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ผลของสารต้านการเกิดออกซิเดชันและผลกระทบรวมต่อ HDPE

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EFFECTS OF ANTIOXIDANTS AND THEIR INTERACTIONS ON HDPE

Montree Chandamneamkij

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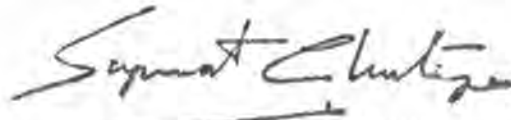
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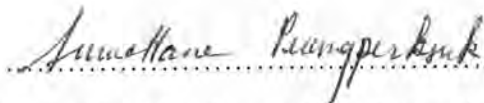
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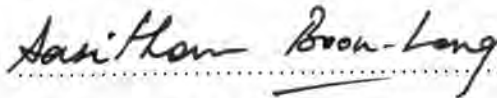
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มนตรี ชาญดำเนินกิจ : ผลของสารต้านการเกิดออกซิเดชันและผลกระทบบ่วมต่อ HDPE
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งานวิจัยนี้เน้นการศึกษาผลของสารต้านการเกิดออกซิเดชันประเภทปฐมภูมิและทุติยภูมิ สาร optical brightener และผลกระทบบ่วมที่สารเติมแต่งเหล่านี้มีต่อ HDPE เนื่องจากการทดลองเพื่อศึกษาผลกระทบบ่วมของสารเติมแต่งชนิดต่าง ๆ เป็นการทดลองที่มีจำนวนตัวแปรหลายตัว ผู้วิจัยจะต้องผสม HDPE กับสารเติมแต่งทั้งหลายในปริมาณต่าง ๆ กันเป็นจำนวนมาก ตลอดจนทดสอบตัวอย่างเป็นจำนวนมาก ทำให้สิ้นเปลืองค่าใช้จ่ายและเวลา เพื่อขจัดปัญหาดังกล่าว งานวิจัยนี้จึงมีการออกแบบการทดลองโดยประยุกต์ใช้หลักการทางสถิติเพื่อให้สามารถลดจำนวนการทดลองลง แต่ยังคงได้ผลการวิเคราะห์ในเชิงสถิติในระดับที่เชื่อถือได้ การวิจัยนี้ได้ออกแบบการทดลองปรับสูตรส่วนผสมของ HDPE โดยวิธีการออกแบบเซ็นทรัลคอมโพสิทโรเทเทเบิล (Central Composite Rotatable Design, CCR) เพื่อแปรปริมาณสารเติมแต่งชนิดต่างๆ ที่เลือกใช้และวิเคราะห์ผลการทดลองโดยวิธีพื้นผิวตอบสนอง (Response Surface Methodology, RSM) ทำให้ได้สมการพื้นผิวตอบสนองแสดงความสัมพันธ์ระหว่างปริมาณสารเติมแต่งชนิดต่าง ๆ กับสมบัติตอบสนองของ HDPE การผสม HDPE กับสารเติมแต่งชนิดต่าง ๆ ตามที่ได้ออกแบบไว้กระทำโดยใช้เครื่องอัดรีดระบบสกรูเดียว โดยได้อัดรีดซ้ำจนครบ 5 รอบ การทดสอบสมบัติทางกายภาพและสมบัติเชิงความร้อนของ HDPE พบว่าเมื่อปริมาณสารต้านการเกิดออกซิเดชันประเภทปฐมภูมิที่สูงขึ้น มีผลให้ระยะเวลาด้านการเหนี่ยวนำออกซิเดชัน (oxidative induction time, OIT) เพิ่มขึ้นด้วย แต่ มักจะเกิดปัญหาคือสีของ HDPE เปลี่ยนเป็นสีเหลืองมากขึ้น การเติมสารต้านการเกิดออกซิเดชันประเภททุติยภูมิและสาร optical brightener สามารถช่วยปรับปรุงสีของ HDPE ให้ขาวขึ้นได้ นอกจากนี้ งานวิจัยนี้ยังพบว่าการผสมรวมกันในอัตราส่วนที่แตกต่างกันของสารเติมแต่งชนิดต่าง ๆ นั้นมีผลต่อสมบัติของ HDPE เช่นการผสมรวมกันของสารต้านการเกิดออกซิเดชันที่ผสมกันแล้วระหว่างประเภทปฐมภูมิกับทุติยภูมิและสาร optical brightener ให้ผลที่เสริมกันดีที่สุดสำหรับการวัดค่า OIT และการผสมรวมกันของ 0.06% ของสารต้านการเกิดออกซิเดชันประเภทปฐมภูมิชนิด Octadecyl 3-(3,5-di-tert.butyl-4-hydroxy phenyl)-propionate กับ 0.02% ของสารต้านการเกิดออกซิเดชันประเภททุติยภูมิชนิด Distearyl thiodipropionate และสาร 2,5-thiophenediylbis(5-tert-butyl-1,3-benzoxazole) optical brightener 0.00072% จะให้ค่า OIT ที่ยาวนานที่สุด ซึ่งผลการวิเคราะห์ของงานวิจัยนี้ทำให้ได้สมการพื้นผิวตอบสนองแสดงความสัมพันธ์ระหว่างสมบัติของ HDPE กับปริมาณสารเติมแต่งชนิดต่าง ๆ

