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Recovery of plastic wastes from dumpsite as refuse-derived fuel and its utilization in small gasification system

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ABSTRACT

An effort to utilize solid wastes at dumpsite as refuse-derived fuel (RDF) was carried out. The produced RDF briquette was then utilized in the gasification system. These wastes were initially examined for their physical composition and chemical characteristics. The wastes contained high plastic content of 24.6–44.8%, majority in polyethylene plastic bag form. The plastic wastes were purified by separating them from other components through manual separation and trommel screen after which their content increased to 82.9–89.7%. Subsequently, they were mixed with binding agent (cassava root) and transformed into RDF briquette. Maximum plastic content in RDF briquette was limit to 55% to maintain physical strength and maximum chlorine content. The RDF briquette was tested in a down-draft gasifier. The produced gas contained average energy content of 1.76 MJ/m^3, yielding cold gas efficiency of 66%. The energy production cost from this RDF process was estimated as USD0.05 per kWh.

1. Introduction

Open dumping is still the most commonly used disposal methods for municipal solid wastes in developing countries. For example, approximately 65% of collected municipal solid wastes in Thailand is being disposed in open dumpsites (Asian Institute of Technology, 2004). Rapid exhaustion of available space for disposing wastes and public opposition against developing new waste disposal site are creating crisis in waste management operation. An approach involving the practice of waste minimization and recycling is needed to extend the service time of existing waste disposal site. Waste mining provides opportunity to provide disposal space for new coming wastes and recycle of valuable materials. It evolves the excavation, transfer and processing of buried wastes taken from an active or closed landfill or dumpsite. This will also help eliminating potential contaminant sources, cost reduction in post-closure monitoring (Hogland et al., 2004).

Refuse-derived fuel (RDF) is a well-known alternative fuel produced from the combustibles in municipal solid wastes which are composed of waste plastic and other materials such as textiles, wood, soil, etc. compatibility exists for several reasons related to economic, environment, political and social aspects (Chang et al., 1997). Energy recovery as RDF is a preferred option for utilizing plastic wastes when their potential recycling as raw material for product manufacturing is not possible because their physical properties have been damaged during long exposure to sunlight. To produce densified RDF from plastic wastes (ASTM, 2006), it is difficult to obtain briquette with good physical strength for its delivery off the site by using only screw compactor. Usually other binding agent must be mixed with plastic wastes before briquette formation. Well-known agents are molasses fibrous and oily organic wastes, sawdust, bitumen, pitch, sulfite liquor, starch, limestone, dolomite, etc. (Yaman et al., 2001). Biomass usually has fibrous structure and contains oily sticky components which facilitate to form a more dense bulk should be increased to a degree at which transportation expenses becomes less and used facilitate ease of feeding for incineration (Yaman et al., 2000).

For RDF utilization, gasification technology has been applied to the production of energy from solid wastes (Belgiorno et al., 2003). This thermo-chemical process converts solid carbon based material into a combustible gaseous product containing CO_2, CO, H_2, CH_4 and other trace gases. The producer gas can be used for heating, lighting and power generation. Recently, a number of researchers have also applied the gasification system to plastic wastes together with biomass (Pinto et al., 2002; Aznar et al., 2006). Even though fluidized and fixed bed steam gasification has proven to be a possible way of converting biomass and plastic undesirable wastes and RDF into fuel gases (Pinto et al., 2002; Dalai et al., 2009), direct gasification using vertical fixed bed gasification system and air as gasifying agent is commonly used in developing countries, especially for biomass utilization (Sheth and Babu,

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