Sustainability in times of COVID-19: Converting face masks into valuable fuel

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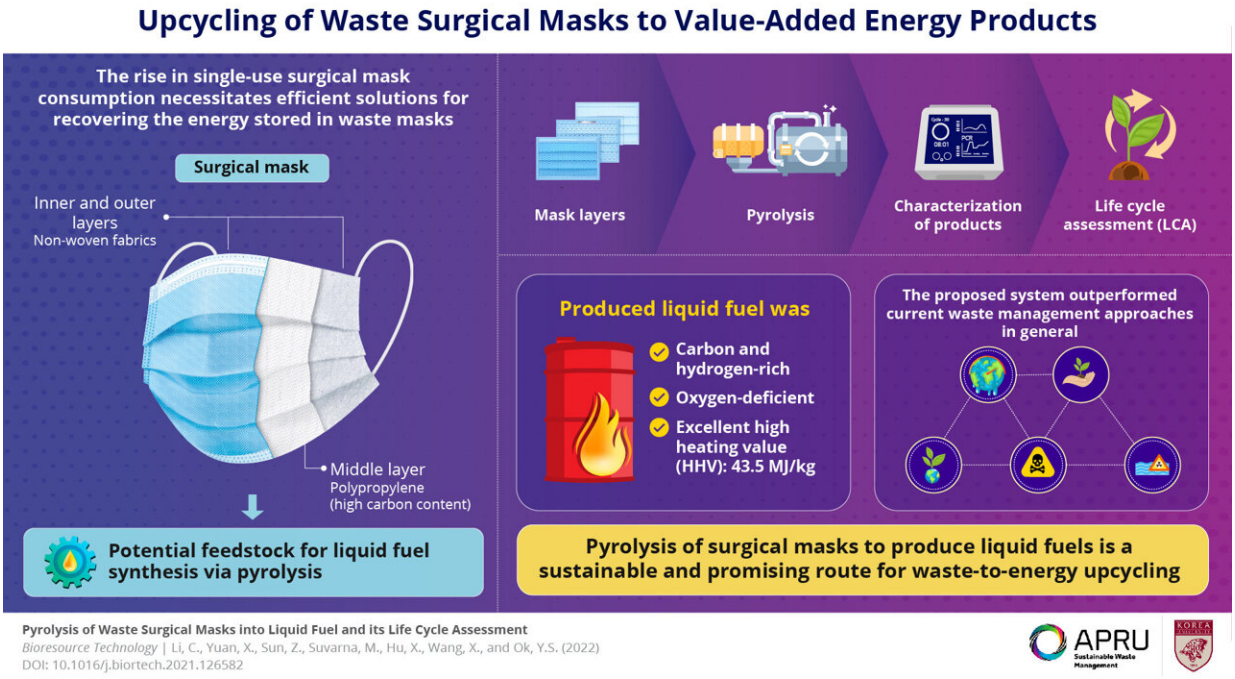

Credit: Korea University

Thanks to the COVID-19 pandemic, millions of single-use face masks are discarded every day, creating a huge surge in plastic pollution. In a recent study, researchers investigated the feasibility and potential environmental benefits of converting discarded surgical masks into burnable fuel via a process called pyrolysis. Their findings pave the way to a novel waste-to-energy upcycling approach, which could help meet

some of the UN's sustainable development goals.

Surgical masks are being used in virtually all countries of the world as the first line of defense against COVID-19. Shortly after the pandemic started, the demand for disposable masks skyrocketed to unprecedented levels; by June 2020, China alone was producing about 200 million masks per day. But the enormous amount of bulk waste constituted by these masks—coupled with staff shortages in waste management systems due to the pandemic—greatly exacerbated the threat that these plastic products pose to both human health and the environment.

Can discarded masks be turned into something useful to keep them away from incinerators, landfill, and our soils and oceans? The answer is a definite yes, as demonstrated by a team of researchers in a recent study published in *Bioresource Technology*, who analyzed the possibility of converting surgical masks into value-added chemicals through a thermal decomposition process called "pyrolysis." This international team of scientists was led by Professor Yong Sik Ok and Dr. Xiangzhou Yuan of Korea University, South Korea, who received great support from Professor Xun Hu of the University of Jinan and Professor Xiaonan Wang of the National University of Singapore and Tsinghua University.

While the pyrolysis of polypropylene—the main component of surgical masks—has already been studied in detail, masks usually contain other fillers that could affect their pyrolysis behavior. Thus, the research team had to carefully analyze how the pyrolysis conditions affected the obtained products, which came in gaseous, liquid, and solid forms. To this end, they ran multiple experiments at different pyrolysis temperatures and with different heating rates, capturing all the outputs and subjecting them to thorough characterization.

In particular, one set of pyrolysis conditions yielded a carbon-rich and oxygen-deficient liquid oil as the main product. Further analyses

revealed that this oil had a high heating value of 43.5 MJ/kg, which is only slightly lower than that of diesel fuel and gasoline. In other words, the results showed that surgical masks can be converted into a burnable fuel that can in turn be used, for example, to generate electricity.

The story does not end there, however, being able to convert waste into something useful doesn't necessarily make it a good idea. It is important to first assess the combined environmental impact of all the processes involved and compare it with that of current practices before thinking of implementing them. Therefore, the researchers conducted a life-cycle assessment (LCA) of their proposed methodology to better understand its pros and cons. The LCA is an approach that is widely to quantify the environmental impacts associated with the entire life cycle of a product; in this case, the discarded masks marked the beginning of the cycle while the electricity generated using the obtained fuel marked its end.

The results of the LCA were promising, indicating that the conversion of waste masks into electricity through pyrolysis offered better performance than most conventional waste management approaches on several fronts, including less CO_2 emissions, less terrestrial ecotoxicity, and less phosphorous emissions. "We verified that upcycling post-consumer surgical masks into value-added energy products represents a sustainable and promising route with notable environmental benefits," says Dr. Yuan.

Overall, the findings of this study indicate that pyrolysis is an attractive option to solve the problems posed by discarded surgical waste masks, paving the way to sustainable waste management, while generating energy and reducing our environmental impact. "Understanding new ways to turn surgical masks into value-added energy products will help us mitigate plastic pollution and achieve sustainable waste-to-energy conversion in the future," says Prof. Ok, "The novel upcycling route proposed in our study could help us protect Earth's ecosystems and reach

several of the United Nation's sustainable development goals."

More information: Chao Li et al, Pyrolysis of waste surgical masks into liquid fuel and its life-cycle assessment, *Bioresource Technology* (2021). DOI: 10.1016/j.biortech.2021.126582

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