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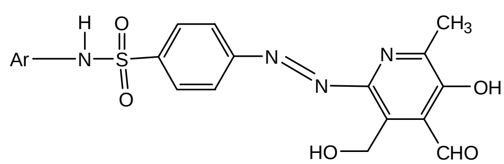
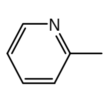
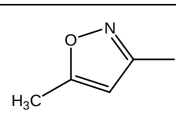
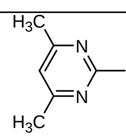
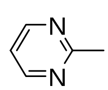
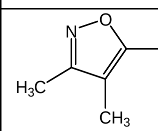
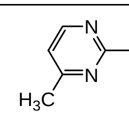
Abstract

Corrosion is one of the serious problems that faces equipments and machines that are used in industrial productivity institute. In order to decrease the effect of corrosion we must search for some inhibitors that work to protect metals from corrosion in acidic media.

In the recent study, two types of organic compounds were prepared and tested as corrosion inhibitors in acidic medium, 0.5M HCl. Azo dyes prepared from coupling reaction of six types of sulfa compounds with pyridoxal hydrochloride. The second type included five compounds of tetrazole. These types of compounds have feature of containing heteroatoms such as oxygen, nitrogen and sulfur in their chemical structures.

Azo dyes compounds have the general chemical structure:



	A1	A2	A3	A4	A5	A6
Ar =						

A1: (N-pyridin-2-yl-benzenesulfonamide azo) pyridoxal

A2: (N-(5-methyl-isoxazol-3-yl)-benzenesulfonamide azo) pyridoxal

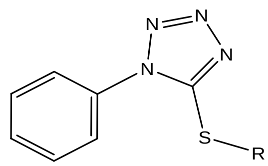
A3: (N-(4,6-dimethyl-pyrimidin-2-yl) - benzenesulfonamide azo) pyridoxal

A4: (N-pyrimidin-2-yl-benzenesulfonamide azo) pyridoxal

A5: (N-(3,4-dimethyl-isoxazol-5-yl)-benzenesulfonamide azo) pyridoxal

A6: (N-(4-methyl-pyrimidin-2-yl)-benzenesulfonamide azo) pyridoxal

The second type of synthesized compounds is tetrazole and its derivatives which have the general chemical structure:



	T1	T2	T3	T4	T5
R =	-H	$-CH_2CH_3$	$-CH_2(CH_2)_2CH_3$	$-CH_2(CH_2)_3CH_3$	$-CH_2$-Ph

T1: 1-Phenyl-1,2,3,4-tetrazole-5-thiol

T2: 5-Ethylthio-1-phenyl-1,2,3,4-tetrazole

T3: 5-Butylthio-1-phenyl-1,2,3,4-tetrazole

T4: 5-Pentylthio-1-phenyl-1,2,3,4-tetrazole

T5: 5-Benzylthio-1-phenyl-1,2,3,4-tetrazole

The prepared compounds were identified by FT-IR spectroscopy, CHNS analysis and ^{1}H-NMR spectroscopy. Also, determination of melting points was performed.

The inhibition efficiency of the synthesized compounds was studied using weight loss method in acidic solution by corrosion rate determination for carbon steel without and with different concentrations ($1x10^{-4}$, $5x10^{-4}$, $1x10^{-3}$ and $5x10^{-3}$) M of inhibitor at different immersion times (1-5) hrs, 303 K and static condition.

The inhibition efficiency of synthesized compounds was calculated, the optimum concentration ($5x10^{-3}$ M) and immersion time (5 hrs) were determined at the same conditions. The compounds have a good corrosion inhibition with efficiency percentage of (69.10%-83.43%) for azo dyes and (80.34%-90.45%) for tetrazole inhibitors.

