

PYROLYSIS OF SEWAGE SLUDGE: KINETIC STUDY



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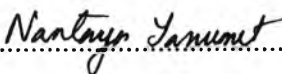
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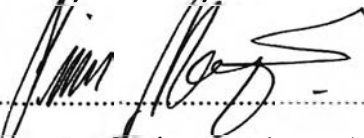

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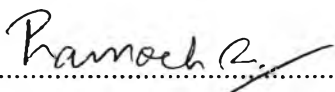
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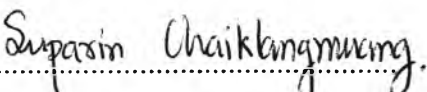

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ABSTRACT

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Puchong Thipkhunthod: Pyrolysis of Sewage Sludge: Kinetic Study

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A suitability of applying sewage sludge as pyrolysis material was realized as it has, on averaged, volatile matters of 40 wt% and heating value of 9.7 MJ/kg. According to a survey of great number of sludge samples by thermogravimetric technique, five mass loss behaviors were found. The overall decomposition is under 600 °C with a maximum rate at approximately 300°C although decomposition at as high as 700 °C is possible according to carbonate degradation. Either pseudo single-, bi- or multi-component can be applied in general case with the confirmation of the primary gas evolution data. However, reaction can be more elucidated by analyzing sludge according to the biomass compositions such as lignin cellulose, hemicellulose and extractives. It is possible to compare between the sewage sludge and those compounds, including complex protein, in terms of mass loss behavior by thermogravimetric and functionality by Fourier Transform Infrared Spectroscopy. That means, all those compounds might compose in sludge and effect to the overall decomposition kinetics. By reverse direction, the formulation of the global mass loss curve from individual components and detection of gas evolution confirms this hypothesis in low temperature region (<400 °C). At higher temperature, it is believed that the sludge is denatured caused by the reaction at low temperature, resulting in the extended decomposition at such high temperature.

บทคัดย่อ

กุชงค์ ทิพย์ขุนทด: กระบวนการไพโรไลซิสของกากตะกอน: การศึกษาด้านจลนพลศาสตร์ของกระบวนการไพโรไลซิส (Pyrolysis of sewage sludge: Kinetic Study)
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จากการศึกษาในเบื้องต้นพบว่า กากตะกอนจากระบบบำบัดน้ำเสีย มีความเหมาะสมที่จะนำมาใช้ในเชิงพลังงานได้ โดยมีคุณค่าความร้อนเฉลี่ย 9.7 เมกกะจูลต่อกิโลกรัม และมีปริมาณสารระเหยเฉลี่ย 40 เปอร์เซ็นต์ จากการศึกษาจลนพลศาสตร์ของกระบวนการไพโรไลซิสของกากตะกอน ด้วยวิธี Thermogravimetric Analysis กากตะกอน มีพฤติกรรมการสลายตัวที่แตกต่างกันไปจัดได้เป็น 5 แบบ โดยจะมีสลายตัวที่อุณหภูมิในช่วงต่ำกว่า 600 องศาเซลเซียส โดยอัตราการสลายตัวสูงสุดที่อุณหภูมิประมาณ 300 องศาเซลเซียส และสามารถอธิบายพฤติกรรมการสลายตัวได้โดย แบบจำลององค์ประกอบเสมือน 1 หรือ 2 หรือ 3 องค์ประกอบ โดยพิจารณาจากพฤติกรรมการสลายตัว ซึ่งยืนยันผลได้จากการศึกษาก๊าซผลิตภัณฑ์ที่เกิดขึ้น จากการวิเคราะห์องค์ประกอบของกากตะกอน พบว่าเป็นไปได้ที่จะประกอบไปด้วยโพลิเมอร์ธรรมชาติที่เป็นสารประกอบในชีวมวล เช่น เซลลูโลส ไชเลน ลิกนิน และสารสกัดจำพวกไขมัน น้ำมัน รวมถึงโปรตีนเชิงซ้อน โดยมีหมู่ฟังก์ชัน และพฤติกรรมการสลายตัวที่คล้ายกัน โดยยืนยันจากจำลองพฤติกรรมการสลายตัวและการกำหนดก๊าซของกากตะกอน จากการรวมพฤติกรรมการสลายตัวและการกำหนดก๊าซของสารองค์ประกอบย่อยเหล่านี้ ซึ่งได้ผลดีในช่วงอุณหภูมิต่ำ (<400 องศาเซลเซียส) นอกจากการปฏิริยาการสลายตัวแล้ว กากตะกอนอาจเกิดการแปรสภาพร่วมด้วยในช่วงอุณหภูมิดังกล่าว และเป็นผลให้เกิดการสลายตัวได้ที่อุณหภูมิสูงขึ้น

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