแผ่นฟิล์มจะมีรูพรุนมากกว่าฟิล์มที่สลายเปี่ยมล้นออกจากแผ่นฟิล์มอื่นๆ เมื่อความเข้มข้นของกรดเพิ่มขึ้น ปริมาณเปี่ยมล้นที่สลายออกจากฟิล์ม และความพรุนของฟิล์มก็จะเพิ่มขึ้น กระบวนการไฮโดรไลซิสด้วยกรดสามารถสลายเปี่ยมล้นได้ดีที่อุณหภูมิที่อยู่ในช่วงอุณหภูมิการเกิดเจลของเปี่ยมล้นสำหรับ และพบว่าเมื่อเพิ่มปริมาณเปี่ยมล้นในแผ่นฟิล์มจาก 2-12 % โดยน้ำหนัก โครงสร้างของแผ่นฟิล์มก็จะเปลี่ยนจากโครงสร้างที่บวมไม่มีรูพรุนเป็นโครงสร้างที่มีรูพรุน และการไฮโดรไลซิสจะสลายเปี่ยมล้นออกจากฟิล์มบางได้มากกว่าฟิล์มหนา เมื่อทดสอบคุณสมบัติเชิงกลพบว่า ฟิล์มก่อนไฮโดรไลซิสมีคุณสมบัติเชิงกลสูงกว่าฟิล์มหลังไฮโดรไลซิสเนื่องจากเปี่ยมล้นที่ถูกละลายออกไป นอกจากนี้ฟิล์มโพลีเอทิลีนที่มีรูพรุนที่เตรียมได้ยังมีคุณสมบัติในการแยกก๊าซที่ดี และสามารถประยุกต์ใช้ในกระบวนการแยกก๊าซได้

ABSTRACT

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A new method of preparing porous polyethylene film was investigated. Low density polyethylene (LDPE) and tapioca starch were mixed together to produce 2, 4, 6, 8, 10, and 12 wt% starch blends. Each blend was melt extruded to obtain LDPE/starch films having thicknesses of 50, 80, and 100 μm . The porous structure of the films was formed by removing starch particles from the films using acidic hydrolysis and enzymatic hydrolysis. For acidic hydrolysis, the films were immersed in solutions of HCl, H₂SO₄, and HNO₃ under various conditions while a solution of α -amylase was employed for enzymatic hydrolysis. For acidic hydrolysis, starch particles were best removed using 5 N HNO₃ at 65°C which gave a reduction in starch level of approximately 85%, whereas for enzymatic hydrolysis the reduction was much lower at about 35%. The amounts of starch removal correlated well with scanning electron micrographs where more pores were observed in HNO₃ hydrolyzed film. The concentration of HNO₃ solution and hydrolysis temperature both played important roles in starch removal. The reduction in starch level increased with increasing acid concentration. At temperatures below the gelatinization temperature range of tapioca starch, starch removal was much lower than that within the gelatinization temperature range.

It was found that as the starch content increased from 2 wt% to 12 wt% the microstructure of the films changed from dense to porous structure. An increase in the film thickness resulted in a decrease in starch removal. Mechanical properties of porous films obtained from both nitric acid hydrolysis and enzymatic hydrolysis were lower than those of untreated LDPE/starch film. The gas permeabilities (P) of the film containing 12 wt% starch before hydrolysis were 45.75, 51.61, 65.13, 19.97, and 43.84 barrers for nitrogen, carbon dioxide, ethylene, propane, and propylene gases, respectively, and 484.40, 506.84, 601.50, 162.88, and 176.52 barrers after nitric acid hydrolysis. The selectivity or separation parameters of porous, HNO₃ hydrolyzed film were $P(N_2)/P(C_3H_8) = 2.97$, $P(N_2)/P(C_3H_6) = 2.74$, $P(CO_2)/P(C_3H_8) = 3.11$, $P(CO_2)/P(C_3H_6) = 2.87$, $P(C_2H_4)/P(C_3H_8) = 3.69$, and $P(C_2H_4)/P(C_3H_6) = 3.41$. The dramatic increase in gas permeabilities coupled with good selectivity indicates that the porous films have good potential for use in industrial gas separation.

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