Atlas of Science
another view on science
https://atlasofscience.org

Ferrate technology: an innovative solution for sustainable sewer and wastewater management

Sewers might be out of sight, but they play a huge role in shaping the well-being of a society. They quietly carry away all the wastewater from our homes, businesses, and factories, preventing harmful viruses, bacteria, and pollutants from spreading. Back in the late 1800s, a large-scale sewer system in London saved millions of lives during a cholera epidemic. So, to keep our communities healthy and livable, maintaining a well-functioning sewer system is essential.

Unfortunately, sewer systems face challenges (Fig. 1). The wastewater they carry is a perfect breeding ground for different microorganisms, like sulfate-reducing bacteria, which produce hydrogen sulfide (H_2S). This gas can cause sewer pipe corrosion, leading to leaks and sinkholes, causing financial strain on governments. Additionally, H_2S emissions can cause unpleasant odors in neighborhoods and health risks for sewer workers. Plus, with ongoing climate change, methane-producing microorganisms in sewers are becoming more of a concern, as methane emissions contribute to global warming and can even lead to sewer explosions.

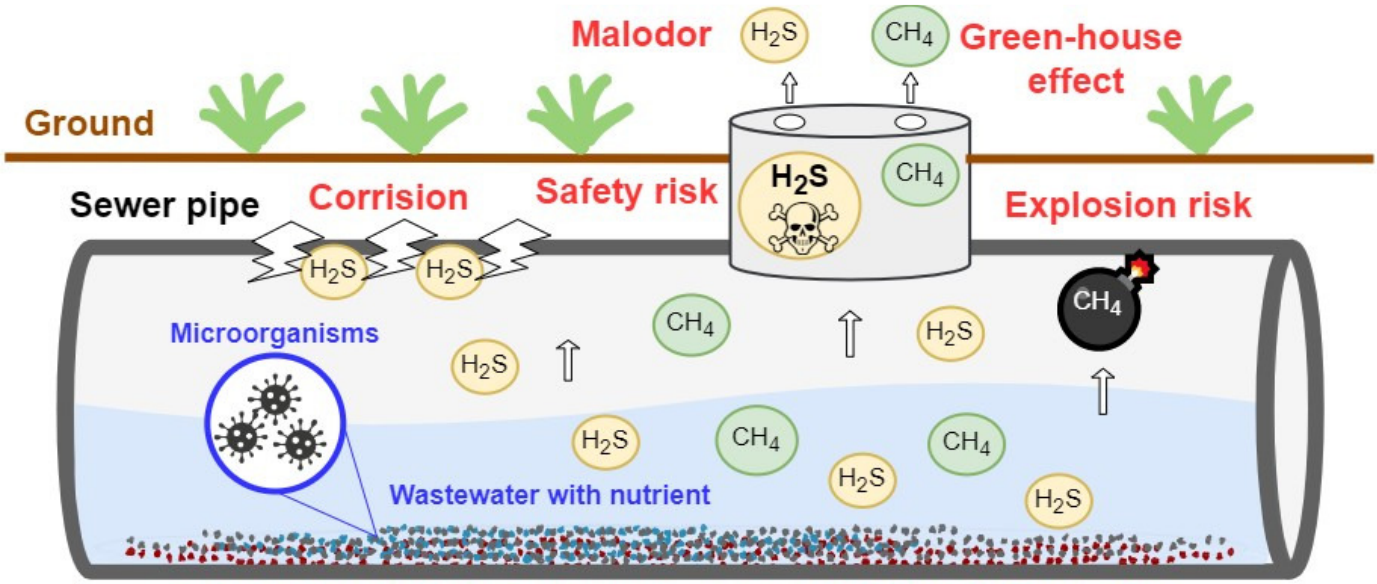

Fig. 1. Illustration of challenges in sewer management caused by sulfide and methane productions.

Over the years, various methods have been tried to deal with H_2S emissions in sewers. These include adding iron salts (ferric/ferrous) or oxygen to the wastewater to either precipitate or oxidize H_2S, or adjusting the pH level to keep sulfide in a less volatile form and reduce its release. However, these methods primarily address existing H_2S, meaning once the treatments are halted, H_2S emissions can quickly rebound. So, they often necessitate ongoing chemical dosing, leading to high costs.

To address this, we developed a new technology using ferrate (Fe(VI)), a powerful chemical that suppresses sulfide production in sewers. Fe(VI)'s high valency gives it strong oxidizing properties, effectively killing

microorganisms in sewers within just 15 minutes (Fig. 2 A and B). By using a pulse dosing strategy, which involves breaking down a single dosing event with a high dosage into 2-3 smaller doses with lower dosages, its efficiency can be enhanced. Additionally, Fe(VI) reduces the ability of microorganisms to attach to sewer walls, making it easier to flush them out. By systematically targeting the microorganisms, both sulfide and methane production in the sewer are significantly curtailed. Our findings indicate that following the application of Fe(VI), it takes an extended period for sulfide and methane production to rebound (Fig. 2C), allowing for intermittent dosing rather than continuous treatment. This proves to be more cost-effective compared to traditional methods.

