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Application of BIS-Carbamates of the MEE Series as Corrosion Inhibitors of Metal Equipment of Oil Refineries

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Abstract: In this work, bis-carbamates of the MEE series were studied for the effectiveness of inhibitory properties for metal structures of oil refineries. The gravimetric method was used for the study. The best inhibitory properties of bis-carbamates of the MEE series have been revealed. The effectiveness of corrosion protection exceeded control. In this connection, it is possible to propose the use of these substances as metal corrosion inhibitors.

Keywords: Bis-carbamate, carbamic acid, inhibitor, stabilizer, antioxidant, oil, aggressive components, corrosion, steel, iron.

Introduction. Carbamates (or derivatives of carbamic acid) are esters of carbamic acid that are widely used in agriculture as active ingredients in pesticides, insecticides, acaricides and biostimulants [1]. Medicine as antiviral drugs [2]. In the polymer industry as polyurethanes. In the oil industry as corrosion inhibitors, stabilizers, antioxidants for oils and fuels [3]. For example, dimethyldithiocarbamate (Carbamate MN) is used in the beneficiation of non-ferrous and rare metal ores: pyrrhotite depressant in the flotation of copper-nickel ores; reagent for cyanogen-free flotation technology of sulfide ores. Polymerization stabilizer in the production of synthetic rubbers and latexes. This proves how biologically active they are and are used in many industries. The literature presents different methods for studying the inhibitory properties of substances [4].

The authors synthesized bis-carbamates of the MEE series and studied their physicochemical properties [5,6]. The purpose of this work is to study the inhibitory properties and evaluate the effectiveness of these compounds by gravimetric method. The gravimetric method is used to determine the corrosion rate for the purpose of corrosion control and evaluation of the protective effect of corrosion inhibitors. The gravimetric method is based on measuring the difference in mass of control metal samples before and after exposure to a corrosive environment. A limitation associated with the use of this method is that it characterizes the average corrosion rate without taking into account the unevenness of corrosion. In general, when working, you should be guided by the current SAUS 9.506 "Inhibitors of metal corrosion in water-oil environments. Methods for determining protective ability."

Materials and Methods. N,N'-hexamethylene bis-[(o-cresolyl)]-carbamate i.e. MEE-1, N,N'-hexamethylene bis-[(m-cresolyl)]-carbamate i.e. MEE-2 and MEE-3 corrosion inhibition

properties of bis-carbamates were studied according to SAUS 9.502-82. The static method of the gravimetric method was used as the research method of industrial-experimental test (IET). In the experiment, 97% iron of size 40x20x2; St3 steel plate consisting of 0.14-0.22% carbon elements was obtained. Samples of industrial waste with a pH greater than 6 were used as an aqueous medium for the test.

Results and Discussions. To simulate real operating conditions of field equipment in two-phase systems, tests of inhibitors are carried out on laboratory installations with intensive mixing of the environment. In a two-chamber vessel, a flow of the test medium is created using a stirrer driven through a water seal. The chamber in which the witness samples are installed is equipped with a thermometer and a reflux condenser. The medium under study is saturated with hydrogen sulfide, which bubbles through the tube. The flow rate of the liquid washing the corrosion samples is determined using a bent tube lowered into the liquid flow. To do this, first determine the flow rate of the liquid flowing out of the siphon in a stationary environment. The liquid from the siphon is taken within a certain time (10 s) into a beaker and weighed on an analytical balance. Then the stirrer is turned on and the liquid flow from the siphon tube is measured again. The technique makes it possible to measure the flow rate of a liquid medium in almost any speed range, and liquid samples taken when measuring the flow rate can be used in corrosion studies to quantify the pH and composition of aggressive components of the medium.

Control samples are cut out in the form of plates from sheet steel 20. If necessary, the samples can be made of the same steel from which the equipment is made.

The sample sizes are chosen to be minimal for compactness, but sufficient to obtain corrosion rates that significantly exceed the sensitivity limit of this method. In laboratory practice, samples with dimensions of 40×20×2 mm or 50×20×2 mm are most often used. The protective effect of corrosion inhibitors (Z, %) is determined by the weight loss of control samples in the absence and presence of corrosion inhibitors and is calculated using the formula:

$$Z = 100 \cdot \frac{K - K_i}{K}$$

where K is the corrosion rate of samples in the absence of an inhibitor, g/m^2•h; K_i - corrosion rate of samples in the presence of an inhibitor, g/m^2•h.

The degree of protection of the inhibitors was carried out in aqueous medium at room temperature. The static method of the gravimetric method was used as the research method of industrial-experimental test (STS). In the experiment, 97% iron of size 40x20x2; St3 steel plate consisting of 0.14-0.22% carbon elements was obtained. Samples of industrial waste with a pH greater than 6 were used as an aqueous medium for the test, the results of which are shown in Table 1.

Table 1. Corrosion test results conducted in accordance with SAUS 9.502-82 standard

Corrosion inhibitors	Inhibitor concentration, mg/l	Protection level (Z%)
MEE-1	50	90,4
	100	91,1
	150	93,0
	200	95,5
MEE-2	50	91,4
	100	92,6
	150	93,6
	200	94,7
MEE-3	50	92,2

	100 150 200	93,6 95,6 97,7

All tested substances have metal corrosion inhibiting properties. Among the tested inhibitors, MEE-3 was found to be the most active inhibitor with 97.7% activity against metal corrosion at a concentration of 200 mg/l. The new MEE series inhibitors have been found to be technologically and environmentally effective for metal structures and water circulation systems.

Conclusion. According to the results, MEE-1 showed the highest protection level of 95.5% at 200 mg/l. The MEE-2 material showed a high result of 94.7%. MEE-3 showed the highest protection result with 97.7%. If you notice, even at 50 mg/l, all substances showed results above 90%. So the level of protection of MEE-3 substance is higher than MEE-1 and MEE-2 substances. These indicators mean that all MEE series substances can be used as corrosion inhibitors for metal construction equipment. But taking into account that these studies were determined as a result of laboratory analysis, it is recommended to support them on an industrial scale.

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