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Bio-catalytic upgrading of heavy and pyrolysis oils: Optioneering of fossil, biorefined and renewable resources

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As fossil fuels deplete, attention is turning intensively by carbon emitting and environmentally damaging extraction methods to use heavy oils and bitumens. *In situ* catalytic upgrading can use platinum group metals (PGMs) in a once through process, which decreases oil viscosity *in situ* and is cleaner, whilst being prohibitively expensive. The once through process also wastes limited PGM resources. For new technologies to become market competitors, they must be either substantially cheaper than their competitors or achieve an outcome that is difficult by current methods. Classical life cycle analysis (LCA) focuses on salient ecological impacts but bypasses key economic aspects and does not assign quantifiable benefits. This research factors in the benefits of environmental protection, reduced CO_2 emissions and the environmental impact of oil extraction and fuel production using a 'well to gate' LCA (also known as cradle to gate), as well as the economics involving the mitigation of 'landfill gate fees' for waste resources and social cost of carbon. The case histories evaluated the involved catalysts biorefined from wastes for application in cleaner extraction, upgrading and processing of heavy fossil and pyrolysis bio-oils, with comparison to their commercial counterparts. Each oil case history has been analysed with both a commercial catalyst and a biocatalyst, which are assessed as an alternative catalyst in oil ratios (%eq. of g/g). Pyrolysis bio-oils from waste wood and algal sources were successfully found to be upgradable using both catalysts. They produce carbon-neutral fuels because of carbon sequestration during photosynthetic biomass growth, and the bacterial components supporting the catalyst become assimilated into the fuel.

Biography

S A Archer is a PhD candidate, studying for a Doctorate in Hydrogen, Fuel Cells and their Applications, whilst working with the Resource Recovery from Wastes programme (RRfW). Her knowledge and skills involve the application of life cycle thinking and environmental impact assessments to produce liquid and gaseous fuel products from biomass and waste residues in addition to biorefined neo-catalysts from resources recovered from waste streams. Her work aims to conduct an LCA on the catalytic upgrading of both heavy fossil oil and pyrolysis oils from dry biomass, comparing commercial and biocatalysts. The environmental impact for each pathway will be identified within a 'well to gate' (cradle to gate) system boundary, alongside an additional fuel use analysis separate from the LCA.

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