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Special Issue: Advanced Thermal Treatment of Waste

Pyrolysis and gasification are advanced thermal treatment technologies which are generating increasing interest as viable alternative environmental and economic options for waste processing. This interest is illustrated, for example, by the recent updating of the Defra guide to the Advanced Thermal Treatment of Municipal Solid Waste (2013). The guide providing local authorities with information on the technologies, potential markets for the product outputs, contractual and financing issues, and planning and permitting. Pyrolysis and gasification offer process routes to recover a range of useful and in some cases high value products from various waste streams. Depending on the technology, the waste can be processed to produce gas or oil products for use as fuels or petrochemical feedstocks and/or a carbonaceous char for use in applications such as effluent treatment or for gasification feedstock. Advantages of such thermal treatment processes include ease of transportation, storage and the decoupling of the production and end-use of the energy source. Pyrolysis and gasification technologies are at the commercial scale, but there is significant research to improve the efficiency of systems, enhance product yield, trial new types of waste and the development of next generation technologies. This special issue of Waste and Resource Management reflects the research being undertaken by industry and academia to advance even further the technologies of pyrolysis and gasification.

Riley (2014) has produced a thought provoking Briefing on Energy from Waste, raising issues of relevance to the incineration, pyrolysis and gasification industries and academia. Technical issues of operating incineration plants and the particular technological challenges of pyrolysis and gasification are presented. The Briefing also acknowledges and discusses that in addition to the technical issues, political, environmental and economic issues are equally important. Riley concludes with an invitation to potential authors of Waste and Resource Management to come forward with papers to address these key discussion topics of energy from waste.

The pilot scale pyrolysis of municipal solid waste and different types of plastic waste using a screw kiln reactor is reported by Miskolczi (2014) from the University of Pannonia, Hungary. The pyrolysis product oil produced by the reactor is fractionated directly in a separator to produce heavy and light oil fractions. High yields of oil could be obtained from the process, for example, municipal solid waste produced 35 wt% light oil in addition to 24 wt% gases. Detailed analysis of the oils and gases produced from the different waste streams are presented in terms of their composition and also the oils are characterised in terms of their fuel properties. Municipal solid waste is a difficult waste stream to process using pyrolysis because of its heterogeneous nature and this is illustrated in the paper by the presentation of analysis of contaminants in the waste feedstock and the product oils and gases.

Chapman et al (2014) report on a modelling and experimental study of the use of oxygen in relation to the fluidised bed gasification of refuse derived fuel. Air is commonly used as the source of oxygen for the partial oxidation (i.e. gasification) of wastes and the typical calorific value of the product gas is between 4-5 MJ/Nm^3. However, using oxygen-based gasification can increase the calorific value to 10-12 MJ/Nm^3. The paper reports on the use of process simulation software to predict the influence of different mixtures of the gasifying agents, air, oxygen and steam with oxygen contents from 21% to almost 100%. The modelling results were validated using an experimental pilot scale fluidised bed reactor with maximum throughput of up to 100 kg/h (Taylor et al, 2013). A techno-economic analysis of the use of oxygen in the gasification process is also presented and discussed in comparison with conventional air gasification.

The theme of using oxygen in the gasification process is also taken up the paper of Du et al (2014). The research group from Huazhong University of Science and Technology (PR China) report on some fundamental work on the use of oxygen and steam for the gasification of biomass in the form of palm oil wastes. The experiments were carried out in a bench scale thermogravimetric analyser coupled to an infra-red analyser which measured the product gas composition. The pyrolysis and gasification of the waste biomass were also simulated using thermodynamic equilibrium software to model the chemical reactions and processes involved. The research showed that both oxygen and steam inputs significantly influence the gasification of biomass and that the temperature of gasification is also a major factor in the process. They conclude that the optimum input of gasifying agents for the biomass waste gasification system can be determined through calculation based on thermodynamic equilibrium together with experimental trials.

Hydrogen is viewed as a potential major low carbon fuel source since when it is combusted only water is the product. This compares with the emission of greenhouse gases when fossil fuels are combusted. Currently by far the majority of hydrogen is generated from fossil fuels, therefore, there is interest in producing hydrogen from alternative feedstocks, such as wastes. Wu and Williams (2014) report on a two-stage pyrolysis-gasification process to produce hydrogen from waste plastics using a 1st stage scale screw kiln pyrolysis reactor and a 2nd stage catalytic, steam reactor. A range of process parameters were investigated, including the type of catalyst, gasification temperature and steam input. They show that a syngas with hydrogen concentrations of ~60 Vol.% can be produced from the plastics.

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