UNIVERSITI PUTRA MALAYSIA

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By

MOHD NAZERI BIN SALLEH

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

April 2003

TO MY BELOVED

PARENTS	:	Hj. Salleh bin Harun Hjh. Sepiah bt Saamah
WIFE	:	Wan Fatimah bt. Wan Daud and
CHILDREN	:	Muamar Adib Hakimi Muamar Zul Ikhman Muamar Zil Haniff Muamar Aliff Imran

'as a source of inspiration'

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

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April 2003

Chairman : Associate Professor Mohd Nasir bin Hassan, Ph.D.

Faculty : Science and Environmental Studies

At present, the Kuala Lumpur City Hall (KLCH) is facing problems in the disposal of their solid wastes due to the rapid increase in the amount generated as a result of rapid urbanisation. Existing landfill site at Taman Beringin is already exhausted and should be closed at any time. Due to this problem, there is a move to treat the solid wastes by thermal treatment technologies. Data on the characteristics of the solid waste is lacking and not reliable for the evaluation of these technologies. In addition, models for estimating the heating value based on the characteristics of Kuala Lumpur wastes are not available. This study was carried out to determine the characteristics and consequently develop the models for estimating the heating value of the Kuala Lumpur solid wastes.

The study analyses and evaluates the physical and chemical characteristics of Kuala Lumpur solid wastes. The study was conducted at Taman Beringin Landfill

from Mac 2000 to Jun 2000. A total of 26 samples were obtained from various sources including residential, commercial, institutional, cleansing and light industrial wastes. The truckload method was used for the sampling and characterising the physical components of wastes. The proximate and ultimate analysis of the wastes were also carried out.

The results of the study showed that Kuala Lumpur wastes constitute 56.29 food and putrescible wastes, 8.23 paper, 13.04 plastics, 1.29 textiles, 0.41 rubber and leather, 1.84 wood, 6.90 yard wastes, 1.55 glass, 2.07 ferrous, 0.30 aluminum, 6.41 other inorganics and 1.29 % of oversized bulky wastes (OBW). The results also show that the average bulk density of solid waste was 265.0 kg/m^3, and contained 54.6 % of moisture, 28.0 volatile matter, 4.9 fixed carbon and 12.5 of ash content. The average higher heating value is 1802 kcal/kg and the lower heating value is 1527 kcal/kg. The average percentage weight of C, H, N and O are 18.62, 2.72, 0.44 and 11.28 %, respectively. The results also shows that sulfur content is less than 0.20 % which contributes minimum error in the heating value estimation.

From this study, three types of models were developed to estimate the heating value of the wastes. Those models are based on composition and moisture content; the second model is based on proximate analysis and third model is based on ultimate analysis. The analyses show that, the model based on waste composition and moisture content is more convenient to use with minimal laboratory works. The best fit model is $HHV_{wet} = 1584.337 + 18.644F + 28.796Pa + 54.457Pc -$

32.596M (R^2 = 0.857), where HHV_{wet} is Higher Heating Value of wastes in kcal/kg in wet basis, F is percentage weight of food and putrescible wastes, Pa is percentage weight of paper wastes, Pc is percentage weight of plastic wastes and M is the moisture content of the waste. The best fit model based on proximate analysis is LHV_{wet} = -569.549 + 80.313 (VM) (R^2 = 0.656) where LHV_{wet} is lower heating value in kcal/kg in wet basis, and (VM) is percentage weight of volatile matter in wet basis. The best fit model based on the ultimate analysis is LHV_{wet} = -335.460 + 122.526C - 24.737O (R^2= 0.936), where LHV_{wet} is lower heating value in kcal/kg in wet basis, C is percentage weight of carbon in wet basis and O is percentage weight of oxygen in wet basis.

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

CIRI-CIRI FIZIKAL DAN KIMIA SISA PEPEJAL YANG DILUPUSKAN DI TAPAK PELUPUSAN TAMAN BERINGIN, KUALA LUMPUR

Oleh

MOHD NAZERI BIN SALLEH

April 2003

Pengerusi : Profesor Madya Mohd Nasir bin Hassan, Ph.D.

