

**LIFE-CYCLE ENERGY AND ENVIRONMENTAL ANALYSIS OF BIO-OIL
PRODUCTION FROM RICE STRAW AND *LEUCAENA LEUCOCEPPHALA*
IN THAILAND**



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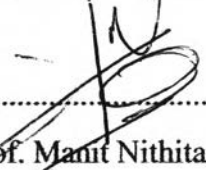
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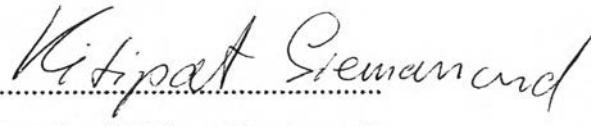
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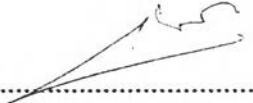

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ABSTRACT

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Keywords: Life Cycle Assessment (LCA)/Life Cycle Energy (LCEA)/Bio-oil/ Fast pyrolysis/Rice straw/ *Leucaena leucocephala*/Thailand

In this study, the life-cycle energy and environmental assessment was conducted for bio-oil production from fast pyrolysis process using rice straw and *leucaena leucocephala* in Thailand. The bio-oil product was targeted to be used as green crude for the refinery. The system boundary covered four stages: raw material plantation and harvesting, transportation, pyrolysis, and upgrading process. The input–output data of plantation were collected at actual plantation sites. For rice straw, it was considered in 2 cases: as waste and as a by-product where economic allocation was required. Since there is no commercial plant in Thailand, data for fast pyrolysis and bio-oil upgrading processes were retrieved from literature and pilot plant. The results were compared with conventional fuels and biofuels based on 1 ton oil equivalent (toe). From the energy analysis, net energy ratios (NER) indicated a net energy gain for both feedstocks with an energy ratio higher than 1. In addition, the NER would be even higher (> 5.0) if heat integration and heat recovery could be applied to the upgrading process. For the environmental performance, the cradle-to-gate results show that the upgrading stage contributes most to the environmental impact which is due to the intensive use of electricity and steam in the process.

บทคัดย่อ

กิตติคุณ นิรัชโรภาส : การวิเคราะห์การใช้พลังงานและผลกระทบทางด้านสิ่งแวดล้อมตลอดวัฏจักรชีวิตของการผลิตไบโอดีเซลจากฟางข้าวและต้นกระถินยักษ์ในประเทศไทย (Life-cycle energy and environmental analysis of bio-oil production from rice straw and *leucaena leucocephala* in Thailand) อ. ที่ปรึกษา: ผศ. ดร. ปมทอง มาลากุล ณ อยุธยา และ ผศ. ดร. มานิตย์ นิธิธนากุล 96 หน้า

งานวิจัยนี้มุ่งศึกษาการวิเคราะห์การใช้พลังงานและผลกระทบด้านสิ่งแวดล้อมตลอดวัฏจักรชีวิตของกระบวนการผลิตไบโอดีเซลด้วยกระบวนการไพโรไลซิสแบบเร็วโดยใช้ฟางข้าวและต้นกระถินยักษ์ในประเทศไทย โดยมีเป้าหมายที่จะนำไบโอดีเซลที่ผลิตได้ไปใช้เป็นน้ำมันดิบสำหรับป้อนเข้าโรงกลั่น ขอบเขตการศึกษาครอบคลุม 4 ขั้นตอน คือ การเพาะปลูกวัตถุดิบและการเก็บเกี่ยว การขนส่ง กระบวนการไพโรไลซิส และกระบวนการอัพเกรด บัญชีรายการสารขาเข้าและขาออกของขั้นตอนการเพาะปลูกนั้นได้ทำการเก็บข้อมูลจากพื้นที่จริง ในกรณีของฟางข้าว ได้แบ่งการพิจารณาออกเป็น 2 กรณี คือ เป็นวัสดุเหลือทิ้งจากการปลูกข้าว และเป็นผลพลอยได้ซึ่งใช้วิธีการปันส่วนแบบเศรษฐศาสตร์ สำหรับข้อมูลที่ใช้ศึกษาในขั้นตอนการผลิตไบโอดีเซลโดยวิธีไพโรไลซิสแบบเร็วและกระบวนการอัพเกรดไบโอดีเซลนั้น ถูกนำมาจากงานวิจัยที่มีการตีพิมพ์ เนื่องจากยังไม่มีโรงงานผลิตไบโอดีเซลเชิงพาณิชย์ในประเทศไทย ผลจากการวิเคราะห์ได้ถูกนำมาเปรียบเทียบกับน้ำมันเชื้อเพลิงธรรมดาและน้ำมันเชื้อเพลิงชีวภาพในหน่วย 1 ตันเทียบเท่า น้ำมันดิบ ผลการศึกษาจากการวิเคราะห์การใช้พลังงานพบว่า การผลิตไบโอดีเซลจากวัตถุดิบทั้งสองให้ค่าพลังงานสุทธิเชิงบวก นอกจากนี้ยังพบว่า หากนำวิธีการบูรณาการเชิงความร้อนและการนำความร้อนกลับมาใช้ใหม่มาประยุกต์ใช้ในขั้นตอนอัพเกรดไบโอดีเซล จะทำให้อัตราส่วนพลังงานสุทธิมีค่าสูงขึ้น (>5) ผลการศึกษาผลกระทบทางสิ่งแวดล้อมในส่วน cradle-to-gate แสดงให้เห็นว่า ในขั้นตอนการอัพเกรดไบโอดีเซลส่งผลกระทบต่อสิ่งแวดล้อมด้านสิ่งแวดล้อมมากที่สุดเนื่องมาจากการใช้ไฟฟ้าและไอน้ำร้อนในปริมาณสูง

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