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ลายมือชื่อนิสิต.....
ลายมือชื่ออาจารย์ที่ปรึกษา.....
ลายมือชื่ออาจารย์ที่ปรึกษาพร้อม.....

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KEY WORD: INTERACTION / HDPE / SYNERGISTIC EFFECTS / ANTIOXIDANTS / OPTICAL BRIGHTENER / HINDERED AMINE LIGHT STABILIZER
MONTREE CHANDAMNEARNKIJ : EFFECTS OF ANTIOXIDANTS AND THEIR INTERACTIONS ON HDPE. THESIS ADVISOR : SIRIJUTARATANA COVAVISARUCH, Ph.D.
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This research aims to investigate the effects of primary, secondary antioxidants, an optical brightener and their interactions on high density polyethylene (HDPE). Five commercially available antioxidants, an optical brightener and an hindered amine light stabilizer (HALS) were compounded with the HDPE. Designing quality formulation compounds generally requires numerous experimental samples and runs which are costly and time-consuming. To minimize the number of experiments, an experimental design had been applied so that the results, obtained from a minimal number of experiments, would still be statistically conclusive. The present study had chosen the technique of Central Composite Rotatable (CCR) for the experimental design. Empirical models depicting relationships between the concentration of additives and their corresponding response will be analyzed by the technique of Response Surface Methodology (RSM). After each compounding formula was designed, the selected additives of the designed amount were compounded by mixing with the unstabilized HDPE. The compounding was conducted by using a single screw extruder. Extrusion was repeatedly performed up to five passes. Physical properties and the thermal stability of the compounded HDPE were investigated. It was found that increasing the concentration of the primary antioxidant enhances the Oxidative Induction Time (OIT) but it also generates considerable discoloration to the appearance of the compounded HDPE. The problem of yellowness can be remedied by adding a secondary antioxidant and an optical brightener. Moreover, the combination of and the ratio of additives used had significant effects on the properties of the HDPE. In this work the combination of the blended antioxidant and the optical brightener gave the strongest synergistic effects on the OIT. The combined use of Octadecyl 3-(3,5-di-tert.butyl-4-hydroxy phenyl)-propionate primary antioxidant by 0.06%, 0.02% Distearyl thiodipropionate secondary antioxidant and 0.00072% of 2,5-thiophenediylbis(5-tert-butyl-1,3-benzoxazole) optical brightener was found to give the best OIT. Further analysis yielded empirical equation showing the relationship between the properties of compounded HDPE and the additives studied.

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