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New Applications of Solid Phase Adsorbents

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ABSTRACTS

IEC 9

Adsorbents for the removal of arsenic from drinking water

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Arsenic occurs naturally in many groundwaters throughout the world. Adsorbents are a common method utilized to lower arsenic concentrations to acceptable levels. Initially alumina was the best available material but this suffered from a low capacity and pH sensitivity and has now generally been superseded in most applications by superior media based upon either titanium or iron oxides. Other media based on oxides of zirconium, lanthanum and even cerium and copper also exist but are rarely encountered outside laboratory trials due to cost and/or performance issues. Common anions, such as chloride, bicarbonate and sulfate, have a negligible effect on the arsenic capacity. The main factors affecting the capacity are the chemical form of the arsenic (*i.e.*, As(III) or As(V)), the pH, the concentration of silica and the concentration of phosphate in the water. This paper will review arsenic adsorbents and their performance in field applications.

IEC 10

Oxo-anion recovery from aqueous systems using nano-porous silica polyamine composites

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Environmental contamination due to anthropogenic wastewater discharges containing high concentrations of toxic metals is omnipresent in the environment. Heavy metal ions from manufacturing sources can compromise the integrity of various ecological cycles as well as negatively impacting the health of humans through drinking water and the food chain. Increased levels of well known poisonous metals such as arsenic, selenium, lead and mercury are frequently detected in aqueous wastes. Arsenic and selenium are highly toxic elements to human health and the environment. Although there are several metal remediation technologies available commercially, most of them are not feasible and/or very expensive. The ferrihydrite process (precipitation with iron (III) oxyhydroxides) is by far the most economical and effective of these technologies and has been widely employed. However, it has the significant disadvantage of creating a large amount of sludge for ultimate disposal and leaching of colloidal iron oxides into aquifers. The other methods suffer from a lack of specificity, low selectivity over sulfate (ion exchange), low mass-to-volume concentrations (bio-reduction), and/or high cost (membrane technologies). This led us to the development of silica polyamine composites functionalized with metal selective ligands for the removal of heavy metals from wastewater streams. We obtained high arsenic (III & V) and selenium (IV & VI) extraction capacities by immobilizing zirconium on our patented silica polyamine composites. The oxo-anions of these two metals bind to the net positive charge on the zirconium, thereby removing them from the wastewater stream and reducing the metal concentrations below the respective MCLs. These silica polyamine composites can also be acid stripped and regenerated for reuse. This aspect is very useful in commercial applications where the toxic metal ions can be selectively extracted and efficiently recovered from acid mine drainage in the presence of high sulfate concentrations, and their removal from seawater systems.

IEC 11

Use of iron oxide modified granular activated carbon for arsenic removal

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Granular activated carbon has been impregnated with hydrous iron oxide to improve the efficacy of the media to remove arsenic from drinking water. Samples were characterized by determining iron and moisture contents and the point-of-zero-charge pH. Arsenic capacity was evaluated in batch As(V) isotherm experiments and in dynamic small column operations. The capacity was found to be 2.6 – 3.0 mg of arsenic per gram of dry carbon in the batch tests while typical performance in standard model water with 300 ppb arsenic and pH ~7.5 in the influent was 2,000 bed volumes to 10 ppb breakthrough. The level of iron loading in the carbon directly affects the arsenic

removal capacity. The presence of silica in the water at levels above 20 ppm was also found to have a significant interfering effect on the arsenic uptake.

IEC 12

Microporous organic polymers as sorbents

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Microporous materials have been widely researched for their applications as sorbents, in gas separations and catalysis due to their high surface areas. High surface area microporous organic polymers may have advantages since they are composed purely of light elements and have access to the potential structural diversity of organic polymers. Here, we demonstrate the synthesis of a new series of microporous materials – conjugated microporous polymers (CMPs) – prepared using Sonogashira-Hiyama coupling. CMPs can have tuneable Brunauer-Emmet-Teller surface areas of up to 1000 m²/g by varying the strut length of the monomers. We will show here that using libraries of monomers with different functional groups can modify the properties of the resulting materials. This allows access to high surface area materials with a variety of surface functionalities, such as differing hydrophobicity. This is a key step towards obtaining functional microporous materials which can adsorb a variety of materials including gases and dyes.