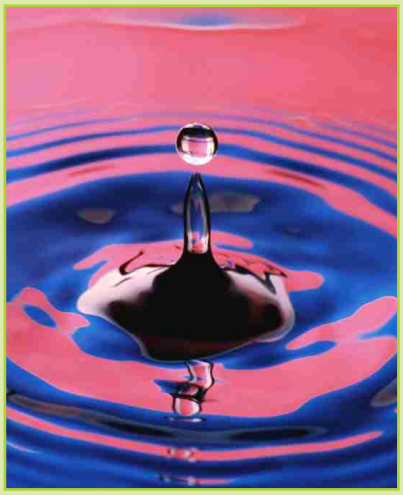
New ozone process for water treatment could cut costs and tackle pollution problems at source

Patented adsorbent uses ozone more effectively and offers alternative to chlorine for industrial applications



'Many industries have waste problems caused by toxic chemicals that are not readily amenable to biological treatment. This new technique offers new options for tackling these problems at source.'

It could soon be easier and cheaper for many firms to clean up toxic chemicals in wastewater using ozone instead of chlorine or chlorine-based compounds, it has been announced. A new, patented technique for using ozone adsorbed on to zeolite pellets to remove organic pollutants has been developed at Bradford University as part of a major waste minimisation initiative backed by Government and industry.

The new process could help to meet growing calls by regulatory bodies worldwide for higher standards of water treatment. As well as reducing costs, it could benefit the environment by raising treatment standards in key areas such as small chemical factories, abattoirs, vegetable washing plants and the pharmaceuticals industry. It could also help to clean up existing sites where pollutants are leaching out.

'Problems of water treatment have multiplied and we now have a better understanding of the toxic effects of very small amounts of some chemicals in our water,' says project leader Dr Mike Slater, of the Department of Chemical Engineering at the University of Bradford. 'Many industries have waste problems caused by toxic chemicals that are not readily amenable to biological treatment. This new technique offers new options for tackling these problems at source.'

The process has been developed as part of the Government's programme for Waste Minimisation through Recycling, Re-use and Recovery in Industry. Following a feasibility study, the Engineering and Physical Sciences Research Council provided a grant of just over £108,000 for a three-year research project. The study at Bradford was supported by industrial partners Bullen Consultants, Invent Water Treatment Ltd and Crosfield Ltd.

Existing techniques for using ozone mainly rely on bubbling the gas into water. Because ozone has low solubility, the process can be inefficient and pollutants may not be completely destroyed. The research shows that higher ozone concentrations can be achieved by loading the gas on to a bed of material through which polluted water is passed.
In the new process, ozone is adsorbed on to a form of zeolite which is turned into pellets. Compared with silica gel, which was initially tested by researchers, the special pellets cost less to dry before they can be re-used and can withstand wetting without breaking up.
'We discovered that you had to have a material that was virtually pure silica. Creating this type of material with the right structure was the object of our work and resulted in the patent,' explains Dr Slater. 'It is possible to make the material by a straightforward industrial process.'

A pilot treatment plant was successfully built as part of the research project. Design procedures have been established to design and cost a full-scale plant. The next step will be to carry out further work to validate calculated plant sizes and costs for a variety of pollutants. Dr Slater's colleague Dr Chedly Tizaoui is now continuing development at Bradford.

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WMR3
(Waste Minimisation through Recycling, Re-use and Recovery in Industry) was a collaborative industrial research programme supported by £12m of funding from EPSRC and DTI during 1995 – 2003.

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Growing interest is expected from small chemical companies facing serious problems in treating wastes to new standards. Large pharmaceutical companies could also make major savings in treating toxic chemicals in large quantities of water by removing the need for costly boiling.

'Legislative pressure is on companies discharging water to meet ever tighter restrictions,' says Dr Slater. 'In the long term everybody has a moral and ecological duty to remove chemicals that could conceivably cause problems themselves or interact with chemicals from other sources. We believe there could be great potential for this new approach as regulations are tightened up.'

Additional project details and background

Why are alternatives to chlorine needed for water treatment?

Regulatory bodies worldwide have called for a gradual improvement in water treatment standards. Chlorine is widely used for water treatment but can sometimes react with other chemicals in waste streams to form worse pollutants such as THMs (trihalomethanes). Ozone, a very powerful oxidant, provides an alternative to chlorine-based compounds for the removal of pollutants and water disinfection.

Is ozone already being used?

Ozone has been used for some time as a substitute for chlorine in the United States and increasingly in Europe. Applications include treatment of drinking water and wastewaters, and in the food and textile industries. Although ozone is not suitable for all applications, it is expected to have an increasing role in the long term.

What are the limitations of existing methods of using ozone?

Existing methods can be costly and safety precautions are required on site. The process of dissolving adequate residual ozone in water can be difficult to achieve and the kinetics of oxidation can be relatively slow.

What are the advantages of the new approach?

By loading ozone on to a solid adsorbent material (or possibly a liquid immiscible with water) higher concentrations can be delivered to attack pollutants. It should be possible to make reactions work faster, deal with a wider range of pollutants and use ozone more efficiently.

How does the process work?

Ozone is loaded on to adsorbent pellets. Polluted water is passed through a bed of these pellets, which create high concentrations of ozone to remove organic pollutants. The bed is then dried and reloaded with more ozone. The special pellets that have been developed need less drying than silica gel, reducing costs.

What did the research project involve?

Different adsorbents were tested and a pilot plant was built so that all aspects of the process could be studied in detail. A patented method has been developed to convert the silica-based adsorbent from powder into 2 mm-diameter pellets suitable for the treatment bed. Good agreement was obtained between theoretical models and experimental results. A design procedure has now been established to design and cost a full-scale plant.

Where is the new process likely to be used?

The main applications will be for treatment of industrial wastewater that is not readily dealt with by standard sewage treatment. The first full-scale plants are likely to be commissioned by smaller chemical companies and in the pharmaceutical industry. In the agricultural industry, the process could be applied in areas such as whey processing, protein recovery and treatment of wastewater from abattoirs and vegetable washing plants.

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