STUDY OF THE INHIBITING PROPERTY OF THIOSEMICARBAZIDE FOR THE CORROSION OF ALUMINIUM AND ZINC

By

ABO EL-KHAIR B. M., ***Kh.*** **M. KAMEL AND I.A. ABDEL-HAMID**

Chemistry Department, University College for Women,
Ain Shams University, Cairo, A.R.E.

ABSTRACT

The effectiveness of thiosemicarbazide as an inhibitor in acidic and alkaline media for the corrosion of Aluminum was investigated. The percentage inhibition was found to increase in acidic solution with concentration up to 87% at $5X10^{-3}$ M inhibitor. For the corrosion of aluminium, thiosemicarbazide (TSC) is more effective inhibitor in acidic medium than in alkaline one. This phenomenon was explained on the basis of Zwitter-ion formation by TSC in alkaline medium. Similar behaviour were also obtained for alkaline corrosion of zinc using TSC as inhibitor.

INTRODUCTION

Organic compounds are widely used as corrosion inhibitors. Most of these organic inhibitors are compounds with at least one polar function, having atoms of nitrogen, sulphur, oxygen and in some cases selenium and phosphorus. An important class of organic inhibitors is thiourea and its derivatives [1, 2]. The effectiveness of the functional atoms with respect to the adsorption process can be taken as being in the following sequences 3, [4] :

$$Se > S > N > O$$

This may be due to tbe difference in the lectronegativities of the elements. However, the mchanism of the action or organic inhibitors depends on their molecular structures [5]. Among other structural parameters which can affect the inhibiting efficiency is the molecular area of the inhibitors [6], as well as their molecular weights [7, 8]. The problem of the action of cations rather than molecules as inhibitors had been considered [9].

The work presented in this manuscript is to evaluate thiosemicarbazide as an inhibitor for the corrosion of aluminium in both hydrochloric acid and sodium hydroxide solutions. Similar studies were done on zinc metal in alkaline medium.

EXPERIMENTAL

Chemicals employed were of the highest purity available. The concentration of thiosemicarbazide studied varied between $0.88X10^{-4}$ and $2.64X10^{-2}$ M. Al and Kn were spectroscopically pure. Determination of the corrosion rate was performed by weight loss measurements. The metallic sheets had an apparent surface area of 100 cm^2 each. The sheets were degreasd and abraded successively down to 00 grade. The results were obtained in duplicate and no significant discrepancies were observed. Measurements were taken for Al in hydrochloric acid and sodium hydroxide solutior (1 N) and for Zn in sodum hydroxide solution (1 N). The percent inhibition (P) was calculated from the following equation[10] :

$$P = 100 \left(1 - \frac{W_2}{W_1}\right)$$

where W_1 and W_2 are the corrosion rates in absence and in presence of inhibitor, respectively.

RESULTS AND DISCUSSION

The corrosion rate of Al (in acidic and alkaline media) and Zn (in alkaline medium) in presence of thiosemicarbazide (TSC) as an inhibitor was measured by weight loss techniques. Fig. 1 is a plot of the corrosion rate of Al versus the logarithm of inhibitor concentration in 1 N HCl and I N NaOH solutions. It was observed that, as the inhibitor concentration increases the corrosion rate decreases asymptotically. This agrees with the results obtained for thiourea and some of its derivatives[11, 12]. Fig. 2 shows a plot of percentage inhibition versus logarithm of inhibitor concentration in 1 N HCl and 1 N NoOH solutions. It is evident that, in both cases the percentage protection increases with increasing inhibitor concentration. The limiting value at an inhibitor concentration of $4.3X10^{-3}$M is about 87% HCl and only 61% NaOH. It was observed that at any inhibitor concentration studied, the percent protection in acidic solution was higher than in alkaline one. This agrees with the previously published results[13] concerning the effect of thiourea on the corrosion of Al in both acidic and alkaline media, where the limiting percent protection for thiourea was found to be about 60% in 1 N hydrochloric acid and 16% only in sodium bydroxide solution.

It can be concluded that, thiosemicarbazide is more efficient inhibitor than thiourea under the same concentration in both acidic and alkaline media.

Fig. 3 represents the change of the corrosion rate of Zn with the logarithm of inhibitor concentration in 1 N sodium hydroxide solution. It was observed that the corrosion rate decreases with increasing concentration of TSC. Fig. 4 shows the change of the percentage inhibition (P) with logarithm of the inhibitor concentration in 1 N sodium hydroxide solution. It can be seen that the protection efficiency increases with increasing inhibitor concentration approaching a limiting value of about 90%.