The inhibition action for azo dyes was compared with the primary amines used in the preparation of these dyes. The azo dyes exhibited greater inhibition efficiency than that in amines, were the percentage of inhibition efficiency were (52.25, 59.55, 55.34, 56.46, 61.52 and 60.96%) for the amines sulfapyridine, Sulfamethoxazole, Sulfamethazine, sulfadiazine, Sulfisoxazole and sulfamerazine, respectively.

The effect of temperature variation on the corrosion rate for different concentrations ($1x10^{-4}$-$5x10^{-3}$M) of the prepared compounds was studied by using weight loss method at four temperature degrees 303,313,323 and 333K and 5 hrs. The experimental results of temperature effect indicated the following:

1- The rate of corrosion for both types of inhibitors decreased with increasing of inhibitor concentration at the certain temperature, while the corrosion rate increased with the rise of temperature.
2- All inhibitors had high inhibition efficiency in reducing the corrosion rate. The inhibition efficiency was decreased by increasing the temperature.
3- The adsorption of the molecules on the metal surface obey Langmuir isotherm. The adsorption constant K_{ads} and free energy of adsorption ΔG_{ads} were calculated for the studied inhibitors. The results showed that the adsorption constants were decreased with increasing the temperature and the negative value of free energy indicated that the adsorption process is spontaneous.

4- The corrosion kinetic was studied by using the relationship between logarithm of corrosion rate and absolute temperature reciprocal according to Arrhenius equation which was used to calculate activation energy. The results indicated that the activation energy E_a for acidic solution without inhibitor (34.34 kJ/mol) was less than that of the activation energy value with the two types of inhibitors, (42.44-55.24 kJ/mol) for azo dyes and (39.57-59.16 kJ/mol) for tetrazole compounds.

5- Thermodynamic functions ΔH and ΔS were calculated and discussed. The positive value of enthalpy indicated that the corrosion reaction is exothermic, while the negative value of entropy reflected the reducing in the entropy value and formation stable layer on the metal surface.

Electrochemical method (Tafel plot) was used to determine the corrosion rate for carbon steel in the presence of different concentrations of inhibitors to reach the optimum concentration of the corrosion rate at the minimum. The relationship between the concentration of inhibitor with inhibition efficiency, electrochemical parameters such as corrosion potential and corrosion current were studied. Also, the effect of temperature on these electrochemical parameters for both inhibitors at $5x10^{-3}$M was studied, and indicated that the increasing temperature shifted the value of corrosion potential to the active direction for uninhibited and inhibited solutions. These results illustrated that the temperature rise affects both anodic and cathodic reactions, increasing the corrosion current and decreasing the inhibition efficiency. The anodic and cathodic Tafel constants (βa and βc)

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were also affected markedly by increasing the temperature. This result led to concluded that these compounds were the mixed type inhibitors.

The electrochemical impedance technique was used to determine the inhibition efficiency for acidic solutions without and with different concentrations of both types of inhibitors. The results indicated that the both types of inhibitors had a high inhibition efficiency to reduce the corrosion rate through the formation of protective layer on the carbon steel surface. The inhibition efficiency values were 72.50%-87.50% for azo inhibitors and 81.48%-91.66% for tetrazole inhibitors at the same concentration of $5x10^{-3}$M.

Finally, the study involved using of new techniques to study the morphological changes in C-steel surface by recording the reflectance FT-IR spectra for carbon steel without and with inhibitors. The spectra indicated that the appearance of characterized bands in the presence of inhibitors was due to adsorption process of inhibitors on the surface of carbon steel alloy. The scanning electron microscope with energy dispersive X-ray spectrometer (SEM/EDX) was used to detect the percentage of corroded iron and percentage of alloy composition before and after immersing in corrosive medium of 0.5M HCl and compare these percentages in the presence of inhibitors. Atomic force microscopy was used to give three dimensional imaging to proof the formation of protective film resulted from adsorbed inhibitor molecules on the alloy surface which private it from corrosion and determination the thickness of corroded surface for C-steel alloy.

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