

PREFACE

Praise is to God upon his blessing, mercy, health and guidance inlead up to the completion of this thesis titled" Analyzing feasibility of waste to energy technologies using life cycle assessment method based on waste stream composition in Surakarta City. This thesis is one of the requirements for achieving Master degree in Environmental Science under postgraduate program study at the Sebelas Maret University. The completion of this thesis will not be successful without the help of the following parties, both in material and spiritual wise. For that, the author would like to thank;

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The author realized that in writing this thesis there is still many shortcomings. Therefore, the author expects criticism and constructive suggestions. The author hopes that this thesis can provide benefits, both for writers and students in need.

Surakarta, 30th June 2016

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ABSTRACT

Increase in volume of waste generated by municipal residents, change in the quality of waste composition and the treatment and disposal method of waste collected are of major concern in Surakarta City which needs urgent workable solutions, hence, this research study has been necessitated.

The objectives of this study is to (1) determine the existing condition of waste stream composition in Surakarta City, and (2) evaluate, based on the result of waste stream composition study, under what circumstances waste to energy technologies will be feasible in Surakarta City using life cycle assessment. In carrying out this research simple random sampling was used. At the final landfill site, measurement on weight, separation of waste into different categories were made and recorded. Proximate analysis was undertaken at the laboratory to determine the moisture content, volatile matter content, ash content, fixed carbon content and calorific value of selected samples of MSW. Finally, life cycle assessment method was used as an analytical tool to assess the feasibility of suitable waste to energy technologies based on the results of waste quantity and composition study undertaken in Surakarta City.

The results showed that out of the samples of MSW collected, 11 types of wastes were identified including food waste, plastic, wood waste, paper, leaf, vegetable, metal, yard waste, textile, rubber and others. Out of these wastes, leave waste was found to be highest with 21.96%, followed by food waste 18.35%, vegetable waste 16.08%, paper with 11.07%, and plastic with 10.92%, wood waste with (5.8%), yard waste (4.63%), textile (4.13%), rubber (2.93%) and other smaller fractions which make up of 4%. In general, MSW in Surakarta City is largely made up of 67% of organic components of waste while inorganic components of wastes make up another 33%. The results of proximate analysis indicated that organic wastes had high moisture content of 81.67% compared to inorganic wastes with 25.8%. On average, the samples of MSW contributed high volatile solids of 35%, ash content of 6.3% and fixed carbon content of 5.5% respectively. The overall result of calorific value was high and found to be 15,770 MJ/kg as dry basis. In this case, inorganic fractions of wastes have high calorific value in general as compared to organic wastes.

Based upon the condition of waste composition identified, when performing life cycle assessment, the result showed that out of all the waste to energy technologies discussed, incineration technology was found to be the most viable form of waste to energy technology option. Incinerating MSW decrease the space they take up and reduce the stress on landfill experienced at Putri Cempo landfill site.

Key word: waste composition, waste to energy, life cycle assessment

Abstrak

Willie Susuki. A131408022.2016. Analisis Kelayakan Sampah Untuk Teknologi Energi Menggunakan Metode Penilaian Siklus Hidup Berdasarkan Komposisi Sampah di Kota Surakarta. Tesis. Pembimbing I: Prof. Ir.Ari Handono Ramelan, MSc. (Hons), Ph.D. Pembimbing II: Prof. Dr. Dwi Aries Himawanto, S.T., M.T

Peningkatan volume sampah yang dihasilkan oleh masyarakat kota, menyebabkan perubahan kualitas komposisi sampah dan pengelolaan sampah yang terkumpul menjadi perhatian utama di Kota Surakarta yang membutuhkan solusi yang bisa diterapkan.

Tujuan dari penelitian ini adalah untuk mengetahui dan mengevaluasi kondisi komposisi sampah di Kota Surakarta. Berdasarkan hasil penelitian terhadap komposisi sampah, yang dapat dimanfaatkan sebagai teknologi yang dapat menghasilkan energi yang layak di Kota Surakarta menggunakan penilaian siklus hidup. Teknik sampling dalam penelitian ini adalah *simple random sampling*. Di Tempat Pemrosesan Akhir, pengukuran berat sampah, pemilahan sampah menjadi kategori yang berbeda kemudian dicatat. Analisis proksimat dilakukan di laboratorium untuk menentukan kadar air, kadar zat terbang, kadar abu, kadar karbon tetap dan nilai kalor dari sampel yang dipilih dari sampah kota. Akhirnya, metode penilaian siklus hidup digunakan sebagai alat analisis untuk menilai kelayakan sampah yang sesuai untuk teknologi yang menghasilkan energi berdasarkan hasil kuantitas sampah dan studi komposisi dilakukan di Kota Surakarta.

Hasil penelitian menunjukkan bahwa dari sampel sampah kota dikumpulkan, 11 jenis sampah yang diidentifikasi termasuk sisa makanan, plastik, limbah kayu, kertas, daun, sayuran, logam, sampah pekarangan, tekstil, karet dan lain-lain. Beberapa sampel yang telah teridentifikasi diantaranya adalah dedaunan sebanyak 21,96%, sisa makanan sebanyak 18,35%, sayuran sebanyak 16,08%, kertas sebanyak 11,07%, plastik sebanyak 10,92% dan komposisi jenis sampah lainnya. Secara umum, sampah di Kota Surakarta sebagian besar terdiri dari 67% komponen organik dari limbah sementara komponen anorganik dari limbah membuat lagi 33%. Hasil analisis proksimat menunjukkan bahwa sampah organik memiliki kadar air yang tinggi dari 81,67% dibandingkan dengan sampah anorganik dengan 25,8%. Rata-rata, sampel dari sampah kota memiliki kadar volatil yang tinggi 35%, kadar abu 6,3% dan kandungan karbon tetap 5,5%. Hasil keseluruhan dari nilai kalori dan ditemukan 15.770 MJ/kg. Pada kasus ini, komposisi anorganik dari sampah memiliki nilai kalori yang tinggi pada umumnya dibandingkan dengan limbah organik.

Berdasarkan kondisi komposisi limbah yang teridentifikasi, saat melakukan penilaian siklus hidup, teknologi insinerasi menjadi pilihan yang paling layak pada pilihan teknologi penghasil energi.

Kata kunci: komposisi sampah, sampah menjadi energi, penilaian siklus hidup

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ABBREVIATION

Initial Letter	Full Texts
LCA	Life Cycle Assessment
MSW	Municipal Solid Waste
ASTM	American Society of Testing and Methods
AD	Anaerobic Digestion
ISO	International Standard of Organization
LCIA	Life Cycle Impact Assessment
MCO	Multi- Criteria Optimization
MCA	Multiple Criteria Analysis
UNEP	United Nation Education Population
WTE	Waste to Energy
RW	Rukun Warga
RT	Rukun Tetangga
GDP	Gross Domestic Product
DKP	Dinas Kebershian dan Pertamanan (Department of Cleanliness and Sanitation)
SWM	Solid Waste Management
DPP	Dinas Pelayanan Pajak (Department of Market Management)