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The NTU research team more studies are needed to determine if this technique can be scaled up.

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Can recycling waste be the key to a sustainable future? Scientists have developed a solar-powered method to turn sewage sludge into green hydrogen and animal feed, tackling both waste and sustainability challenges.

Using a three-step solar-powered process, scientists at Singapore's Nanyang Technological University (NTU) integrated mechanical, chemical, and biological techniques to treat the sewage sludge.

"Our method transforms waste into valuable resources, reducing environmental damage while creating renewable energy and sustainable food. This exemplifies the circular economy and contributes to a greener future," Associate Professor Li Hong, who is the lead researcher of the study, said.

From waste to wealth

The sludge-to-food-and-fuel method process starts with mechanically breaking down sewage sludge, followed by a chemical treatment that removes harmful heavy metals from organic materials like proteins and carbohydrates.

A solar-powered electrochemical process then uses specialized electrodes to convert these materials into valuable products, including acetic acid—used in food and pharmaceuticals—and hydrogen gas for clean energy.

Finally, light-activated bacteria are added to the processed liquid, turning nutrients into single-cell protein for animal feed.

Eco-friendly, cost-effective, and scalable lab tests revealed that the new method recovers 91.4 percent of the organic carbon in sewage sludge—converting 63 percent into single-cell protein without harmful by-products. These results are nearly double the efficiency of traditional anaerobic digestion, which typically recovers about 50 percent of the organic material.

Sustainable sewage recycling tech yields promising results

The proof-of-concept tests also confirmed that the process not only recovers significantly more resources but also completely removes heavy metal contaminants, reduces the environmental footprint, and offers better economic feasibility compared to conventional techniques that produce biogas and nutrient-rich residue.

The solar-powered process also achieved an energy efficiency of 10 per cent, generating up to 13 liters of hydrogen per hour using sunlight, which is around 10 percent more energy efficient than the conventional hydrogen generation methods.

Additionally, it cuts carbon emissions by 99.5 percent and energy use by 99.3 percent compared to traditional methods. It also removes harmful heavy metals from the sludge—which would otherwise be disposed of without proper treatment—making it an exceptionally eco-friendly choice.

“We hope that our proposed method shows the viability of managing waste sustainably and shift how sewage sludge is perceived — from waste to a valuable resource that supports clean energy and sustainable food production,” Dr Zhao Hu, the research’s first author, said in a press release.

The NTU research team added that while the results are promising, more studies are needed to determine if it can be scaled up.

A key challenge is the cost of using an electrochemical process to completely break down organic materials and extract all heavy metals from waste. Additionally, designing a complex system for a wastewater treatment facility adds to the difficulty.

RECOMMENDED ARTICLES

As per United Nations, around 2.5 billion more people will be living in cities by 2050.

Along with the growth of cities and industries comes an increase in sewage sludge, which is notoriously difficult to process and dispose of due to its complex structure, composition, and contaminants such as heavy metals and pathogens.

According to UN-Habitat, over 100 million tonnes of sewage sludge are generated globally each year—and this figure is only increasing. Conventional disposal methods, such as incineration and landfilling, are simply not enough to tackle this escalating problem.

The study has been published in the journal *Nature Water*.