Engineers propose greener recycling for medical PPE waste

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Under the intensity of a prolonged pandemic, the world finds an ever-growing and seemingly never-ending waste stream of used surgical masks, plastic face shields, and medical gloves and gowns. Cornell

engineers now offer a solution to sustainably reroute the discarded material.

A medium-temperature reaction called pyrolysis can reduce the plasticized medical-protection garb back into an original form—such as chemicals and petroleum—and then recycle it, perhaps into fuels, according to a new study.

The method involves no incineration or landfill use.

"The scale of disposing used medical personal protective equipment (PPE) is enormous," said Xiang Zhao, a doctoral student and an author on the paper. "Fast pyrolysis is proven to effectively convert waste PPE into value-added products. The pyrolysis method can replace PPE incineration or sending it to landfills, which is what happens now."

Zhao, working with his advisor Fengqi You, the Roxanne E. and Michael J. Zak Professor in Energy Systems Engineering, in the Smith School of Chemical and Biomolecular Engineering, published the proposed technology framework, "Energy and Environmental Sustainability of Waste Personal Protective Equipment (PPE) Treatment Under COVID-19," in January in the journal *Renewable and Sustainable Energy Reviews*.

Their framework—first focusing on New York state—proposes collecting waste PPE from hospitals and medical centers, and then sending it to pre-processing and decontamination facilities in New York or Suffolk counties. There, it would be shredded, sterilized and dehydrated to become small particles, and then brought to an integrated pyrolysis plant, like one contemplated for Rockland County, north of New York City.

In the case of You and Zhao's model, the medium-temperature pyrolysis

(about 1,200 degrees Fahreneheit) can deconstruct the plasticized gowns and gloves, which are derived from petroleum, into chemicals such as ethylene, butane, gasoline, bauxite, propene, propane, diesel, light naphtha and sulfur.

"For an analogy, pyrolysis is similar to baking in an oven," said You, a senior faculty fellow at the Cornell Atkinson Center for Sustainability. "If you set the oven temperature very high, your meat becomes a chunk and charcoal. But if you use a lower oven temperature, the meat is going to be juicy. In pyrolysis, the temperature is the trick."

Health care facilities around the world are creating about 7.5 pounds per person of PPE waste daily through COVID-19-associated services, according to the United Nations Environment Programme.

To get a sense of the enormity of the disposal dilemma, one hospital with 300 medical personnel could generate more than a ton of medical garb waste daily. That translates to more than 400 tons of annual medical PPE waste in a single COVID-handling facility, You said.

In the paper's energy analysis and environmental lifecycle assessment, the proposed optimal PPE processing system avoids 41.52% of total landfilling and 47.64% of the incineration processes. This method shows an environmental advantage by reducing total greenhouse gas emissions by 35.42% emissions from conventional incineration and energy saving by 43.5% from landfilling, the researchers said.

"This is a viable strategy for disposing and processing waste PPE," You said. "It is a treatment method with low greenhouse gas emissions, it alleviates fossil fuel emission depletion and it saves a lot of polluting material from landfills."

More information: Xiang Zhao et al, Energy and environmental

sustainability of waste personal protective equipment (PPE) treatment under COVID-19, *Renewable and Sustainable Energy Reviews* (2021). DOI: 10.1016/j.rser.2021.111786