The more efficient adsorption inhibition of thiosemicarbazide than thiourea is probably due to the larger area or volume occupied by TSC from the additional - NH-group in its molecule. Furthermore, the different charge distribution on TSC molecule increases its adsorption behaviour. Due to the lower concentration of protons in alkaline medium, he inhibitor reacts forming Zwitter-ions [13].

The applicability of Langmiur's adsorption isotherm to the adsoorption of the inhibitor on the corroding surface was confirmed, since a straight line with a slope of 0.42 as given in Fig. 5 was obtained. However the deviation of the value of the slope from unity may be attributed to lateral interaction effects which are not accounted for in deriving the equation. Similar behaviour was obtained for acid corrosion of mild steel in presence of TSC [12].

From the above results it can be concluded that, thiosemicarbazide is an excellent inhibitor for the corrosion of Al showing marked efficiency than thiourea at comparable concentrations.

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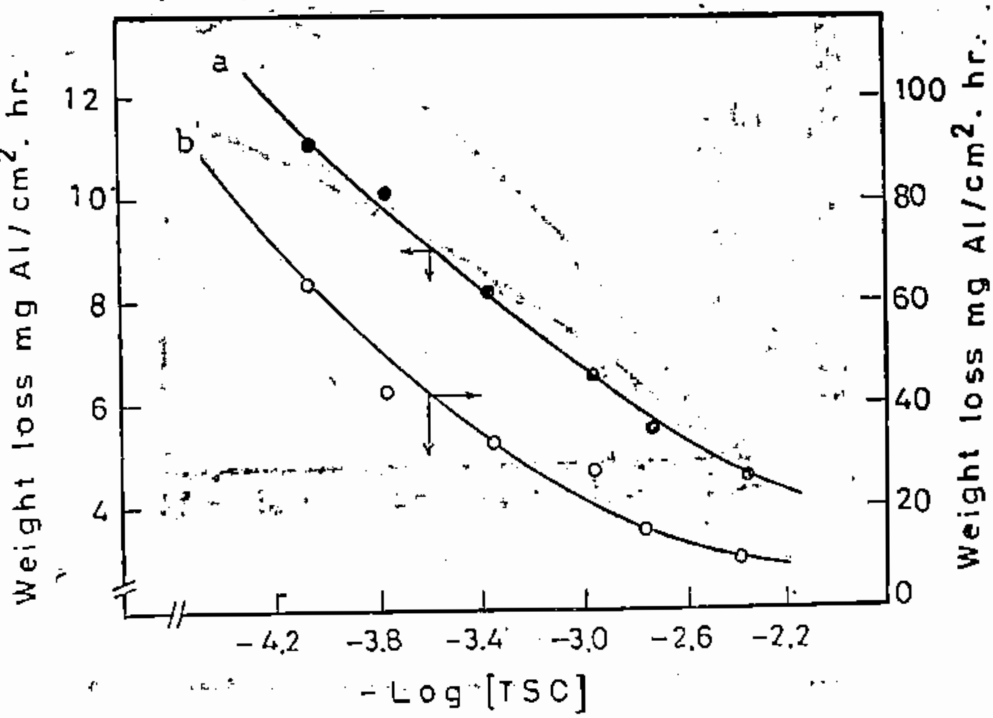

Fig. 1

Fig. 1. Effect of the concentration of thiosemicarbazide on the corrosion rate of Al in alkaline and acid media :

a) in 1.0 N NaOH at 30°C.

b) in 1.0 N HCl at 24°C.

