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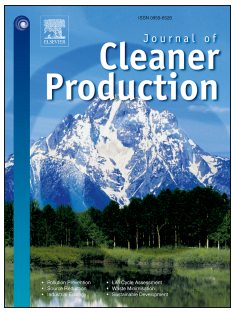

Comparative study on the life-cycle greenhouse gas emissions of the utilization of potential low carbon fuels for the cement industry

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Comparative study on the life-cycle greenhouse gas emissions of the utilization of potential low carbon fuels for the cement industry

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ABSTRACT

A life cycle assessment (LCA) model has been developed to evaluate the greenhouse gas (GHG) emissions associated with the use of alternative fuels in the production of clinker, an intermediate product in the manufacture of cement, and to confirm the categorization of these alternatives as low carbon fuels (LCFs) compared to the conventional use of fossil fuels. This model has included all GHG emission sources associated with clinker production, such as the kiln process, production and transportation of raw materials and fuels, and electricity production. Four potential LCFs are investigated including construction and demolition (C&D) wood waste, asphalt shingles, railway ties, and plastics. At the case study plant (Lafarge Cement in Bath, Ontario), the model estimates that the production of 1 metric tonne (t) of clinker produces a total of 971.4 kg of carbon dioxide equivalents (including all GHGs from fuels and raw materials), of which 388.6 kg CO_2-e are associated with combustion of fossil fuels at a mixture of 99 wt% petroleum coke and 1 wt% coal. Emissions are decreased to 582.6 kg CO_2-e/t clinker (a 40% reduction) when 100% fossil fuels are replaced with C&D wood waste, in which all carbon is from biogenic sources. If the volume of C&D waste required to fuel 100% of cement plant operation were to be diverted from a typical landfill (with no flaring or energy recovery), emissions equivalent to 488.6 kg of CO_2-e/t clinker would be avoided. Using 100% C&D waste, the reduced emissions in energy production coupled with avoided emissions at the landfill would effectively reduce total emissions at the plant by more than 90% compared to the baseline emissions associated with fossil fuel use. All four of the alternative fuels examined with the model provided significant GHG emission reductions at higher substitution rates, confirming their characterization as LCFs, and suggesting that the use of LCFs in cement manufacture can be effective in reducing emissions associated with global warming. Since the LCA model is able to predict the global warming potential (GWP) for any potential LCFs at any substitution ratios, it may be used as a pre-screening tool for the selection of future LCFs for the cement and other carbon-intensive industries, facilitating increased LCF usage and hence contributing to GHG reductions across the cement sector.

Keywords: Clinker, greenhouse gas, landfill, life cycle assessment, low carbon fuel