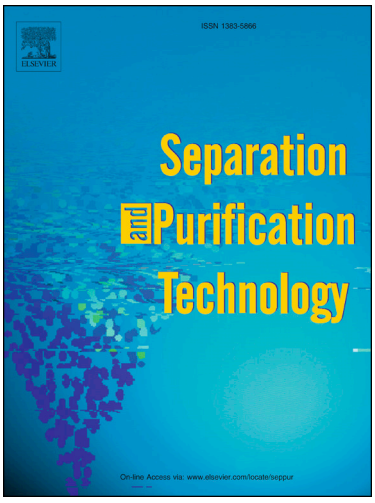

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Selective extraction and separation of germanium by catechol based resins

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Abstract

Germanium extraction has been studied using ion-exchange process thanks to polymeric resins. The ion-exchange resins have been prepared from catechol and with admixture with 8-hydroxyquinoline by alkaline polycondensation with formaldehyde. The polymeric resins were characterized and involved in sorption experiment. The selectivity sorption of germanium was studied in the presence of elements such as silicon, zinc or copper which are likely to be competitive cations in solutions from urban mines or mine deposits. Selective extraction and separation of germanium have been demonstrated. Changes in the selectivities properties of the resins have been observed through the incorporation of 8-hydroxyquinoline in the catechol matrix.

1. Introduction

Germanium is a trace component in the Earth's crust and natural waters. It is used as a component of optical fibers, polymerization catalyst, element in infrared optics and electronics, and in many other applications. The wide use of Ge in the manufacture of electronic makes it an element of high technological value.[1] Germanium is recovered as a by-product of zinc or copper and zinc ores, it is also extracted from some coals deposits.[2] The separation of germanium from acid solutions has received considerable attention because of its economic implications. Hydrometallurgy appears to be the most attractive process for the recovery of germanium. This includes, the liquid-liquid extraction,[3-6] flotation[7, 8] and the resin[9-11] separation methods. Polyols are known to form complexes with germanium[12]; therefore polymeric solids containing hydroxy groups, such as N-methylglucamine[9, 13] and catechol derivatives[14-17] have been used for the preconcentration and separation of germanium. Catechol forms a negatively charged complex with germanium in solution[17-21] and that complexation with germanium and catechol forms a symmetric structure in three dimensions which is a more stable complex compared with the silicate ion.[15, 16] In most of the recovery system using catechol, the germanium ion is complexed with catechol in a homogeneous system, and the resulting anionic germanium complex is then captured using an anion-exchange resin or membrane.[15, 17] The predominant oxidation state of germanium is Ge(IV) however the Ge^{4+} ion is easily hydrolysed and is rarely existing in aqueous solutions.[13] Indeed, germanium is mainly found in the form of germanic acid, $Ge(OH)_4$, and Ge-oxoanions in aqueous solutions. At pH lower than 4, germanium predominantly exist in non-complexed form and at higher pH the formation of a catechol complex is proposed according to the equation 1 and illustrated in Figure 1.[17, 21]

$$Ge(OH)_4^0 + 3C_6H_4(OH)_2 \leftrightarrow Ge(C_6H_4O_2)_3^{2-} + 2H^+ + 4H_2O \qquad (1)$$