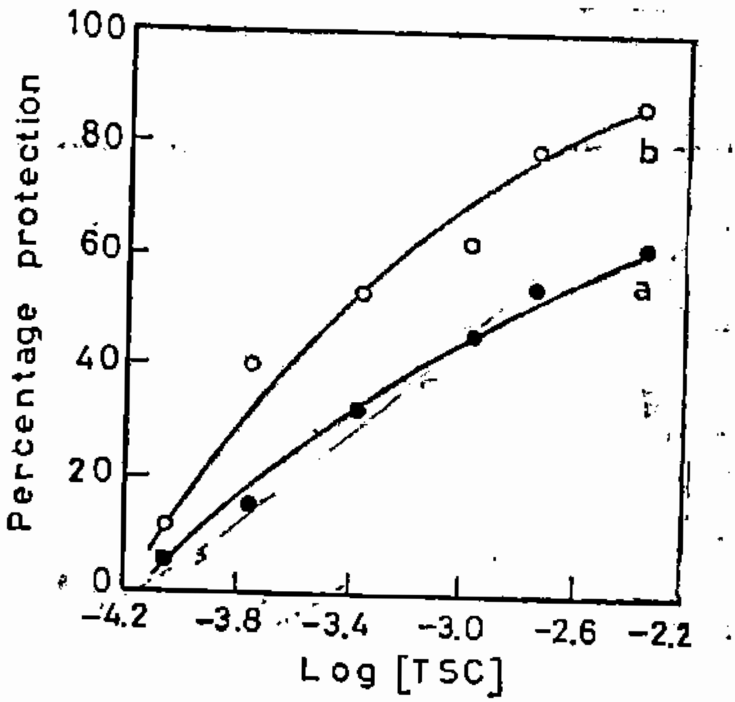

Fig. 2

Fig. 2. Effect of inhibitor concentration on the percentage protection of Al in :

a) 1.0 N NaOH

b) 1.0 N HCl.

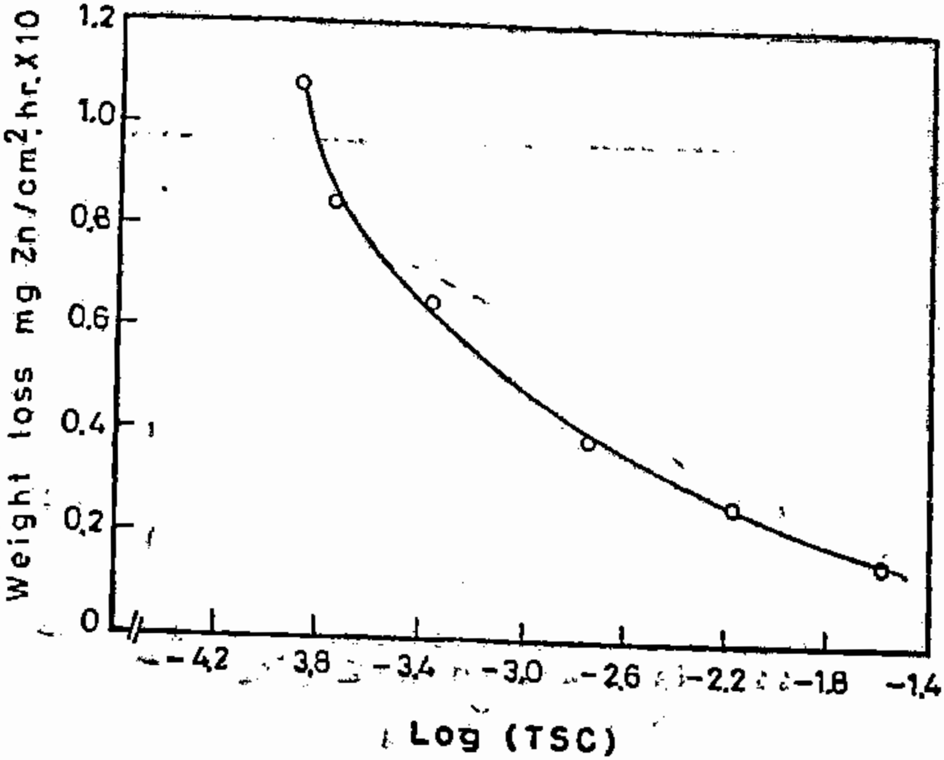

Fig. 3

Fig. 4. Effect of inhibitor concentration on the percentage protection of Zn in 1.0 N NaOH at 25°C.

