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Protective Action Of New Amine-Containing Inhibitors

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Abstract: This study investigates the protective action of newly synthesized amine-containing corrosion inhibitors derived from local raw materials and the distillation residues of monoethanolamine vacuum distillation in the chemical industry of Uzbekistan. It is shown that a multi-component inhibitor containing hydroxyethyldenediphosphonic acid (HEDP), sodium hydroxide, zinc oxide, glycerin, water, and the vacuum distillation residue of monoethanolamine (COMEA) can be used to protect steel equipment and pipelines in the oil and gas industry. Changes in the absorption spectra intensity of active functional groups of the inhibitors were studied using IR spectroscopy. Parameters such as corrosion current, stationary potential, corrosion rate, degree of protection, and effective activation energy (ΔE_eff) were determined.

KEYWORDS: Inhibition, gravimetry, thermodynamics, steel corrosion, inhibitor, protective mechanism, activation energy, Gibbs energy, corrosion rate, protective effect.

Introduction: Corrosion inhibitors are used in all areas of human activity: in the atmosphere and water, in fuel extraction and transportation, in energy, construction, and mechanical engineering. In most cases, corrosion environments—especially natural ones—have a pH close to neutral. Corrosion of metals in neutral aqueous environments usually causes localized surface damage. Among organic compounds, salts of carboxylic acids (RCOOH), where R is an alkyl, heteroalkyl, alicyclic, or aromatic group, are widely used as inhibitors in neutral media [1]. The primary cause of damage and wear of metal equipment and pipelines is corrosion destruction in acidic and neutral environments. The aggressiveness of the environment is largely determined by mineralization degree, salt (anion) composition of reservoir waters, and increases in content of H_2S, CO_2, CO, S, R-SH, organic acids, temperature, and pH [2]. Uzbekistan imports corrosion inhibitors, and the demand is high, especially in the chemical, electrochemical, petrochemical, gas industries, and water supply systems.

OBJECTS AND METHODS

The study focused on amine-containing inhibitors synthesized from local raw materials. The inhibitors (denoted IKA-1 to IKA-3) are transparent liquid masses that dissolve well in water and acidic environments. They do not form separate phases during storage and are effective in both soft and hard water (hardness 2–18 mg-eq/L), which is typical across regions of Uzbekistan. The inhibitors were tested in concentrations from 0.001% to 1.0% mass. The effect of neutral media on the corrosion behavior of St.3 steel was studied using gravimetric (mass loss) and electrochemical methods. Corrosion rate (K), inhibition coefficient, and protection fficiency (Z) were calculated according to formulas from [3].

RESULTS AND DISCUSSION

Corrosion-electrochemical behavior of St.3 steel in $3 \cdot 10^{-3}$ mol/L NaOH solution without (1), and with inhibitors IKA-1 (2), IKA-2 (3), and IKA-3 (4), is shown in Fig.1.

The results show that the inhibition efficiency of inhibitors IKA-6, IKA-7, and IKA-8 in strongly alkaline-saline solutions does not change with temperature. The solution contains 3% NaOH + 3% NaCl, indicating significant adsorption of metal samples on the surface [4]. Fig. 1. Effect of temperature on inhibition efficiency of IKA-6 (1), IKA-7 (2), IKA-8 (3) in 3% NaOH + 3% NaCl solution.

As temperature increases, the mobility of hydroxyl and chloride ions increases, resulting in greater adsorption on the metal surface. This sharply inhibits electrochemical corrosion processes and helps evaluate inhibitor effectiveness. The level of protection (Z) decreases slightly even at low temperatures. Higher temperatures also lead to more salt and oxide layers forming on the metal, which accelerate corrosion. Inhibitors help by minimizing formation of these layers.

Thermodynamic parameters of corrosion inhibition of St.3 and St.12 steel in alkaline-saline environments at 298 K were calculated using IKA-6, IKA-7, and IKA-8.

Table 1.

Thermodynamic parameters of St.12 steel corrosion in 3% NaOH + 3% NaCl (T=298K, C_ing=1.0%)

Inhibitor	*E_act (kJ/mol)*	*ΔH (J/mol)*	*ΔS (J/mol·K)*
Background	*40.87*	*41.52*	*74.82*
IKA-6	*60.39*	*-44.31*	*41.25*
IKA-7	*64.43*	*-43.98*	*44.84*
IKA-8	*72.09*	*-45.43*	*48.34*

Table 2.

Thermodynamic parameters of St.12 steel corrosion in 3% NaOH + 3% NaCl (T=298K, C_ing=1.0%)

Inhibitor	E_act (kJ/mol)	ΔH (J/mol)	ΔS (kJ/mol)
Background	42.51	43.05	48.84
IKA-6	65.58	-59.43	50.52
IKA-7	68.33	-57.31	52.18
IKA-8	78.48	-55.98	54.82

Stronger inhibitor films result in reduced influence of active ions. The ΔH values of 55.9 and 45.4 kJ/mol (with and without inhibitors, respectively) indicate an exothermic corrosion process. Higher ΔH values in the presence of inhibitors suggest chemical interaction between inhibitor molecules and metal ions, forming insoluble complex films. The increase in ΔS (from 48.8 to 54.82 J/mol·K) also confirms complexation. Higher E_act indicates that inhibitors raise energy barriers at the cathode and anode, reducing corrosion.

CONCLUSION

Studies of St.3 steel corrosion in acidic and hydrogen sulfide environments in the presence of amine- and phosphate-containing inhibitors showed high efficiency.

The best inhibitor was found to be diethylaminoethyl methacrylate phosphate among alkylamines, likely due to the high number and size of radicals, requiring the lowest protective concentration compared to other tested amines.

REFERENCES

1. Bober Y.G. Corrosion Inhibition of Iron in Neutral Media with Substituted Phenylanthranilic Acid Salts, Moscow, 2009.
2. Kuznetsov Yu.I., Vagarov R.K. Protection of Metals, 2000, Vol. 36, No. 5, p. 520.
3. Oserbaeva A.K., Nurullaev Sh.P., Kodirov Kh.I. Protection of Steel from Corrosion in Acidic and Neutral Environments, Universum: Chemistry and Biology, No. 11 (53), 2018, pp. 58–61.
4. Oserbaeva A., Ismailova N., Ayimbetov M. Isotherms of Adsorption Process in Hydrogen Sulfide Medium, International Journal of Materials and Chemistry, Nov. 2023