

**RHEOLOGICAL PROPERTIES OF ELECTORRHEOLOGICAL
FLUIDS: SILICA, POLYANILINE AND POLYANILINE-COATED
SILICA SUSPENSIONS**

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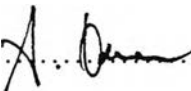
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กรองทิพย์ มาทะ : สมบัติทางวิทยากระแสของของไหลอิเล็กทรอนิกส์โพลีโวลติคอลล : สารแขวนลอยของซิลิกา, พอลิอะนิลีน, และ ซิลิกาซึ่งเคลือบผิวด้วยพอลิอะนิลีน (Rheological Properties of Electrorheological Fluids: silica, polyaniline, and Polyaniline-Coated Silica Suspensions) อ.ที่ปรึกษา : Prof. Alexander M. Jamieson และ รศ. ดร. อนุวัฒน์ ศิริวัฒน์ 99 หน้า ISBN 974-334-175-7

ของไหลอิเล็กทรอนิกส์โพลีโวลติคอลลเป็นสารแขวนลอยชนิดหนึ่งซึ่งประกอบด้วยอนุภาคขนาดเล็กกระจายตัวอยู่ในตัวกลางทำละลายซึ่งไม่นำไฟฟ้า เช่น ซิลิโคนออยล์ ของไหลนี้มีคุณสมบัติพิเศษ คือ เมื่อได้รับการเหนี่ยวนำจากสนามไฟฟ้า อนุภาคจะมีการจัดเรียงตัวเป็นโครงสร้างที่มีลักษณะเป็นสายโซ่ในทิศทางขนานกับทิศทางของสนามไฟฟ้าซึ่งอนุภาคในสายโซ่เหล่านี้ยึดติดกันด้วยแรงไฟฟ้าสถิต ทำให้สมบัติทางวิทยากระแสเปลี่ยนแปลง เช่น ความหนืดของสารเพิ่มขึ้น จากคุณสมบัติพิเศษนี้สามารถนำไปประยุกต์ใช้ได้กับเครื่องจักรกลหลายชนิด เช่น เบรค คลัทช์ในรถยนต์ วาล์วในเครื่องจักร หรือแม้แต่ข้อต่อในขาและแขนเทียม ในการทดลองนี้ใช้อนุภาคต่างกัน 3 ชนิด คือ ซิลิกา พอลิอะนิลีน และ ซิลิกาซึ่งเคลือบผิวด้วยพอลิอะนิลีน กระจายตัวอยู่ในซิลิโคนออยล์ ทำการศึกษาผลของความแรงของสนามไฟฟ้าที่ให้ต่อของไหล, ปริมาณของอนุภาค, และขนาดของอนุภาค ที่มีต่อสมบัติทางวิทยากระแส เมื่อของไหลนี้ได้รับการเหนี่ยวนำจากสนามไฟฟ้า ค่าสตอเรจ และ ลอสโมดูลัสจะมีค่าคงที่ในช่วงความเค้นต่ำ เมื่อความเค้นเพิ่มขึ้น ค่ามอดูลัสทั้งสองจะลดลงอย่างรวดเร็ว เนื่องจากโครงสร้างที่เป็นสายโซ่บิดเบี้ยวและถูกทำลายในที่สุด เมื่อเพิ่มความแรงของสนามไฟฟ้า ค่าสตอเรจมอดูลัส และ ลอสโมดูลัสจะเพิ่มขึ้น เนื่องจากแรงทางไฟฟ้าสถิตระหว่างอนุภาคเพิ่มขึ้น ทำให้ความแข็งแรงของสายโซ่เพิ่มขึ้น และเมื่อปริมาณของอนุภาคเพิ่มขึ้น ค่ามอดูลัสทั้งสองเพิ่มขึ้น เนื่องจากมีจำนวนของสายโซ่เพิ่มขึ้น หากปริมาณของอนุภาคสูงพอจะมีการเกิดของคลัสเตอร์ซึ่งมีความแข็งแรงมากกว่าสายโซ่เดี่ยว อย่างไรก็ตามที่ความถี่สูงๆ ผลทางอิเล็กทรอนิกส์โพลีโวลติคอลลจะลดลง เนื่องจากอนุภาคไม่สามารถยึดกันเป็นสายโซ่ได้เร็วพอ

ABSTRACT

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Electrorheological (ER) fluids, typically composed of small particles dispersed in nonconducting liquids, are fascinating materials whose structure and rheological properties can be dramatically altered by external electric fields. In this study, three types of particles; silica, polyaniline, and polyaniline-coated silica were used as the dispersed phase and silicone oil as the medium. The effects of the weight fraction and size of particles and electric field strength were investigated by a modified cone and plate rheometer, connected to a high voltage generator under oscillatory shear. All of the ER fluid samples showed the linear viscoelastic behavior only at small strain amplitudes. The ER effect could be enhanced by increasing the weight fraction of the particles and the electric field strength. The effect in linear viscoelastic region was larger than that of nonlinear due to the less deformation of chain structures. Upon subsequent applications of the electric fields, the samples showed almost the same response. After the electric field was released, the samples recovered almost completely. However, at higher frequencies, the ER effect tended to diminish.

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