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Dewan Bandaraya Kuala Lumpur (DBKL) kini menghadapi masalah dalam pelupusan sisa pepejal di sebabkan peningkatan jumlah penjanaan sisa yang mendadak, sejajar dengan kepesatan urbanisasi. Tapak pelupusan sisa pepejal yang sedia ada di Taman Beringin telah sarat dan akan ditutup bila-bila masa. Susulan dari masalah tersebut, satu cadangan telah dibuat untuk merawat sisa pepejal dengan menggunakan teknologi rawatan termal. Data berkaitan dengan sisa pepejal di Kuala Lumpur adalad tidak lengkap dan diragui untuk penilaian teknologi ini. Tambahan pula, model bagi menganggar nilai haba berdasarkan ciri-ciri sisa pepejal Kuala Lumpur masih belum ada. Oleh yang demikian, kajian ini dijalankan untuk menentukan ciri dan selanjutnya membangunkan model untuk membuat anggaran nilai haba bagi sisa pepejal di Kuala Lumpur.

Kajian ini telah menganalisis dan membuat penilaian ke atas ciri fizikal dan kimia sisa pepejal yang dihasilkan di Kuala Lumpur. Kajian telah dijalankan di tapak Pelupusan Taman Beringin selama tiga bulan bermula Mac hingga Jun 2000. Sejumlah 26 sampel telah diambil daripada pelbagai sumber sisa pepejal termasuk dari perumahan, perdagangan, institusi, aktiviti kebersihan dan industri ringan. Persamplen dan pencirian komponen fizikal sisa pepejal telah menggunakan kaedah 'truckload'. Analisa hampiran dan muktamad juga dijalankan.

Keputusan yang diperolehi menunjukkan bahawa kandungan sisa pepejal di Kuala Lumpur terdiri daripada 56.29 sisa makanan, 8.23 kertas, 13.04 plastik, 1,29 kain, 0.41 getah dan kulit, 1.84 kayu, 6.90 sisa kebun, 1.55 kaca, 2.07 logam, 0.30 aluminium, 6.41 lain-lain sisa inorganik dan 1.29 % sisa bersaiz besar. Keputusan juga menunjukkan purata ketumpatan pukal sisa pepejal adalah 265.0 kg/m^3, dan kandungan kelembapan sebanyak 54.6 %, bahan mudah mengwap sebanyak 28.0 %, karbon tetap sebanyak 4.9 % dan kandungan abu sebanyak 12.5 %. Purata nilai haba tinggi and rendah bagi sisa tersebut adalah 1802 kcal/kg dan 1527 kcal/kg. Purata peratus berat bagi C, H, N dan O adalah masing-masing 18.62, 2.72, 0.44 dan 11.28 %. Kajian juga menunjukkan kandungan sulfur adalah kurang dari 0.20 peratus dan memberikan sisihan minimum dalam penganggaran nilai haba.

Dari kajian ini, tiga jenis model telah dibangunkan bagi menganggar nilai haba iaitu model berasaskan komposisi dan kandungan kelembapan, model kedua berasaskan analisis hampiran dan ketiga model berasaskan analisis muktamad.

Kajian telah menunjukkan model berasaskan komposisi dan kandungan kelembapan adalah lebih mudah digunakan serta penggunaan kerja makmal yang minima. Antara model tersebut, model yang terbaik adalah HHV_{wet} = 1584.337 + 18.644F + 28.796Pa + 54.457Pc – 32.596M (R^2 = 0.857), dimana HHV_{wet} adalah nilai haba tinggi sisa pepejal dalam keadaan basah (kcal/kg), F adalah peratus berat sisa makanan, Pa adalah peratus berat kertas, Pc adalah peratus berat plastik dan M adalah kandungan kelembapan sisa pepejal. Model yang terbaik berasaskan kepada analisa hampiran adalah LHV_{wet} = -569.549 + 80.313 (VM) (R^2 = 0.656), dimana LHV_{wet} adalah nilai haba rendah sisa pepejal dalam keadaan basah (kcal/kg) dan (VM) adalah peratus berat bahan mudah mengwap dalam keadaan basah. Model terbaik berasaakan analisa muktamad adalah LHV_{wet} = -335.460 + 122.526C - 24.737O (R^2= 0.936) dimana LHV_{wet} adalah nilai haba rendah sisa pepejal dalam keadaan basah (kcal/kg), C adalah peratus berat karbon dalam keadaan basah dan O adalah peratus berat oksigen dalam keadaan basah.

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TABLE OF CONTENTS

LIST OF TABLES