Corrosion control with Organic Compounds for mild steel in acidic media

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Abstract

Several types of corrosion inhibitors were synthesized in the laboratory and their influence on the inhibition of corrosion of mild steel in 1N HCl was investigated by weight loss techniques. The inhibition efficiency (IE) of these compounds was found to vary with concentration, temperature and immersion time. Good IE was evidenced in both acid solutions.

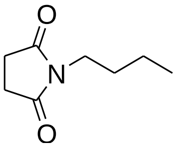
*Keywords: I*soindoledione, Pyrrolidinediones, Corrosion inhibitior, Acetic medium, Mild Steel

Introduction

Steel is the most important engineering and construction material in the world. It is used in every aspect of our lives, from automotive manufacture to construction products, from steel toecaps for protective footwear to refrigerators and washing machines and from cargo ships to the finest scalpel for hospital surgery. There are several thousands steel grades published, registered, or standardized worldwide, all of which have different chemical compositions, and special numbering systems have been developed in several countries to classify the huge number of alloys[1-5]. In addition, all the different possible heat treatments, microstructures, cold-forming conditions, shapes, and surface finishes mean that there are an enormous number of options available to the steel user[6,7]. Fortunately, steels can be classified reasonably well into a few major groups according to their chemical compositions, applications, shapes, and surface conditions. Corrosion problems have received a considerable amount of attention because of their attack on materials. The use of inhibitors is one of the most practical methods for protection against corrosion. Several works have studied the influence of organic compounds containing nitrogen on the corrosion of steel in acidic media [8–19], most organic inhibitors act by adsorption on the metal surface [14].

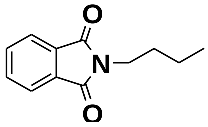
Experimental Section

We are successfully synthesised [20] some Imides, N,N-Diacetylamines**,** cyclicacetylamines namely isoindoledione and pyrrolidinediones. A number of imides and cyclicimides are key intermediate in organic synthesis and it were found to possess an biologically active compounds like drugs, fungicides and herbicides etc. So, we have chosen three molecules namely **1-Butyl-pyrrolidine-2,5-dione, 2-Butyl-isoindole-1,3-dione and 2,6-Dibutyl-pyrrolo[3,4-f]isoindole-1,3,5,7-tetralone** for corrosion inhibition study.



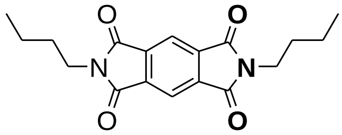
Compound 1

1-Butyl-pyrrolidine-2,5-dione



Compound 2

2-Butyl-isoindole-1,3-dione



Compound 3

2,6-Dibutyl-pyrrolo[3,4-f]isoindole-1,3,5,7-tetralone

A mixture of 1 mmole of dicarboxylic acid , 1.1 mmol of amine and catalytic quantity of $Yb(OTf)_3$ in 10 ml acetic acid was refluxed at 120 ^{0}C. The progress of the reaction was monitored by thin layer chromatography using hexane-ethyl acetate solvent system. After 5 hr. the reaction was completed, heating was stopped. After cooling, 25 ml. of water and 25 ml. of ethyl acetate were added, the mixture shaken well, separated, and the aqueous layer was washed with ethyl acetate, separated. The combined ethyl acetate layer was washed with 20 ml. of water 10 times for removal of excess acetic acid. Organic layer was dried with sodium sulphate, the filtrate was concentrated. The corresponding product was obtained in good yield [20].

All yields reported were based on isolated compounds. TLC separations were carried out on silica gel plates with UV indicator from Aldrich; visualization was by UV fluorescence or by staining with iodine vapor. IR spectra were recorded on a FT-IR Bruker Vector 22 Infrared spectrophotometer using KBr disks. NMR spectra were recorded on FT-NMR Bruker 400/200 MHz spectrometer as $CDCl_3$ solutions with TMS as internal reference. All the new products obtained were fully characterized by spectroscopic methods such as IR, ^{1}H NMR, ^{13}C NMR and mass spectroscopy.

