

**LIFE CYCLE MATERIAL FLOW ANALYSIS OF PVC PRODUCTS  
IN THAILAND**

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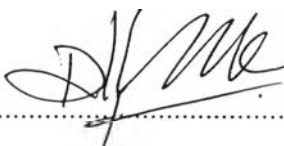
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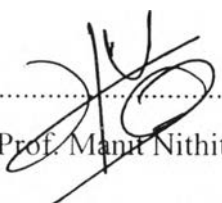
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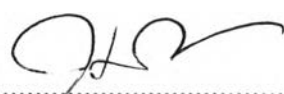
  
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## ABSTRACT

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The purposes of this research work were to study material flows of selected PVC products based on life cycle approach (gate-to-grave) covering production, usage, and end-of-life and to develop models for life cycle material flow analysis (LC-MFA) in order to assess the metabolism of PVC products in Thailand. First, the proposed material flow models were developed for LC-MFA of the selected PVC products, both hard and soft products, including pipe, profile, cable, floor tile, floor-covering, shoes and hose. Production data of these PVC products during 1971-2013 were used as an inflow of the models. Adjustable parameters of the models were the average service lifetime of each product, variation of the service lifetime based on normal distribution, and PVC waste management systems (recycle, landfill, and incineration). Based on this, dynamic models of input and output of the system could be constructed and used to calculate/predict of the outflow of PVC products in different pathways. In addition, four scenarios were created by varying different ratios of waste managements. From all PVC waste management scenarios studied, the results indicate that the recycle process had a significant role in reducing PVC waste emission and accumulation. Moreover, on-site data were collected at actual waste collection sites, disposal sites, and recycle shops and used to adjust the LC-MFA model to reflect present situation. From landfill site visits, the target PVC products have a relatively small amount of PVC waste at landfill sites. From recycle shop, we found that up to 95% of Pipe & fitting are being recycled which is highest followed by hose (63% recycled) and shoes (almost 20%). Other products still show low recycling rate which may be due to lack of application for recycled wastes, etc.

## บทคัดย่อ

ธนากร รอดเจริญ : การศึกษาการไหลของมวลสารตลอดวัฏจักรชีวิตของผลิตภัณฑ์พีวีซีในประเทศไทย (Life-Cycle Material Flow Analysis of PVC Products in Thailand) อ. ที่ปรึกษา: ผศ. ดร. ปมทอง มาลากุล ณ อยุธยา และ ผศ. ดร. มานิตต์ นิธิธนากุล, 104 หน้า

งานวิจัยนี้ทำการศึกษทำการศึกษการไหลของมวลสารตลอดวัฏจักรชีวิตของผลิตภัณฑ์พีวีซี ภายใต้วิธีการเข้าถึงวงจรชีวิตแบบ จากประตูโรงงานสู่หลุมขยะ (gate to grave) ซึ่งครอบคลุมตั้งแต่ กระบวนการผลิต การใช้งาน และการสิ้นสุดชีวิตของผลิตภัณฑ์พีวีซี อีกทั้งยังทำการพัฒนาแบบจำลองการไหลของมวลสารของผลิตภัณฑ์พีวีซีภายในประเทศไทย เริ่มต้นด้วยการสร้างแบบจำลองการไหลของตัวแทนผลิตภัณฑ์พีวีซี ซึ่งครอบคลุมทั้งในส่วนที่เป็น พีวีซีนึ่ง และพีวีซีแข็ง ได้แก่ ท่อและข้อต่อ กรอบประตู หน้าต่าง สายไฟ กระจังเบียงยง เสื่อน้ำมัน รองเท้า และสายยาง ข้อมูลการผลิตผลิตภัณฑ์พีวีซี ตั้งแต่ปี 2524 ถึงปี 2556 ถูกใช้เป็นข้อมูลป้อนเข้าในแบบจำลอง อีกทั้งยังมีการสร้างตัวแปรที่ทำการปรับค่าได้ ได้แก่ อายุเฉลี่ยของผลิตภัณฑ์ การกระจายตัวของอายุของผลิตภัณฑ์ รวมถึงสัดส่วนการจัดการขยะหลังการใช้งาน (ฝังกลบ เผา และรีไซเคิล) ภายใต้การศึกษาในครั้งนี้ การป้อนค่าของการผลิตอย่างต่อเนื่องทุกปีในแบบจำลองการไหล จะทำให้เราสามารถคำนวณและทำนายปริมาณขยะพีวีซีที่จะออกสู่สิ่งแวดล้อม นอกจากนี้ยังมีการสร้างสถานการณ์ตัวอย่างโดยการปรับเปลี่ยนค่าอัตราส่วนการจัดการขยะพีวีซี จากการศึกษาทั้งหมดสถานการณ์พบว่า สถานการณ์ที่มีการรีไซเคิลมาก จะทำให้ขยะพีวีซีออกสู่สิ่งแวดล้อมและสะสมในสิ่งแวดล้อมนั้นน้อยลงอย่างเห็นได้ชัดเจน นอกจากนี้ยังมีการออกเก็บข้อมูลภาคสนามเพื่อที่จะนำข้อมูลมาปรับแบบจำลอง ให้สามารถสะท้อนการไหลเวียนของพีวีซี ภายในประเทศไทย จากการออกเก็บข้อมูลภาคสนามพบว่า ที่หลุมฝังกลบมีการพบขยะพีวีซีน้อยมาก และการการเก็บข้อมูลที่ร้านรีไซเคิล พบว่าท่อและข้อต่อพีวีซี สามารถรีไซเคิลได้มากถึงร้อยละ 95 รองลงมาคือ สายยาง ร้อยละ 63 และรองเท้า ประมาณร้อยละ 20 ส่วนผลิตภัณฑ์อื่น ๆ เช่นพบว่ายังมีสัดส่วนการรีไซเคิลที่น้อย ทั้งนี้อาจเนื่องมาจาก การขาดผลิตภัณฑ์ที่รองรับสำหรับการพีวีซีรีไซเคิล

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