Turning organic waste into renewable biofuel additives using radiation

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Engineers at Lancaster University have led research that discovers a way to generate renewable biofuel additives, using radiation that could be derived from nuclear waste.

The renewable proportion of petrol is set to increase to 20 per cent over the coming years, meaning the discovery of a new production pathway for these additives could help in the fight to cut carbon dioxide emissions and tackle climate change.

In the research paper entitled 'Nuclear-driven production of renewable fuel additives from waste organics', published in the journal *Communications Chemistry*, engineers propose a process to generate one such additive, solketal, using waste from both biochemical and nuclear industries—termed a nuclear biorefinery.

Lancaster University Ph.D. researcher Arran Plant said: "This research presents a new advance that utilizes radiation that could, in the future, be derived from nuclear waste to produce renewable biofuel additives from biodiesel waste, which could then be used in modern petroleum fuel blends. With the renewable proportions of petroleum-derived fuels set to increase from 5 per cent to 20 per cent by 2030, fuel additives sourced this way could help address net-zero carbon emission targets."

Malcolm Joyce, Professor of Nuclear Engineering at Lancaster University, said: "Co-generation with nuclear energy is an important area of current research, for example, using heat alongside the production of electricity. We set out to determine whether radiation might also present a similar possibility, and discovered that it can: in this case yielding a low-carbon fuel additive."

Dr. Vesna Najdanovic, an expert in biofuels from Aston University, and previously at Lancaster University, said: "I am so excited about our work as it reveals a new method for processing wastes from biodiesel industry using spent nuclear energy. This green technology will pave the pathway to use waste as a resource to produce valuable chemicals and biofuels."

Reliable, low-carbon energy from nuclear or biofuels is integral to many

strategies to reduce carbon emissions, however nuclear plants have high upfront costs and the manufacture of biodiesel produces waste glycerol, which has few secondary uses.

Combining technologies to create raw materials from waste glycerol using ionizing radiation could diversify nuclear energy use, and also make a valuable use of biodiesel waste.

Researchers have discovered that leftover energy from spent nuclear fuel can be harnessed to produce a short-lived, radiation-induced catalyst. This catalyst facilitates a reaction that produces both solketal and acetol. This process forgoes the requirement for costly and energy-intensive steps such as pH changes, high temperatures, high pressures or additional catalytic reagents with negligible ongoing radiation-processing costs once fully set up.

Solketal is an emerging fuel additive that increases fuel octane numbers and reduces gum formation, consequently preventing irregular fuel combustion (knocking) and engine efficiency losses while also lowering particulate emissions. Meanwhile, acetol can be used in the production of other useful chemicals such as propylene glycol and furan derivatives, or as a dyeing agent for textile manufacturing.

Considering the scalability of this process to existing nuclear facilities within Europe (i.e. spent fuel pools or contemporary Pressurized Water Reactors), researchers have hypothesized that 10^4 tons per year of solketal could be generated by nuclear co-production. This would equate to significant quantities of usable fuel blend per year.

An increase of 5 per cent to 20 per cent v/v in the renewable proportion of commercial petroleum blends is forecast by 2030, and it was announced recently that E10 petrol will be adopted as the standard grade in the UK. Nuclear-driven, biomass-derived solketal could contribute in

this context towards net-zero emissions targets, combining low-carbon co-generation and co-production.

More information: Plant, A.G. et al, Nuclear-driven production of renewable fuel additives from waste organics, *Commun Chem* (2021). doi.org/10.1038/s42004-021-00572-5

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