Preventing the Rising Tide of AMR: Utilising MOFs to Remove Antibiotics from Wastewater

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(a) Purpose of study or research hypothesis
This research will develop an industrially viable and continuous process to remove antibiotics from wastewater using metal-organic frameworks (MOFs).

(b) Key issue(s) or problem(s) addressed
Anthropogenic water pollution is a serious and global problem due to rapid industrialisation and an increase in the world's population. Antibiotics in wastewaters have been identified as pollutants in their own right and as pressures for antimicrobial resistance (AMR) in the environment. For example, ciprofloxacin and amoxicillin are on the World Health Organisation's List of Essential Medicines (2017) and have been recommended for the EU Water Framework Directive's 2nd Watch List, requiring monitoring and evaluation of treatment technologies to assess and reduce the risk that they pose to humans and the environment. As the human population grows and ages, requiring increased medication, the presence of antibiotics in wastewater and resultant AMR influence is only set to rise. Wastewater treatment plants have not been designed to remove antibiotics from wastewater therefore, methods to remove these substances from wastewater streams are needed urgently.

(c) Methodology or approach used
MIL100-(Fe) was produced via microwave synthesis and characterised for purity (PXRD, powder X-ray diffraction), presence of functional groups (FTIR, Fourier transform infrared spectroscopy), particle morphology (SEM, scanning electron microscopy) and thermal stability (TGA, thermogravimetric analysis). Experiments to determine the water stability of the MOF under various conditions and its ability to remove antibiotics from simulated and real wastewater, will be carried out to establish the industrial feasibility of antibiotic removal. Antibiotic concentrations will be analysed using LC-MS (liquid chromatography-mass spectrometry) to determine the adsorption capacity of the MOFs.

(d) Results or conclusions derived from the project
MIL-100(Fe) was synthesised successfully as demonstrated by characterisation using PXRD, TGA, SEM and FTIR. Isothermal and kinetic analysis was conducted using the synthesised MOFs for removing the target antibiotics from water matrices, with determination of removed antibiotics by LC-MS.

(e) Implications of the project relevant to congress themes
Removing antibiotics from wastewater will reduce the amount of antibiotics present in the environment and reduce the spreading of resistant bacteria in animals, plants, and humans thus mitigating the advancement of AMR. This research aligns with the congress themes of managing water scarcity, water sanitation and health and improving water quality, as well as contributing to the UN's Sustainable

Development Goals. In order to inform policy, we need to understand how AMR affects other areas of global significance including the circular economy, for example valorisation of antibiotics in waste streams from pharmaceutical manufacturers. This research will appeal to those who are responsible for wastewater treatment, to implement the technology for use at scale and encourage water providers to invest in further materials development.

Keywords : Metal-organic frameworks, wastewater, antibiotics, removal, adsorption