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ImpAs: A new filter to remove Arsenic in drinking water

The ImpAs sorbent is composed of a molecular receptor immobilised onto a resin. This novel material has a high adsorbing capacity which makes it unique for applications in point-of-use and point-of-entry water treatment systems to remove arsenic from contaminated water.

Background

Arsenic (As) in drinking water is threatening the health of people in more than 70 countries and it is estimated that 170 million people are being unknowingly exposed to unsafe levels of arsenic in drinking water. Many countries such as China and India have regulatory limits five times higher than the recommended WHO guideline (10 ppb). The most widely used methods for arsenic remediation are based on adsorption of arsenic on iron oxides. However, iron oxides suffer from fast saturation and poor selectivity, making them unsuitable for ground-waters with high concentration of competing anions and leading to the need of large amounts of sorbent. This makes it impractical to apply iron oxides in point of use devices.

These challenges are overcome by a new sorbent material, ImpAs. The sorbent comprises of a molecular receptor immobilised onto a resin (solid support) that removes arsenate and has greater regeneration capacity compared to existing sorbents.

Proposed solution

A team at Imperial College London has developed a novel sorbent material that enhances arsenic remediation in drinking water. The key features of this technology include:

- A molecular receptor is immobilized on to a resin to yield a functionalised material
- ImpAs demonstrates high affinity for arsenate over a wide range of pH, with highest affinity at pH7.
- 5 mg of ImpAs can adsorb twice as much arsenate (i.e. arsenic(V)) from natural groundwater compared to existing commercial materials such as Bayoxide E33. In waters with competing ions, ImpAs adsorbs three-fold more arsenate compared to Bayoxide E33.
- ImpAs can be easily regenerated and re-used; studies showed its capacity was not impaired after five desorption cycles.

Benefits

- High adsorption capacity for arsenate (i.e. arsenic (V)) from drinking water
- Efficient arsenate remediation at a wide range of pH values (pH 5 to 10)
- High selectivity to arsenate against common competing anions such as bicarbonate and sulphate
- High regenerative capacity
- Ideal resin for point of use and point of entry water treatment systems due to small amount of sorbent needed

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Applications

The ImpAs resin can efficiently remove arsenate from drinking water. Therefore, a significantly smaller amount of sorbent material is needed to remove the same amount of arsenic than the one required with iron oxides. This makes ImpAs a very useful material for point-of-use water filtration systems. Its applicability is further increased by its superior selectivity for arsenate over other competing anions. Furthermore since ImpAs has greater regenerative capacity, the media does not need to be changed often which makes it cost-effective.

Market Opportunity

For remediation at the point-of-use in household water treatment (POU HWT) devices, adsorption is the most suitable removal technique. However, due to the poor selectivity of iron oxides for arsenic, large sorbent volumes are needed, in particular, in areas with "challenging" waters with high concentrations of anions like silica, bicarbonate, phosphorous and sulphate. Cartridges such as the Brita™ filter embedded in water jugs are the most popular POU HWT devices for a range of contaminants (but not yet for arsenic), due to simple, easy-to-use design. A POU jug filter containing a high-affinity arsenic adsorbent resin would provide an economical and user- and environmentally friendly method of removing arsenic from drinking water.

BWT group estimates the volume of the European market only for water treatment systems in point-of-entry sector at €1.8 billion, with annual market growth estimated at between 2% and 3% per year. The point-of-use water treatment systems market is estimated to reach USD 24.5 billion by 2020, with a projected CAGR of 9.86%, from 2015 to 2020. Factors such as increasing water contamination, growing awareness about the benefits of clean drinking water, and increasing construction activities drive the point-of-use water treatment systems market.

Intellectual property information

ImpAs and methods of use for removing arsenic from aqueous solutions are protected by European and US patents: EP3154675 & US10479703B2

Inventor information

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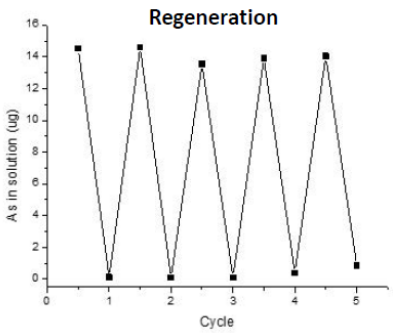

Fig 1: The ability of ImpAs to bind arsenate is not impaired even after multiple desorption cycles. Conditions: 5mg of ImpAs shaken with 5mL of arsenate at 3000 ppb, pH 7, 5 cycles. Desorption was carried out by shaking with 5mL of brine solution at pH 10.

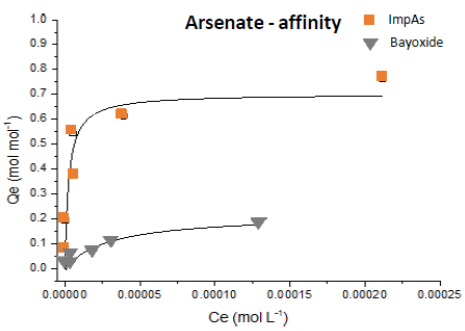

Fig 2: Adsorption isotherms show greater affinity of ImpAs sites as compared with Bayoxide – 1 mol of ImpAs sites would absorb 0.7mol of As; whereas 1 mol of Bayoxide would absorb 0.2mol of arsenate. Conditions: 10mM HEPES solutions, pH 7.

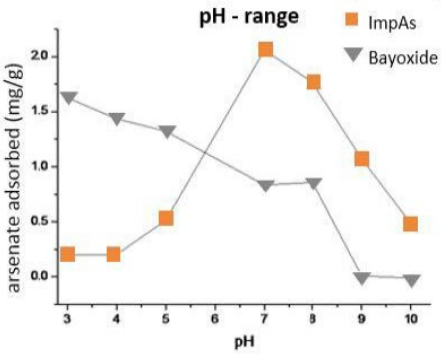

Fig 3: ImpAs shows greater affinity for arsenate above pH 6 than Bayoxide, which would make it better suited for alkaline waters. No pH adjustment of natural waters would be required. Conditions: 5 mg of sorbent with 50 mL arsenate solution for 24 h, arsenate at 300ppb.