LOW-TEMPERATURE MICROWAVE PYROLYSIS OF SEWAGE SLUDGE

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ABSTRACT

Microwave pyrolysis is proposed as one of several optional technologies for disposing and recycling sewage waste in Malaysia. In this study, sewage sludge was dried and pyrolyzed at low temperature (maximum 650ºC) in a single process at laboratory scale. Sewage sludge was placed in a quartz reactor, which was placed in a microwave cavity oven. The modified household microwave oven used has a frequency of 2.45 GHz and input power of 700 W. Graphite was used as microwave absorber in order to facilitate the sewage sludge to reach temperature required for pyrolysis process to take place. The carbonaceous residue (char) and pyrolytic oil produced were analyzed for the proximate and ultimate composition and the gross calorific value. It is found that in this study, the overall heating rate was 118 ºC/min with heating time of 5 minutes. Microwave pyrolysis of sewage sludge at 650°C gives rise to formation of about 28% char, 6% pyrolytic oil and 68% non-condensable gases (dry basis).The gross calorific value of the pyrolytic oil was 28852 kJ/kg, which is higher than that of lignite and sub-bituminous coal thereby reflecting the potential of this fraction as fuel material.

Keywords: *sewage sludge, pyrolysis, low-temperature, microwave, drying*

INTRODUCTION

The problem of sewage sludge disposal is proving to be one of the most complex environmental problems nowadays. The amount of sewage sludge generated by wastewater treatment plants has been increasing at a rapid pace in recent years and has drawn serious attention from the society. In Malaysia, approximately 3 million m^3 of sewage sludge is produced by Indah Water Konsortium (IWK) annually and the total cost of managing was estimated at RM 1 billion. This sludge volume is expected to rise to 7 million m^3 by year 2020 [1].

Handling this waste is not easy and inevitably gives rise to some collateral pollution. Present practice in Malaysia is either to co-dispose it with solid waste at landfill sites or direct disposal in shallow trenches [1]. However, disposal by land filling and trenches require a lot of space and the soil has to be sealed adequately to prevent leaching of harmful compounds. Therefore, the country has to adopt a more practical, economic and acceptable approach in managing and disposing sewage sludge.

Sewage sludge is abundant in volatile matter and therefore represents a valuable resource which can be converted to useful products if it is subjected to the suitable treatment. In the past decade, the pyrolysis of sewage sludge is receiving increasing attention as an economic and environmentally acceptable route to waste disposal. The products of pyrolysis are gas, oil and carbonaceous residue. More importantly, the gas can be used as fuel [2,3,4]. The carbonaceous residue can also be burnt as fuel, disposed of – since the heavy metals are fixed inside the carbonaceous matrix – or be upgraded to activated carbon [5], and the oil can either be used as fuel or as raw material for chemicals [6].

In microwave pyrolysis, sewage sludge with high moisture content undergoes drying and pyrolysis in a single step [3, 5]. An advantage in microwave process is the short time needed to achieve heating compared to conventional heating methods [7]. Other characteristics of microwave process that are not available in conventional processing of materials are; penetrating radiation, controllable electric field distributions, selective heating of materials through differential absorption, and self-limiting reactions [8].

In previous studies conducted on microwave pyrolysis of sewage sludge, focused was the sewage sludge pyrolysis at high temperature using a 1000 W microwave oven, (temperature ranging from 800 to 1000°C) which maximizes the production of non-condensable gases [3, 5, 7]. Although thorough discussions on the