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DEPARTMENT OF PROCESS ENGINEERING AND APPLIED SCIENCE

TITLE OF THESIS:	WASTE DERIVED FUELS FOR CO-PROCESSING IN ROTARY CEMENT KILNS
TIME/DATE:	12:00 pm, Monday, November 14, 2016
PLACE:	Room 3107, The Mona Campbell Building, 1459 LeMarchant Street

EXAMINING COMMITTEE:

Dr. William Hallett, Department of Mechanical Engineering, University of Ottawa (External Examiner)

Dr. Donald Jones, Department of Civil and Resource Engineering, Dalhousie University (Reader)

Dr.Jan Haelssig, Department of Process Engineering and Applied Science, Dalhousie University (Reader)

Dr. Michael Pegg, Department of Process Engineering and Applied Science, Dalhousie University (Co-Supervisor)

Dr Mark Gibson, Department of Civil and Resource Engineering, Dalhousie University (Co-Supervisor)

DEPARTMENTAL REPRESENTATIVE:	Dr. Adam Donaldson, Department of Process Engineering and Applied Science, Dalhousie University
CHAIR:	Dr Lorn Sheehan, PhD Defence Panel, Faculty of Graduate Studies

ABSTRACT

Co-processing waste as alternative fuel in cement kilns presents a two-pronged solution to cost and environmental concerns in resource utilization. It is the simultaneous recovery of energy and recycling of resources where waste from different sources are used in the manufacture of a valuable commodity such as cement. In this study, bench-scale and full-scale experiments have been used to identify and characterize examples of Waste-derived Fuels (WDF) available for co-processing in cement kilns in Nova Scotia, Canada.

Field trials were used to select optimum kiln delivery approaches which overcame practical operational challenges in the delivery of Waste Asphalt Roofing Shingles (WARS) into the local cement kiln. The consumption of shingles was improved from 5% to 17% by mass of total fuel combusted.

A bench-scale tube furnace was used to determine the Volatile Organic Compounds (VOC) content and particle distribution of combustion products generated from WDF. Plastic-derived Fuel (PDF) from Low Density Polyethylene (LDPE) film, plastic containers and Expanded polystyrene (EPS) were found to have more suitable characteristics compared to waste carpets and discarded clothing on an equivalent energy basis. The bench-scale VOC trends with respect to calorific value, moisture content and ash content matched full-scale trends of clinker production rate, kiln gas flowrate and kiln gas temperature studied in full-scale tests conducted in this work and by others.

A Heated Grid Reactor (HGR) was designed and constructed, and then used in conjunction with Thermogravimetric Analysis (TGA) and emission measurements, in several combustion experiments on waste plastics, waste shingles and blends with coal and coke. Particulate emissions sampled from the combustion of the fuel blends containing WDF did not differ significantly from that of the mixture of coal and coke only. Indeed, blending with plastics and shingles was seen to improve the combustion efficiency by reducing the Time to Ignition (TTI) and the extent of devolatilization achieved in the coal and coke fuel samples over a 5 to 10 second fast heating period.

Using these experiments, a bench-scale screening procedure for WDF to be used as cement kiln fuel was applied to study, assess and to provide preliminary expectation for WDF application in a local cement kiln. The results also showed that the proper co-processing of WDF in Nova Scotia will not only result in macro-scale environmental gains, but also improve the efficiency of the combustion process on a micro level and without significantly affecting particulate emissions.