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Editorial

Sustainable Industrial Processes

Industries face mounting challenges in the paradigm shift to a more circular economy. Research and development is increasingly focused on finding ways to turn waste into resources, recover energy and materials and make better use of resources extracted from the natural environment. At the same time industry and consumers seek to cause less harm in the form of pollution or CO_2 emissions. In this issue of the *Johnson Matthey Technology Review*, we look at current and future technologies that may be used by industries including energy, fuels, chemicals, pharmaceuticals and transport to create the products we need while meeting the United Nations (UN) 2030 goals for sustainable development (1): "development that meets the needs of the present without compromising the ability of future generations to meet their own needs" (2).

Resources from Biomass and Waste

Continuing the theme from our previous issue (3), several articles present different approaches to future fuels and chemicals. These approaches include water electrolysis, utilisation of biomass and waste and CO_2 reduction.

Electrification will provide alternatives to fossil fuel use in many areas of industrial science and technology but some areas like long-haul aviation will likely continue to need liquid fuels. These fuels will be provided through one or more of the technologies being developed today. For example, a technology recently commercialised by Johnson Matthey and bp uses a Fischer-Tropsch process to create sustainable jet and diesel fuels from waste, biomass or existing CO_2 emissions. The challenges involved in achieving a commercially viable process at scale are explained.

The technoeconomics and life cycle assessment of producing sustainable commodity chemicals from waste biomass using aerobic fermentation at scale are explored in another Johnson Matthey collaboration, this time with the University of Nottingham and Northumbria University, UK. Rigorous process modelling has determined at what point the production of commodity chemicals from a lignin source will become commercially viable. The future of this promising technology looks bright, with the authors concluding that their platform has promise as a best-in-class technology for the production of a broad spectrum of renewable commodity chemicals.

Activated carbon can be produced and characterised from biomass waste for applications in environmental protection, clean energy and catalysis. The work is presented by Gebze Technical University, Turkey, in collaboration with Gasification Consultancy Ltd, UK. Waste biochar from the gasification of biomass is the feedstock, and removal of contaminants is key to its successful use.

Reducing CO_2 emissions from iron metallurgy will become increasingly important. The electrification of primary iron production in a carbon-free process is presented in a collaborative research article from National Technical University of Athens, Laboratory of Metallurgy and Mytilineos SA, Metallurgy Business Unit-Aluminium of Greece. The technology is demonstrated at an early stage with additional optimisation recommended by the authors. Catalytic hydrogenation of CO_2 to methane using power-to-gas combined with biomass gasification is another option to reduce the CO_2 emissions of the steel industry, presented by Montanuniversität Leoben, Johannes Kepler Universität Linz and K1-MET GmbH, Austria.

Circular Economy

This journal has long championed sustainable technologies involving the precious metals. Metals are inherently recyclable and none more so than the platinum group metals (4). Today's focus on electrification of transport and energy means that elements such as lithium, nickel, cobalt and manganese join their precious cousins as critical materials for the clean energy revolution. Clean and efficient extraction of these minerals from spent lithium-ion cathodes is an emerging area of study that will become increasingly important in the coming years when batteries begin to reach end-of-life. Recycling techniques need to be developed for the sustainable development of the lithium-ion batteries industry as discussed in this issue. Meanwhile life cycle assessment of the entire lithium-ion batteries production process from both primary ore and recycled material is provided in the output from an Innovate UK project involving Johnson Matthey and the Warwick Manufacturing Group, UK.

A Cleaner Environment

Energy efficiency will be a key enabler for a transition to a low carbon future. High technology industries like electronics, energy and medical applications require novel materials and processes. Cooling is a challenge, especially at the microscale. Nanofluids containing titania offer a potential solution and are investigated in this issue.

Conventional technologies will continue to be used alongside newer ones. To help define the next generation of emissions legislation to clean up the air in China, a portable emissions measurement system was used to investigate on-road tailpipe volatile organic compounds emissions in diesel trucks compliant with Euro III–V. The results with recommendations from the authors are presented in this issue.

Conclusion

It will become apparent from reading this issue that collaborations both within and between industry and academia are vital to progress. The research projects described here are just a selection. Many more advances can be expected in the coming years and decades as fruitful collaborations continue apace, with industry and academia working together to meet the challenges of the present and the future.

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