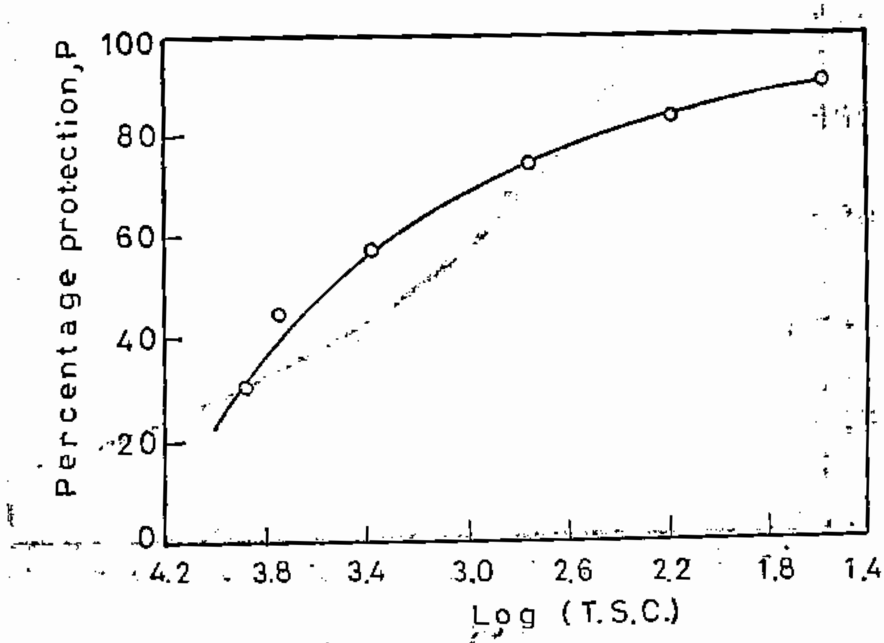

Fig. 4

Fig. 3. Effect of the concentration of thiosemicarbazide on the corrosion rate of Zn in 1.0 N NaOH at 25°C.

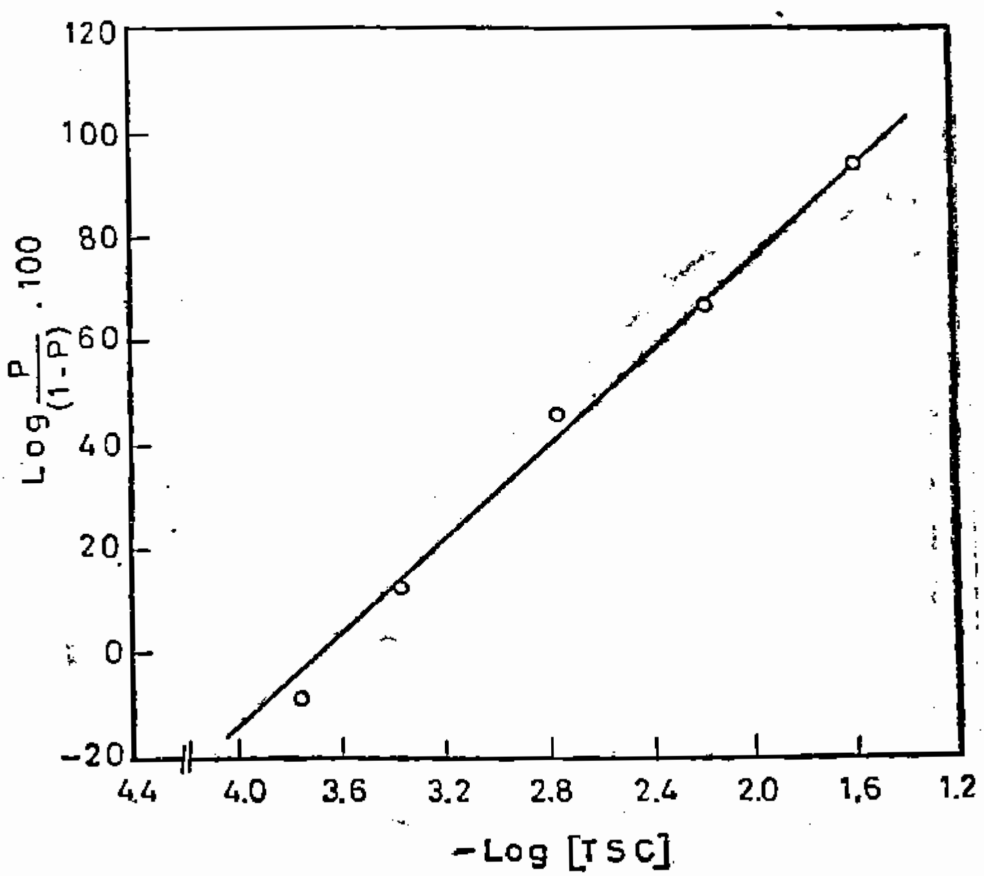

Fig. 5

Fig. 5. Log P/ (1 - P) versus log the concentration of thiosemicarbazide for the corrosion of Zn in presence of TSC in 1.0 N NaOH at 25°C.