Adsorption of cobalt on lead dioxide from aqueous solutions has been studied in relation to shaking time, amount of adsorbent, pH, and concentration of the adsorbate. The data fitted very well Langmuir, Freundlich, and Dubinin–Radushkevich isotherms and their corresponding constants were calculated. In another set of experiments the influence of different anions and cations on the adsorption of cobalt under the optimum experimental conditions have been determined. EDTA, tartrate, citrate, thiocyanate, oxalate, U(VI), Al(III), Fe(III), Cr(III), and Th(IV), drastically reduced adsorption of cobalt. Therefore these anions and cations should be removed before adsorption of cobalt on lead dioxide. Adsorption of other metal ions on the oxide were measured under identical conditions. The $K_D$ values indicate that cobalt can be separated successfully from Hg(II), Ag(I), Ta(V), In(III) and Tc(VII).

Adsorption of metal ions on oxides is important in analytical chemistry, radiochemical, environmental studies and waste disposal. Oxides are also used in hydrometallurgy, food technology, partition chromatography, metal recovery and industrial waste treatments. Hydroxides and oxides of various metals have been studied as co-precipitants or ion exchangers, for the separation/preconcentration of trace amounts of metal ions present in solution, containing other metal ions in large amounts. Lead dioxide for its well known adsorption properties, has been employed for the adsorption studies of several metals including thallium, antimony, bismuth, univalent and bivalent metal nitrates, chromium separation of fission products, separation of iron and chromium.

Radioisotopes of cobalt are generally used in research and medicine. They contribute to the entire radiation field during most of the contamination processing operation. Most of the radiation exposure rate calculations done for the decontamination waste are based on radiation emitted from $^{60}$Co. Cobalt is an important element in fuel processing and waste disposal. It is also known that water supplies may become contaminated by many radionuclides, in which $^{60}$Co is also included. So its separation/removal is very essential. Proconcentration/separation procedures based on adsorption are important in analytical and radiochemistry of trace elements, because of...
their simplicity, efficiency and selectivity. The adsorption of cobalt on metal oxides has been the subject of several investigations in the past. Adsorption studies of cerium, europium, and manganese on lead dioxide and cobalt on manganese dioxide were reported earlier. The present communication deals with the adsorption of cobalt on lead dioxide from aqueous solutions.

Experimental

Lead dioxide Fluka microanalytical reagent, black in color, was used as such. The BET surface area determined by nitrogen adsorption was found to be 2.57 m$^2$/g. The average pore diameter, porosity, and bulk density were found to be 0.56 μm, 0.36 cm$^3$/g, and 2.43 g/cm$^3$, respectively. All solutions were prepared from doubly distilled deionized water and analytical reagents. $^{60}$Co tracer was produced by irradiating specpure cobalt metal in a PARR-1 research reactor of PINSTECH at a thermal flux of $2 \cdot 10^{13}$ n·cm$^{-2}$·s$^{-1}$. All other tracers used in this study were produced locally, and their radiochemical purity was checked by γ-spectroscopy. Preparation of buffer solutions, procedure for the measurement of adsorption, computation of distribution coefficient and percent adsorption, as well as the instruments used were described in detail elsewhere. All the experiments were performed at (293 ± 0.1) K and the data recorded as the mean of triplicate runs.

Results and discussion

Effect of shaking time

Experiments were conducted to determine the optimum shaking time for the adsorption of cobalt on lead dioxide from aqueous solution of pH 6. For these studies 40 mg of the oxide was used, whereas the concentration of cobalt was kept at $7.95 \cdot 10^{-6}$ mol·dm$^{-3}$ in the pH 6 solution employed. Figure 1 shows the distribution coefficient of cobalt as a function of shaking time in the range of 1 to 40 minutes. The adsorption equilibrium was achieved within a few minutes. However, 15 minute shaking time was employed for further measurements. This behavior was also observed for the adsorption of cerium, europium, manganese on lead dioxide and of mercury on manganese dioxide from aqueous solutions.

Adsorption dynamics were studied using various rate-controlling steps. The study of adsorption dynamics is quite significant in waste water treatments, as it describes the solute uptake rate, which controls the residence time of the adsorbate uptake at the