Inhibition Efficiency of Proteins & Carbohydrates & Dissolution of Tin in Nitric Acid

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The inhibition efficiency of high molecular weight proteins (gelatin and albumin) and carbohydrates (dextrin and starch) on the dissolution of tin in 4.0M nitric acid has been studied by the thermometric method. It is found that the percentage inhibition increases in the order dextrin < starch and albumin < gelatin.

The action of organic compounds as inhibitors of corrosion in acid solutions is generally explained in terms of adsorption. Shams El-Din showed that gelatin can be used as an inhibitor for pitting corrosion of iron in H₂SO₄ solution containing chloride ions. Information is also available that proteins and polysaccharides have inhibitive properties. In this note we have examined inhibitor efficiency of proteins (gelatin and albumin) and carbohydrates (starch and dextrin) on the dissolution of tin in HNO₃ solution. The inhibition efficiencies of these high molecular weight compounds have been compared with those of glycine, L-alanine, glucose and fructose to assess the effect of molecular size on inhibition efficiency.

The thermometric method for corrosion assessment, was used to ascertain the inhibition efficiency of these compounds. Commercially available tin rods, containing 0.03% As, were cold-worked in the form of strips (64 × 10 × 0.5 mm³). The pretreatment of the specimens and the procedure employed have been previously reported. The inhibitors, used in 4.0M HNO₃ solutions, were: albumin (Prolabo, France), gelatin (BDH), dextrin (BDH), starch (Veb. Laborchemie, DDR), glycine, L-alanine (both BDH), glucose (Nasr Co, Egypt), fructose (Reidel) and sucrose (Veb. Berlin-Chemie, Berlin).

The reaction number (R.N.) is defined as:

\[ \text{R.N.} = \frac{(T_m - T)}{t}, \text{°C min}^{-1}, \]

where \( T_m \) and \( T_i \) denote respectively, the maximum and initial temperatures and \( t \) the time taken to reach \( T_m \). All experiments were started at \( T_i = 20 \pm 0.1 \text{°C} \).

The thermometric curves for the dissolution of tin in 4.0 M HNO₃ containing increasing amounts of gelatin are shown in Figure 1. The inhibition efficiency of the additives was evaluated in terms of the relative percent lowering in R.N., given by the expression:

\[ \text{P.O.} = \frac{[\text{R.N.}_\text{free} - \text{R.N.}_\text{inhibi}]}{\text{R.N.}_\text{free}} \times 100 \]

The thermometric curves representing the dissolution of tin in 4.0M HNO₃ solutions containing increasing amounts of the aforementioned inhibitors were traced. Figure 1, shows the thermometric curves in the presence of increasing amounts of gelatin. Similar curves were also obtained with other inhibitors. This concentration of the acid was chosen because the thermometric curves of additive-free solutions could be recorded over reasonably short periods, and to avoid complications arising from the interference of an exothermic reaction which occurs in concentrated solutions. Under the conditions of temperatures and acid concentration and experimental time duration (the maximum temperature reached 60°C, maximum period for each measurement 80 min), gelatin is fairly stable and is not likely to undergo acid hydrolysis.

All the additives retard the dissolution process as indicated from the observed decrease in the corresponding R.N. values. This effect is produced through a decrease in \( T_m \) with simultaneous increase in time, \( t \), needed to reach it, which signifies strong adsorption of the additives. The progressive diminution in the slope of the rising parts of the thermometric curves with increase in additive concentration indicates that they are adsorbed on the anodic sites, since these parts of the curves represent the apparent rate of the anodic reaction. This behaviour resembles that of alkylamines and some naturally occurring...
The percentage inhibition increases with increase in inhibitor concentration, up to a certain concentration after which further addition of inhibitor has, albeit, a limited effect (Fig. 2). This can be accounted for by assuming the complete formation of a monomolecular layer from the adsorbate surface. For one and the same concentration of the inhibitors, percentage inhibition increases with the increase in the size (mol. wt) of the inhibitor (Fig. 2). The percentage efficiencies of the various inhibitors follow the order: fructose < glucose < sucrose and dextrin < starch, and glycine < L-alanine and albumin < gelatin. Though glucose and fructose have the same size (mol. wt) the former is a more effective inhibitor. The increase of the inhibiting action with the molecular size is expected because (i) larger molecules ensure higher surface coverage and (ii) repetition of the functional groups in high molecular weight compounds reinforces adsorption of inhibitor on metal surface.

References
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