ISSN 2070-2051, Protection of Metals and Physical Chemistry of Surfaces, 2011, Vol. 47, No. 3, pp. 381–394. © Pleiades Publishing, Ltd., 2011.

PHYSICOCHEMICAL PROBLEMS OF MATERIALS PROTECTION

Effect of Temperature on the Inhibition of the Acid Corrosion of Steel by Benzimidazole Derivatives[1]

F. M. Mahgoub[a, b], F. M. Al-Nowaiser[a], and A. M. Al-Sudairi[a]

[a] *Chemistry Department, Faculty of Science, King Abdul Aziz University, Saudi Arabia*

[b] *Materials Science Department, Institute of Graduate Studies and Research, Alexandria University, Egypt*

e-mail: ftm_mahgoub@yahoo.com

Received June 17, 2009

Abstract—The effect of 2-mercaptobenzimidazole (inh. I) and 2-mercapto-5-methylbenzimidazole (inh. II) on the corrosion of mild steel in 1M solutions of sulphuric acid has been investigated in relation to the concentration of the inhibitor as well as temperature by various monitoring corrosion techniques. The results obtained revealed that these compounds are good inhibitors. All the impedance diagrams gave semicircles for both inhibitors indicating that the corrosion of mild steel is controlled by a charge transfer process and the presence of either inhibitor does not alter the mechanism of the dissolution of mild steel. In general, both inhibitors efficiencies increased with increasing the inhibitors concentration at all temperatures used. On the other hand, inhibitors efficiencies were almost constant with increasing the temperature at concentrations 5×10^{-4} M, 1×10^{-3} M and 5×10^{-3} M. The best performance was noticed in case of (inh. II) especially at the concentration 5×10^{-3} M. Adsorption of both inhibitors was found to follow Langmuir, Flory–Huggins isotherms and kinetic-thermodynamic model. The binding constants "*K*" were calculated for both inhibitors. On increasing the temperature, the value of "*K*" increased in both cases indicative of stronger binding of the inhibitor molecule to the mild steel surface and hence higher inhibition efficiency at higher temperatures. The activation energy of the corrosion reaction decreases with increasing the concentration of (inh. I) or (inh. II). The adsorption of both inhibitors on the surface of mild steel is probably chemisorbed on the electrode surface. The thermodynamic parameters were calculated. Mass loss measurements revealed that both inhibitors exhibit maximum inhibition efficiency with increasing the concentration and temperature which confirm the data obtained from *AC* impedance. *DC* polarization data reveals that, both inhibitors does not alter the mechanism of anodic behaviour of mild steel and they behave as mixed type inhibitors. Again both inhibitors exhibit maximum inhibition efficiency with increasing the concentration and temperature which confirm the data obtained from *AC* impedance.

DOI: 10.1134/S2070205111030087

1. INTRODUCTION

Mild steel is one among the widely used engineering materials. While its excellent mechanical properties and low cost make mild steel the first choice of any fabricator. Its susceptibility to rusting in humid atmosphere and its very high corrosion rate in acidic environments are major restraints in its use on a much larger scale [1, 2].

Acid solutions are extensively used in industry, the most important of which are acid pickling [3, 4], industrial acid cleaning, acid-descaling and oil well acidizing. The commonly used acids are hydrochloric acid, sulphuric acid, nitric acid, etc. [5]. Sulphuric acid is used in pickling processes of mild steel. In the course of pickling, there is the danger that metal dissolution upon the already cleaned metal surface will occur after the removal of the oxides, scale or other coatings. That involves a loss of dissolved metal as well as acid consumption. The mild steel corrosion, also, involves hydrogen formation, which is dissolved by the metal in atomic form. That gives rise to decrease in the ductility of metal known as pickling brittleness. Inhibitors are added to the acid to prevent these disadvantages associated with a metal corrosion in pickling. The temperature dependence of percent inhibition efficiency (*% IE*) of an inhibitor can be divided into three sections:

(a) Inhibitors whose (% IE) decreases with the temperature increase:

The effect of 4-(2'-amino-5'-methyl phenyl azo) antipyrine (AMPA) on the corrosion of mild steel in a 2 M HCl solution was studied by S.S. Abd El Rehim et al. [6] using weight loss and potentiodynamic polarization techniques. Polarization data show that the compound behaves as a mixed-type inhibitor. Flory–Huggins adsorption isotherm and El Awady thermodynamic-kinetic model fit the experimental data of the studied compound. AMPA increases the activation energy of the corrosion reaction, which may be due to physical adsorption.

[1] The article is published in the original.