Recovery of gold (III), palladium (II) and platinum (IV) ions from chloride solutions on the solvent impregnated resin (SIR) — Dowex Optipore L493

Grzegorz Wójcik, Zbigniew Hubicki, Magdalena Górska

University of Maria Curie-Sklodowska Faculty of Chemistry, Department of Inorganic Chemistry, Pl. M. Curie-Sklodowskiej 2, 20-031, Lublin, Poland, e-mail: grzegorzwojciukumcs@wp.pl

The method described in this paper using Dowex Optipore L493 for removal of gold (III), palladium (II), and platinum (IV) ions from hydrochloric solutions is found effective for separation of gold, palladium and platinum.

There were carried out laboratory studies of selective removal of platinum (IV), gold (III) and palladium (II) microquantities from 0.1–6 M hydrochloric on the solvent impregnated highly cross-linked styrenic polymer, Dowex Optipore L493 using Cyanex 301.

In these experiments the recovery factors % R of gold (III), palladium (II) and platinum (IV) depending on phases contact time were obtained. The gold, palladium and platinum concentrations were determined by the AAS method.

Keywords and phrases: gold, platinum, palladium, solvent impregnated resins.

Introduction

Precious metals such as: gold, palladium and platinum has been known and appreciated for ages with regard to their physical and chemical proprieties exploited in many fields.

The main application of platinum and palladium are in electronics and many catalytic industrial processes. The number of industrial processes particularly for the production of chemicals based on palladium or platinum reactions is still growing.

Palladium finds many catalytic applications in industry such synthesis of hydrogen and automobile catalytic converters. Gold was used as a medium of monetary exchange, in electronic, medicine or jewellery industries [1].

The increasing demands for precious metals besides their limited resources and high costs of their production, force to look for new sources [2].

Well known techniques for separation and recovery of precious metals in the case of concentrated solutions are not useful for treatment of low concentrated solutions. Many sorbents including ion-exchange resins became alternative to the use of solvent extraction processes [3]. Moreover, traditional methods to obtain these metals require using aggressive reagents and their use has a negative impact on the environment. One approach to solve this problem is based on recovery of ions from chloride solution using impregnated resin, which gives essential ecological and economical challenges and advantages [2].

This solvent impregnated resin (SIR) approach avoids emulsification and simplifies the phase separation after extraction [4]. Impregnation of an organic extractant into a polymeric support offers ease of solvent impregnated resin preparation and a wide choice of reagents of desired selectivity [5]. SIRs consist of commercially available macroporous resins impregnated with an extractant [4].

Experimental

Dowex Optipore L 493 was impregnated by using Cyanex 301. Dowex Optipore L493 is a highly cross-linked styrenic polymer characterized by such parameters as surface area >1100 m²/g, pore volume 1.6 cm³/g and average pore diameter 46Å.

Cyanex 301 is bis(2,4,4-trimethylpentyl)dithiophosphinic acid. It is a green mobile liquid. The flash point has a value 347 K.

Cyanex 301 was produced by Cytec Chemical Company. Cyanex 301 was produced by Cytec.
Recovery of gold (III), palladium (II) and platinum (IV) ions from chloride solutions on the solvent impregnated resin (SIR)

Canada Inc. The other reagents were chemically pure and produced by POCh, Poland.

The resin was washed three times with acetone to remove any impurities. Next Dowex Optipore L 493 was rinsed thoroughly with deionised water. After that the resin was dried in air at 298 K. 15 g of prepared resin were mixed with 6 g Cyanex 301 (ratio: 1:0.4) and stirred for 4 hours. Next the mixture of impregnated resin and solution was separated by filtration, washed with distilled water to remove acetone and dried at 298 K.

The samples of impregnated resin (0.25 g) with 25 cm³ corresponding solution were mechanically shaken from 1 to 360 minutes. After that the solution with impregnated resin was filtered. Gold, palladium and platinum concentrations were determined by the AAS method.

In these experiments % R of gold (III), palladium (II) and platinum (IV) depending on time was obtained.

Results

The influence of hydrochloric acid concentration on gold (III), palladium (II) and platinum (IV) ions sorption on Dowex Optipore L493 is shown in Fig. 1–3.

The prepared impregnated sorbent is characterized by the good sorption of Au (III) ions in hydrochloric acid concentration range 0.1 to 6 M. At pH 3 and in hydrochloric acid concentration range 0.1 to 6 M the values of recovery factors (%R) of gold (III) ions were about 99% in the phase contact time about 90 min.

Sorption of Pd (II) ions was slightly worse than that of Au (III) ions and depended on hydrochloric concentration too. Sorption of palladium (II) ions increases with the increasing hydrochloric acid concentration. The values of % R for palladium ions at HCl concentration 6 M were about 97%.

Sorption of Pt (IV) ions was the worst. With the increasing concentration hydrochloric acid the increase of % R to about 40 was observed and depended on hydrochloric acid concentration too.

The prepared SIR as a result of solvent impregnation process can be considered effective for separation of gold and palladium from platinum containing solution. The difference in values of recovery factor between palladium (II), gold (III) and platinum (IV) ions is about 60%.

References


