IMPROVEMENT OF NATURAL RUBBER PROPERTIES BY MODIFICATION OF SILICA SURFACE USING A CONTINUOUS ADMICELLAR POLYMERIZATION SYSTEM



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ABSTRACT

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Fillers such as silica are often added to rubber to improve performance in commercial applications. The use of silica in rubber compounds provides beneficial properties such as improved reinforcement. A major problem with using commercial silica as a filler is that porous structure of silica can adsorb accelerators, leading to deactivate vulcanization. Moreover, acidity of silica surface can retard cure time. Those actions may affect poor compatibility between the silica and rubber. In practical, improvement silica properties can be achieved by admicellar polymerization to modify the surface characteristics. Currently, this process has been successfully performed only in a batch reactor, which is not feasible for industrial applications. In this work, a continuous reactor for the admicellar polymerization was developed. Cetyltrimethylammonium bromide, styrene and isoprene were used as surfactant and co-monomers, respectively. The results showed that modification of the silica surface reduced the BET surface area and increased the mean agglomerate particle size for all samples. Scanning electron micrographs showed the increase in the particle agglomeration. Fourier transform infrared spectroscopy proved the existence of polystyrene and polyisoprene on the modified silica. The use of the modified silica in rubber compounds significantly reduced T_{90} cure times and improved modulus, abrasion resistance, and resilience. The optimum conditions for silica modification were 5 g co-monomer loading per 1 kg silica at 30 min retention time.

บทคัดย่อ

กรณี นนทะสร : การเพิ่มคุณสมบัติของยางธรรมชาติด้วยการปรับปรุงผิวซิลิกา โดย วิธีแอดไมเซลลาร์โพลีเมอไรเซชั่นแบบต่อเนื่อง (Improvement of Natural Rubber Properties by Modification of Silica Surface using a Continuous Admicellar Polymerization System) อ. ที่ ปรึกษา : รศ. ดร. สุเมธ ชวเดช, ผศ. ดร. ปราโมช รังสรรค์วิจิตร, ดร. นุชนาฏ ณ ระนอง, ผศ. ดร. จอห์น เฮช โอ เฮเวอร์ และ ศ. ดร. เจฟฟรี เฮช ฮาร์เวลล์ 79 หน้า ISBN 974-03-1583-6

สารเติมแต่งเช่น ซิลิกา ถูกเติมลงไปในยางเพื่อปรับปรุงคุณสมบัติให้เหมาะสมกับการนำ ไปใช้ทางการค้า การใช้ซิถิกาในยางทำให้เกิดผลดีต่อคุณสมบัติของยาง เช่น เพิ่มการเสริมแรง แต่ ปัญหาหลักในการใช้ซิลิกาคือลักษณะ โครงสร้างที่มีรูพรุนของซิลิกาจะ ไปคูคซับตัวเร่งปฏิกิริยา ประกอบกับความเป็นกรคที่ผิวของซิลิกาจะเพิ่มเวลาในการคงรูปยาง ซึ่งอาจมีผลต่อความเป็นเนื้อ เคียวกันระหว่างซิลิกากับยาง ทางหนึ่งในการแก้ปัญหานี้สามารถทำได้โดยอาศัยกระบวนการ แอคไมเซลลาร์โพลีเมอไรเซชั่นในการปรับปรุงผิวของซิลิกา ปัจจุบันพบว่าเครื่องปฏิกรณ์แบบกะ สามารถใช้ในการปรับปรุงพื้นผิวของซิลิกาได้เป็นอย่างดีแต่ไม่เหมาะกับการใช้งานในเชิง งานวิจัยนี้มุ่งพัฒนาเครื่องปฏิกรณ์แอคไมเซลลาร์โพลีเมอไรเซชั่นแบบต่อเนื่อง โดยใช้เซติลไตรเมทธิลแอมโมเนียมโบรไมด์ สไตรีนและไอโซพรีน เป็นสารลดแรงตึงผิวและ โค-โมโนเมอร์ตามลำคับ การปรับปรุงผิวของซิลิกานี้ส่งผลให้พื้นที่ผิวลคลงและค่ากึ่งกลางของ ขนาดการจับตัวของเม็ดซิลิกาของทุกตัวอย่างเพิ่มขึ้น ผลจากเครื่องสแกนนิ่งอีเล็คตรอน ไมโครสโคป แสดงการเพิ่มขึ้นของการเกาะตัวกันของเม็ดซิถิกา ผลจากเครื่องฟูเรียทรานฟอร์ม อินฟาเรคสเป็กโตรสโคป พิสูจน์ว่ามีสไตรีนและไอโซพรีนบนผิวของซิลิกาที่ได้รับการปรับปรุง การใช้ซิลิการที่ได้รับการปรับปรุงผิวแล้วในยางสามารถลดเวลาในการขึ้นรูปอย่างเป็น นัยสำคัญ ทั้งยังปรับปรุงค่าโมคูลัส ค่าความด้านทานการขัคถูและค่าการกระคอน จากการศึกษา พบว่าสภาวะที่เหมาะสมที่สุดสำหรับการปรับปรุงผิวซิลิกาคือการใช้โมโนเมอร์ 5 กรัมต่อ ซิลิกา 1 กิโลกรัม ที่เวลาในการทำปฏิกิริยา 30 นาที

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