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**Utilization of Mineral Fillers in High Density Polyethylene**



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การวิจัยนี้ศึกษาผลของการเติมสารตัวเติมประเภทแร่ต่อสมบัติของโพลีเอทิลีนชนิดความหนาแน่นสูง สารตัวเติมประเภทแร่ที่ใช้คือ แคลเซียมคาร์บอเนต และทาลค์ ส่วนสารตัวเติมสังเคราะห์ที่ใช้คือ คาร์บอนแบล็ค สารปรับปรุงสภาพพื้นผิวที่ใช้คือ สารประเภทไททาเนต เนื่องจากแคลเซียมคาร์บอเนตและทาลค์ ไม่มีพื้นผิวที่ไวต่อการเกิดปฏิกิริยา ดังนั้นจึงไม่สามารถใช้กับสารควบคู่ประเภทไฮลเลนได้ การศึกษาผลของแคลเซียมคาร์บอเนต, ทาลค์, คาร์บอนแบล็ค และสารควบคู่ ได้ประยุกต์ใช้การออกแบบการทดลองตามหลักสถิติชนิด Factorial Design ซึ่งทำให้สามารถหาผลกระทบของตัวแปรแต่ละตัว และความสัมพันธ์ระหว่างตัวแปรต่อสมบัติเชิงกลและสมบัติเชิงความร้อน การทดลองที่ออกแบบจะใช้ปริมาณสาร 2 ระดับ ( $2^k$  Factorial Design) ซึ่งทำให้สามารถวิเคราะห์ตัวแปรหลายๆตัวได้ในเวลาเดียวกัน ตัวแปรที่ใช้มี 5 ชนิดคือ แคลเซียมคาร์บอเนต, ทาลค์ ชนิดที่ปรับปรุงสภาพพื้นผิวและไม่ปรับปรุงสภาพพื้นผิว และคาร์บอนแบล็ค การศึกษานี้พบว่าตัวแปรทุกๆตัวมีผลต่อสมบัติเชิงกลเรียงตามลำดับคือ แคลเซียมคาร์บอเนต, ทาลค์, คาร์บอนแบล็ค และสารปรับปรุงสภาพผิว แต่ไม่มีผลต่อสมบัติเชิงความร้อน สารตัวเติมทุกตัวมีผลต่อสมบัติเชิงกลคล้ายคลึงกัน คือทำให้โพลีเอทิลีนมีความแข็งแรงเพิ่มขึ้น ในขณะที่ความเปราะลดลง เนื่องจากแคลเซียมคาร์บอเนตเป็นตัวแปรที่มีผลกระทบสูงสุด การวิจัยนี้จึงเลือกแคลเซียมคาร์บอเนตเป็นตัวแทนสำหรับสารตัวเติมประเภทแร่ เพื่อศึกษาหาผลกระทบโดยละเอียด การวิจัยนี้พบว่าปริมาณแคลเซียมคาร์บอเนตที่เหมาะสมคือ 10-20 phr เพราะจะไม่ทำให้โพลีเอทิลีนมีความเปราะมากเกินไป ส่วนปริมาณสารควบคู่ที่เหมาะสมประมาณ 0.5 %

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MR. VERASAK COODTAPAN : UTILIZATION OF MINERAL FILLERS IN HIGH DENSITY POLYETHYLENE.

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This research aims to study the utilization of mineral additives for high density polyethylene (HDPE). The mineral fillers used are calcium carbonate and talc. In addition, carbon black will also be employed. Interfacial affinity between HDPE and the applied fillers are modified by the use of a coupling agent. Titanate type of coupling agent was employed in the present study because fillers such as calcium carbonate and talc do not respond to silanes. Experimental design was based on a factorial design method to find factors and interactions that effect the mechanical and thermal properties of the filled-HDPE. A two-level full or  $2^k$  factorial design was considered to be best for the needs of the present study because it enables the possibility of assessing several factors and their interactions simultaneously. The effect of five factors were studied namely the  $\text{CaCO}_3$  with and without pre-treatment with titanate coupling agent and carbon black. The main finding is that the mechanical properties are significantly effected. The order of the significance of the effect is as following: untreated  $\text{CaCO}_3$  > treated  $\text{CaCO}_3$  > untreated talc > treated talc > carbon black. The thermal properties are not significantly effected by the five factors and their interactions. The  $\text{CaCO}_3$  is selected to study the effect of mineral filler on the mechanical properties of HDPE composites. In the study, the modulus, yield stress, hardness and the heat deflection temperature increase when the filler content is increase. The value of fracture energy and the yield strain decrease when the filler content is increased. Surface treatment of  $\text{CaCO}_3$  with titanate coupling agent enhances the adhesion between the filler and polymer surface. The suitable  $\text{CaCO}_3$  content is in the range from 10 to 20 phr as the system still possesses adequate ductility. The best concentration of titanate coupling agent is 0.5 %.

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