Sorption of Nickel on Zeokarb 226 (NH₄)²

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Received 4 November 1976; accepted 7 December 1976

Sorption of nickel on Zeokarb 226 (NH₄ form) as a function of pH has been studied. The results show that nickel is initially sorbed as Ni⁺ which transforms to NiOH⁺ with increase of loading. This provides an example of site sharing on a cation exchanger.

CARBOXYLIC acid exchangers are recommended for the recovery of nickel from electrolyte baths, waste solutions, etc. However, there are apparent differences in the pH conditions of sorption. Hence sorption of nickel as a function of pH was studied by equilibrating varying amounts of the metal ion in 100 ml at different pH values (adjusted with ammonium chloride and ammonium hydroxide) with 0·25 g of Zeokarb 226 (NH₄). The nickel in the solution phase at equilibrium was determined either complexometrically or spectrophotometrically. When the amount of nickel taken is small, its sorption is practically quantitative in the pH range of 6-0 to 9-0. Studied at higher concentrations, it is maximum at pH 7·5 and less on either side as against 7·0 (ref. 5) and 6·0-6·5 (refs. 6 and 7) recommended by earlier workers on similar exchangers with different ionic forms.

The sorption profile of nickel on a column was obtained by passing 0·05 M nickel solution at pH...
7.5 through a column (0.5 × 4.0 cm) of 1.0 g of the exchanger (5.93 meq.) and analysing 50 ml fractions of the effluent for the nickel content, till the effluent concentration reaches that of the influent. It is interesting to note that the nickel sorbed, by the breakthrough, is more than the capacity of the exchanger. Also the curve consists of two steps (curve 1, Fig. 1). The column was then washed with water. The sorbed nickel was eluted with 34.2 meq. of hydrochloric acid, followed by two steps (curve 1, Fig. 1). The column was then washed with water till free of acid. This effluent contained 23.1 meq. of free acid and 10.28 meq. of Ni²⁺. Since the excess acid (5.17 meq.) consumed over that required for regeneration of the exchanger into H⁺ form (5.93 meq.) is nearly equal to half the meq. of nickel eluted, it is concluded that nickel is present mostly as NiOH⁺ by the time the exchanger is nearing exhaustion. Considering this data and the two steps in the sorption profile, it is inferred that nickel is initially sorbed as Ni²⁺, which transforms to NiOH⁺ with increase of loading. This may be considered as an example of site-sharing on a cation exchanger. The sorption reactions may be represented thus:

\[ 2\text{RCOO} \cdot \text{Ni} \cdot \text{NH}_4 \cdot \text{H}_2 \text{O} \rightarrow \text{RCOO} \cdot \text{Ni} \cdot \text{OH}^+ \cdot \text{NH}_3 \cdot \text{H}_2 \text{O} \]  

When 7.0 meq. of Ni²⁺ at pH 7.5 were equilibrated with 2.70 meq. of the exchanger, it was observed by a similar analysis of the exchanger that 1.71 and 0.78 meq. of Ni²⁺ were sorbed as Ni²⁺ and NiOH⁺ respectively. This lends further support for the transformation of Ni²⁺ species to NiOH⁺ species with increase of loading.

When the exchanger of the same capacity was taken in Na⁺ form, 11.22 meq. of Ni²⁺ was sorbed, and 0.78 meq. of Ni²⁺ were sorbed as Ni²⁺ and OH⁻ than RCOO⁻NH₄.

Though sorption of nickel was decreasing with increase of NiOH⁺ concentration in the solution phase (as expected), sorption of 75% and 60% of 2.0 and 0.5 mg of nickel taken was observed in batch experiments in the presence of 2.0 g of ammonium chloride in 100 ml at pH 7.5, when equilibrated with 0.25 g of exchanger. Nickel can, therefore, be recovered almost quantitatively from spent catalysts by employing the exchanger columns in series. Desorption of nickel with formic acid (curve 2, Fig. 1) was found to be as efficient as hydrochloric acid. This gives nickel formate for obtaining the active catalyst.

Similar experiments with a sulphonic acid exchanger (Dowex 50 × 8, NH₂⁻) revealed the sorption as well as desorption to be considerably less efficient, proving the greater advantage of a weak cation exchanger for the recovery of nickel.

The authors are grateful to Dr M. Sankar Das and Shri P. Murugaiyan for useful discussions.

References

Corrosion Inhibition Characteristics of Some Furan Derivatives from Their Quantum Chemical Values

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Quantitative chemical values such as ionization potentials and electron affinity of some furan derivatives have been successfully correlated with their corrosion inhibition characteristics in acid dissolution of iron.

Furan derivatives have been used as corrosion inhibitors in the anodic dissolution of iron. Vosta and coworkers have correlated the quantitative chemical parameters of a series of structurally related compounds with their corrosion inhibition characteristics. This paper reports a correlation between some quantum chemical parameters such as ionization potentials and electron affinities of furan and some of its derivatives with their corrosion inhibition characteristics.

A cylindrical piece of iron (99.99% pure) mounted on teflon holder was used as the electrode. The electrode surface was polished successively with 150, 250, 360, and 600 emery papers and degreased with acetone and dried. Disc surface (0.2 cm² area) was exposed to the solution and satisfactorily tight seals were provided between iron surface and teflon.

Triply distilled water was used. Furan, furfurylamine and furoic acid were of AR grade and used as such.

The galvanostatic method used for steady state polarization studies consisted of a constant current generator and one vernier potentiometer having different channels for measuring corrosion current and corrosion potentials. All experiments were carried out at 25°C ± 0.1°C. Corrosion rates were measured in terms of log icorr (current density) in 1M perchloric acid containing 0.1M inhibitor solution.

The relation between inhibition characteristics and quantum chemical data shows that log icorr mostly depends upon the energy of the highest occupied molecular orbital (HOMO) which is a theoretical analogue to the ionization potential of a substance. The lowest free molecular orbital (LFMO) which gives idea about electron affinity of the molecule is also shown to be dependent on the log icorr values (Fig. 1). It is observed that the inhibition characteristic increases with increase in the energy of HOMO, i.e. with decrease in ionization potential. Thus the inhibition eff-