Making coal from food waste, garden cuttings – and even human sewage

June 15 2020, by Rex Merrifield, From Horizon Magazine

Millions of tonnes of organic waste are currently dumped in landfill, where it decomposes and gives off greenhouse gases. Credit: Pixabay/Ben_Kerckx, licenced under Pixabay licence

Food waste, garden cuttings, manure, and even human sewage can be turned into solid biocoal for energy generation, and, if scaled up, could help match the industrial demand for carbon with the need to get rid of organic waste and reduce greenhouse gas emissions.

Europe has a biowaste problem. Rather than using the carbon-rich material for fuel, millions of tonnes of organic waste material are dumped in landfill, where it decomposes and gives off greenhouse gases.

At the same time, the EU imports millions of tonnes of coal for industrial use and energy generation. That brings in a raw material that's subject to vulnerable supply chains, adds to carbon emissions and on which the EU aims to decrease its dependency.

Efforts to match those imbalances could find a solution in biocoal—a carbon-neutral commodity made from organic waste that can be used as a source of energy, industrial raw materials or even as a way to store carbon, rather than emit it into the atmosphere.

'(Biocoal) technology can play a strong role (in the market), firstly because we recover high value material, secondly because it is quick, and thirdly … because it can avoid CO_2 emissions," said Marisa Hernandez Latorre, the founder and chief executive of sustainable technology company Ingelia, based in Valencia, Spain.

One way to make the coal substitute is a process known as hydrothermal carbonisation (HTC), which uses superheated water under pressure to produce biocoal in a few hours. It normally takes millions of years for fossil coal to form geologically.

"It's really a very simple and stable process, because it acts like an acceleration of the natural formation of coal," Hernandez Latorre said.

Ingelia has developed a proprietary HTC process for three biocoal plants—in Spain, the UK and Belgium, with a total capacity of 8,000 tonnes of biocoal per year. Several more are awaiting regulatory approval and should double capacity in the next couple of years.

"HTC biocoal … not only avoids the use of hard coal in industrial processes, but also the emission of methane from landfill," Hernandez Latorre said, adding that the technology can recover up to 95% of the carbon from organic waste.

Methane is an even more potent greenhouse gas than carbon dioxide and a notable source is rubbish dumps. Europe abandons millions of tonnes of biowaste in landfill every year, and even where sites have methane-capture systems, a substantial portion of the gas can escape.

Pressure-cooker

Several different HTC methods have been developed, but the process generally works along the lines of a pressure-cooker, though the ingredients range from residue from food or drinks processing, agricultural waste, forestry industry discards such as woodchips and sawdust, to maize cobs and sewage.

The biowaste is put into a device known as a reactor, in temperatures from 180°C-250°C under pressure of the order of 2 megapascals (MPa) or 20 atmospheres. This means the water in the system is superheated, rather than converted into steam.

The reactor converts the solids in the organic material into hard biocoal—also known as hydrochar—while the liquids can be collected separately and used as bio-fertiliser and any gases given off are captured and used to power the system.

The biocoal has similar characteristics regardless of the biowaste used, though different raw materials do influence the quality by determining the ash content. Conditions in the reactor destroy pathogens and the resulting products are sterile. The coal slurry can also be processed to remove stones or shards of glass or metal, before being compressed into briquettes or pellets.

Ingelia's basic HTC process can use food waste, for example, to produce biocoal similar to fossil browncoal, comprising about 60% carbon. This hydrochar can then go through extra steps to make higher-value 'designer' biocoal, removing ash and volatiles to ensure carbon content up to 90% – able to compete with top-grade hard coal.

"We can use (further processing) to tailor the final product, to recover from the bio-material exactly what they need for the industrial processes, in a circular economy (system)," Hernandez Latorre said.

Biocoal briquettes or pellets can be made from organic waste like food scraps. Credit: Ingelia

Greenhouse gases

Hernandez Latorre says that internal Ingelia research shows that between 6.5 and 8.3 tonnes of CO_2 equivalent are avoided per tonne of HTC biocoal produced, compared to a landfill operation with or without a methane-recovery system.

She says biocoal can have a market value of €170 per tonne for the most basic hydrochar, to more than €400 per tonne for top-grade biocoal with the highest carbon content, depending on its intended use.

Ingelia has combined its findings from several research projects into its HTC process and is aiming its technology at industries that rely on coal, sewage processing, which has to deal with organic waste, and energy producers moving away from coal-fired power generation towards renewables.

With the fall in coal prices and demand in the economic slowdown caused by the COVID-19 pandemic, it may take time for biocoal to displace fossil fuels in industry worldwide. But it offers one solution for those obliged to deal with organic waste and to meet the EU's plan to become carbon-neutral by 2050.

Hernandez Latorre, who on 12 June was named the EU's Mission Innovation Champion for her work in clean energy research, sees it playing an increasingly important role in the next 10-15 years.

"The market is really prepared to accept or implement new technologies, the only thing is they need to be sufficiently developed at scale," she added.

Industries need sufficient market availability of biocoal to plan ahead for substitution of fossil fuels. And investors want to be sure they will have enough biowaste to process—and commitment from users to take their products—before they invest in sophisticated HTC units that could cost hundreds of thousands or even millions of euros.

Low-tech

Those set-up costs are prohibitive in many developing countries, even though biowaste poses a problem worldwide.

But a low-cost, low-tech version that uses human faeces to make biocoal and fertiliser could bring a double benefit to places where people lack sanitary facilities, said South Korean researcher Dr. Jae Wook Chung.

He sees potential to both generate income for communities and address their environmental and health problems caused by untreated excrement, citing WHO estimates that 673 million people have to defecate in the open – in the street, behind bushes or into open water.

Research has shown HTC reactors can be made for less than €20,000, but Dr. Chung aims to use a project called FEET to develop an even simpler, cheaper model that can be used in poor, high-density communities such as the Kibera slum in Kenya's capital Nairobi.

He envisages a system about the size of an oil barrel, made with stainless-steel tubing available as a building supply in many developing countries. And he wants to monitor temperature and pressure from outside the reactor, avoiding expensive probes.

Dr. Chung will also focus on ways to ensure a sustainable supply of waste for processing—perhaps through organised emptying of pit latrines or portable lavatories—and to demonstrate the economic benefits of the biocoal and liquid fertiliser.

He sees making a sanitation system profitable for the community as key to making it sustainable, and to providing toilets in regions currently lacking them.

'(The) economic benefit would also help those who have a cultural barrier to using conventional toilets move away from open defecation," he said.

Provided by Horizon: The EU Research & Innovation Magazine

Citation: Making coal from food waste, garden cuttings – and even human sewage (2020, June 15) retrieved 27 April 2024 from https://phys.org/news/2020-06-coal-food-garden-human-sewage.html