Furthermore, ferrate technology offers other benefits (Fig. 2C), such as not producing carcinogenic by-products and generating non-toxic substances that can help with sulfide precipitation and phosphorus removal downstream. Our recent study also shows that it promotes energy recovery from wastewater by increasing methane yield during sewage sludge anaerobic digestion.

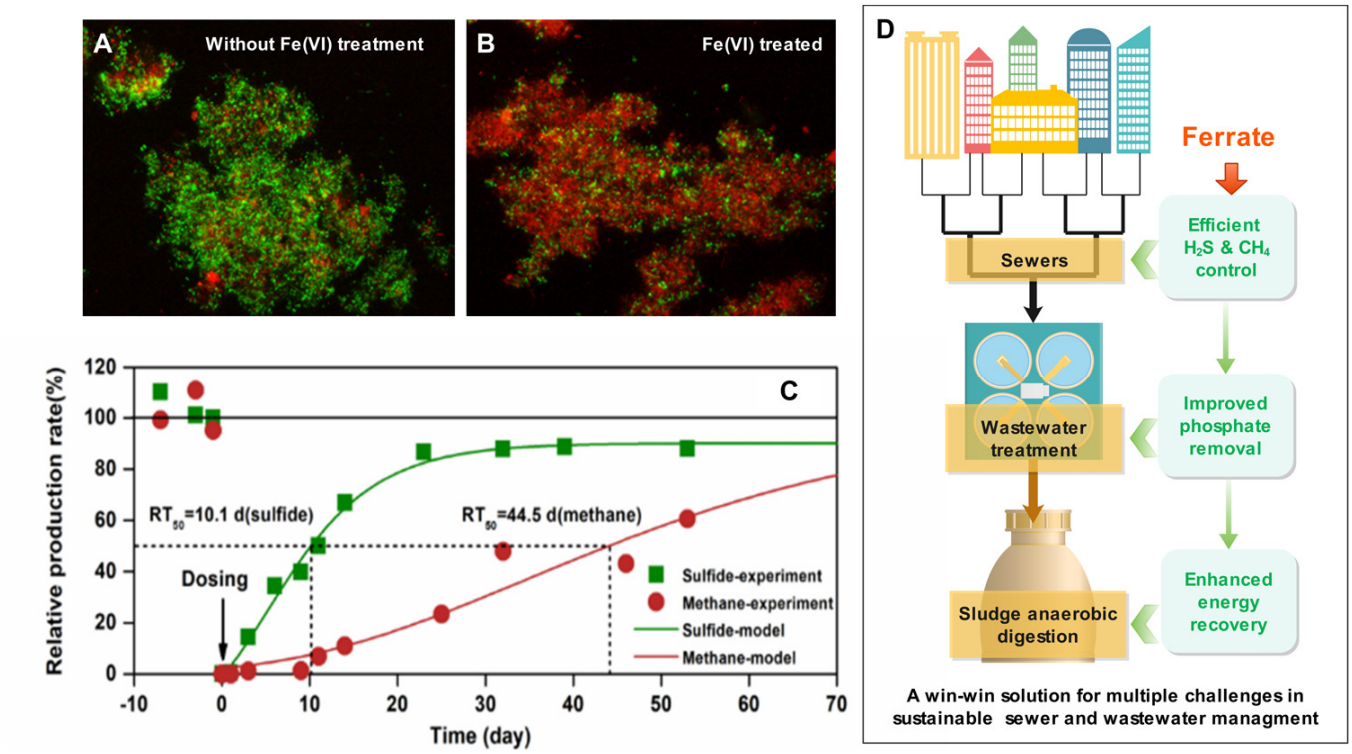

Fig. 2. (A) and (B) Fluorescence microscope image showing live (green) and dead (red) microorganisms in sewers with and without Fe(VI) treatment. (C) The recovery of sulfide and methane production rates in the sewer reactor after treated by Fe(VI). (D) An illustration of multiple benefits in sewer and wastewater management can be achieved by Fe(VI) technology.

In summary, our technology provides an effective and economical solution for sustainable sewer management, ensuring the safety and health of our communities. It also offers additional benefits for wastewater treatment and energy recovery, making it a win-win solution for multiple challenges.

Jing Sun[1], ***Xiaofang Yan***[2]
[1]*College of Environmental Science and Engineering, Tongji University, China*
[2]*Environmental Technology, Wageningen University & Research, The Netherlands*

Publication

Rapid and strong biocidal effect of ferrate on sulfidogenic and methanogenic sewer biofilms
Xiaofang Yan, Jing Sun, Ahezhuoli Kenjiahan, Xiaohu Dai, Bing-Jie Ni, Zhiguo Yuan
Water Res. 2020 Feb 1