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ABSTRACT

This work is carried out to address specific hazardous air and water pollutants control related issues. All the suggested solutions use ‘adsorption’ as the main remediation technique. The present work is mainly focused on two classes of adsorbents. One is the low-cost porous adsorbents such as saw dust and the other are microporous adsorbents such as activated carbon. Former may be used for mass-scale industrial applications whereas the latter may be used for high-end applications respectively. Specific hazardous air and water pollutants were selected based on the application and relevance to national needs as well as their environmental and health impacts. These include radioactive air pollutants such as radioactive iodine or methyl iodide and non-active toxic chemical gases such as cyclohexane which is a simulant of organic vapor gases and sulfur dioxide which represents acidic gases. Among hazardous water pollutants, ionic liquids were considered which represent new generation solvents and cadmium which represents heavy metals and has not been studied extensively in the local perspective of Pakistan.

This work has been carried out in order to suggest feasible solutions for specific air and water pollution priority areas. Experimental work was carried out in various laboratories in Pakistan, Canada, France and Spain.

Chances of an accidental release of radioactivity from a nuclear power plant require proper anticipatory planning and processing to protect the public from its hazardous effects. Nuclear charcoal filters installed within the ventilation system of a nuclear power plant are the first line of defense against such an incident, personal and protective filtration equipment being the last resort. Impregnated activated carbon is an integral part of all such filters. A pilot scale setup was designed, fabricated and developed to impregnate coal based raw activated carbon with triethylenediamine. Process parameters like contact time, process temperature and impregnant input quantity were varied and their optimum values were worked out to be 110 minutes, 90 °C and 10 % of the wt. of activated carbon respectively. The samples thus prepared were characterized by elemental analysis, measuring percent TEDA by UV-visible spectroscopy, TGA, FTIR, SEM, Surface area and porosity

measurement, sulfur dioxide and radioactive methyl iodide adsorption. The removal efficiency of radioactive methyl iodide was more than 98 % in all samples.

Loss of adsorption capacity of activated carbon as a result of oxidation of its surface is called ageing. Argon and hydrogen heat treatments were given to the activated carbon and the samples were characterized by Boehm titrations, surface area and pore size distribution measurement, TGA and XRD. The samples were later exposed to dry/dry or wet/wet adsorption of cyclohexane. Hydrogen treated samples improved the wet/wet cyclohexane adsorption of activated carbon.

Generally available literature related to adsorption studies deals with low concentration solutions. Activated carbons pre-treated with hydrogen and nitric acid were soaked in a range of concentration of copper acetate solutions. The resulting samples were characterized by AAS, titrations and gravimetry. The high concentration behavior was very different from low concentration. Double Langmuir isotherm was fitted to the adsorption data of raw and hydrogen heat treated sample. The adsorption data of nitric acid treated sample however, did not fit to Langmuir only. It was rather fitted to a combined Langmuir-Freundlich isotherm.

Ionic liquids are a new class of solvents, generally categorized as environment friendly. Owing to their very low vapor pressure, they may become persistent organic pollutants. Three types of activated carbons were used to remove various imidazolium and pyridinium based ionic liquids from water. Raw activated carbons were characterized by N_2 adsorption measurement, Boehm titrations and pH of the point zero of charge measurement. Isotherms were studied, using UV-Visible spectrometry, in buffer solutions at pH = 2, 7 and 9, in the temperature range 20-50°C. Kinetics models were found to be dependent on adsorbent type. The kind of interactions between organic cations and the carbon surface were found to be related to the amount of oxygenated groups and to the ionic liquid type. The calculated thermodynamic parameters showed that as compared to methylimidazolium, the adsorption of longer chain cations and pyridinium like cations was more spontaneous.

Heavy metal pollution of water is a very serious issue in Pakistan. Cadmium as a typical heavy metal was subjected to adsorption onto a blue pine sawdust (Pinus Wallichiana) using atomic absorption spectroscopy as the analysis technique. Optimization of the process parameters like contact time (1-120 min), dosage of adsorbent (0.025-0.5 g)/10 ml, concentration of cadmium (9-

1780 μM) and of nature (pH 1-10) was done. Maximum adsorption (ca. 95.3%) was achieved from deionised water in 30 minutes at pH 7 using 0.2 g adsorbent/10 ml adsorbate solution. The adsorption data follow Langmuir, Freundlich and Dubinin-Radushkevich (D-R) isotherms. The kinetics of adsorption obeys Morris-Weber and Lagergren equations. The first order rate constant and the intraparticle diffusion rate have also been estimated. Sawdust has been proved to have potential to remove cadmium ions from aqueous solutions at trace or sub-trace concentration, to preconcentrate or treat industrial wastewater.