SLUDGE DEWATERING AND DRYING USING MICROWAVE HEATING

By

WISSAM N OMAR

Thesis Submitted to the School of Graduate Studies, Universiti Putra Malaysia, in Fulfillment of the Requirements for Degree of Master of Science

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بسم الله الرحمن الرحيم

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لله رب العالمين

Abstract of the thesis presented to the Senate of Universiti Putra Malaysia in fulfillment of the requirement for the degree of Master of Science

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December 2003

Chairman: **Pprofessor Azni Idris, Ph.D.**

Faculty: **Engineering**

Industrial and domestic activities produce large quantities of residual sludge. Nowadays a wide reduction of these waste volumes is necessary. Drying of the sludge which reduces its volume and mass is an important aspect for sludge management. The mechanical dewatering by pressure filters or centrifuges is not always sufficient to satisfy new environmental regulations and a thermal drying step is often needed. Microwaves are electromagnetic waves whose frequency ranges lie between that of radio waves and infrared radiation. Microwave is of rapid, volumetric and selective heating source. This study describes the evaluation of the possible use of microwave heating as a new sludge thermal treatment technology and faster sludge drying and dewatering technique.

In this study, a domestic microwave oven was modified and converted into batch microwave oven with continuous weight an temperature measurement. Four different types of sludge were microwave dried under different operating condition to investigate the microwave potential in drying domestic, agriculture, and chemical sludge.

The study shows that microwave drying is more efficient than convective drying up to about 20 to 36 times and ohmic heating up to 2.5 times depends on the sludge type. . Microwave still slow and not efficient at final stage of drying or at low residual moisture content. Agriculture sludge (Palm Oil sludge) was dried faster than other types under microwave energy

Volume of sewage and palm oil sludge reduces up to five times by the conventional drying process, eight times by the microwave drying process and eleven times by the incineration process.

Microwave treatment show more stable end product than dried sludge but less than incinerated ash in terms of the leaching properties, and it is less than the maximum limits stated by US EPA for disposal of waste to landfill.

Finally, the effect of the sludge type on the gas emissions during microwave drying was investigated. Gas Emissions fluctuates during microwave treatment of sludge. CO_2 and SO_2 emissions increase at the end of the microwave drying process due to the increase in the temperature and the burning of the dry sludge powder.

Abstrak tesis dikemukakan kepada Senat Universiti Putra Malaysia sebagai memenuhi keperluan untuk ijazah Master Sains

POTENSI DARIPADA PEMANASAN GELOMBANG MIKRO UNTUK PENGURANGAN AIR DAN PENGERINGAN LUMPUR SISA

Oleh

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December 2003

Pengerusi: **Profesor Azni Idris, Ph.D.**

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Aktiviti industri dan tempatan menghasilkan lumpur sisa yang besar. Pada masa sekarang ini pengurangan isipadu daripada lumpur sisa adalah diperlukan. Pengeringan lumpur sisa untuk mengurangi isipadu dan jisim adalah penting dalam pengurusan lumpur sisa. Pengurangan air dengan penyaring bertekanan atau penggempar tidak selalu sesuai dengan peraturan alam sekitar, oleh karena itu pengeringan secara pemanasan adalah diperlukan.

Gelombang mikro adalah gelombang elektromagnetik yang mempunyai julat diantara gelombang radio dan pancaran infra merah. Kajian ini bertujuan untuk menilia mengevaluasi kemungkinan penggunaan gelombang mikro sebagai teknologi rawatan panas, pengeringan dan pengurangan daripada lumpur sisa.

Kajian ini menggunakan pemanas gelombang mikro (ketuhar) tempatan. Empat jenis lumpur sisa yang berbeza dikeringkan dengan gelombang mikro dengan keadaan operasi yang berbeza untuk mengetahui potensi gelombang mikro sebagai pengering tempatan, pertanian dan sisa bahan kimia.

Hasil kajian ini menunjukkan bahawa pengeringan dengan gelombang mikro lebih efisien daripada pengeringan secara "perolakan sehingga" sampai 20-36 kali, bergantung kepada jenis lumpur sisa. Lumpur sisa hasil pertanian (kelapa sawit) lebih cepat kering daripada jenis lumpur sisa yang lain. Isipadu daripada kotoran dan lumpur sisa kelapa sawit berkurang sehingga 5 kali dengan proses pengeringan gelombang mikro dan 11 kali dengan proses pembakaran.

Rawatan gelombang mikro menunjukkan hasil akhir yang lebih stabil daripada pengeringan dan lebih rendah daripada pembakaran dari segi 'leaching properties' dan juga lebih rendah daripada patas maksimum yang ditetapkan oleh US EPA untuk bahan sisa yang akan dibuang ke tanah.

Pengaruh daripada jenis lumpur sisa terhadap rawatan pengeluwan gas juga diselidiki. Pangeluwan gas didapati berubah-ubah selama rawatan lumpur sisa dengan gelombang mikro. Gas CO_2 dan SO_2 meningkat pada akhir proses pengeringan kro disebabkan oleh meningkatnya suhu pembakaran tepung lupur sisa .

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WISSAM N OMAR

January 2004

I certify that an Examination Committee met on date of viva to conduct the final examination of Wissam N Omar on his Master of Science thesis entitled "Sludge Dewatering and Drying Using Microwave Heating" in accordance with Universiti Pertanian Malaysia (Higher Degree) Act 1980 and Universiti Pertanian Malaysia (Higher degree) Regulations 1981. The Committee recommends that the candidate be awarded the relevant degree. Members of the Examination Committee are as follows:

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This thesis submitted to the Senate of Universiti Putra Malaysia has been accepted as fulfillment of the requirement for the degree of Master of Science. The members of the Supervisory Committee are of follows:

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DECLARATION

I hereby declare that the thesis is based on my original work for quotations and citations which have been duly acknowledged. I also declare that it has not been previously or concurrently submitted for any other degree at UPM or other institutions.

WISSAM N OMAR

Date:

TABLE OF CONTENTS