Results and Discussion

We have successfully demonstrated that amide derivatives of isoindoledione, pyrrolidinediones can be used as corrosion inhibitor for steel API 5L-X60 in 1N HCl. Inhibition efficiency increases with increase in the aromatic character with the number of heteroatom. Among the compounds 1–**3**, **2,6-Dibutyl-pyrrolo[3,4-f]isoindole-1,3,5,7-tetralone** (compound **3**) was found to be a good inhibitor for carbon steel (API 5L-X60) corrosion in 1N HCl solution. The results obtained from electrochemical studies were in good agreement with those obtained from weight loss measurements.

Corrosion tests were made in 1N-hydrochloric acid on mild steel samples **2** cm. square and **32** mm. thick, with a hole drilled in one corner for suspension from a glass hook for 7 days. This steel was rubbed with a fine abrasive cloth to smooth the sample but not to give it a high polish. After washing with water and alcohol and carefully drying, each sample was accurately weighed. After conclusion of the test the sample was rubbed with a soft brush rinsed in boiling water, dried, and again weighed. The rate of corrosion was reported as loss in grams. The following table gives the corrosion rates of the bare metal check samples:

Table 1: Weight loss data for the synthesized compounds **1-3**

System	Wt. Loss (mg)	Inhibition efficiency (%)
Test **1**: Control: 1N HCl	72.5	---
Test **2**: 500 ml of 1N HCl + 120 ppm chloride and 50 ppm compound 1	27.9	62
Test **3**: 500 ml of 1N HCl + 120 ppm chloride and 50 ppm compound 2	18.5	74
Test **4**: 500 ml of 1N HCl + 120 ppm chloride and 50 ppm compound 3	6.3	91

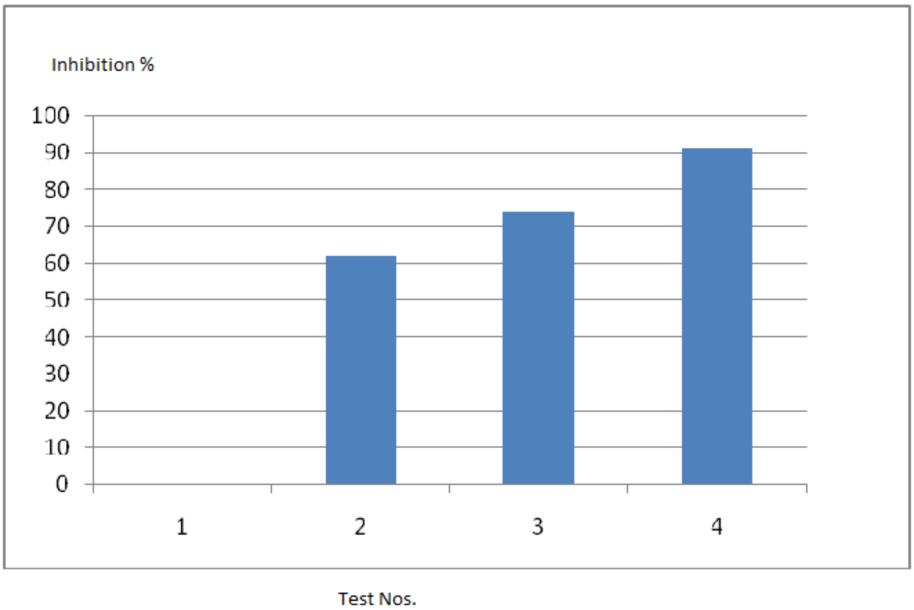


Figure 1: Image for Inhibition Efficiency in percentage

From the above table 1-Butyl-pyrrolidine-2,5-dione (compound 1) shows 62% of inhibition efficiency, 2-Butyl-isoindole-1,3-dione (compound 2) shows 74% inhibition efficiency and 2,6-Dibutyl-pyrrolo[3,4-f]isoindole-1,3,5,7-tetralone (compound 3) shows 91%. The molecule having the more number of heteroatom shows the more percentage of inhibition efficienvy due to the binding of the loan pair of electron on the oxidized metal surface, so corrosion will be prohibited.

Summary

Attempts have been made to determine what physical properties of the organic inhibitors are responsible for forming the protecting blanket or film, thereby protecting the metal against acid corrosion, but complete or satisfactory constants are available for the 2,6-Dibutyl-pyrrolo[3,4-f]isoindole-1,3,5,7-tetralone examined. The stereochemical structure, however, determines the cross-sectional area parallel to the metal surface and therefore is a determining factor in the effectiveness as an inhibitor.

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