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ИССЛЕДОВАНИЕ ЭФФЕКТИВНОСТИ ИНГИБИТОРА ТАРДИОЛА

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Аннотация. *В данной статье была исследована эффективность антикоррозионых добавок. Коррозия определяется как разрушительное и непреднамеренное разрушение материала (в частности, металлов и сплавов), вызванное воздействием окружающей среды. К сожалению, для металлов почти все среды могут в той или иной степени вызывать коррозию, поскольку корродированное состояние является более стабильным. Коррозионная стойкость - это свойство металла или, в целом, материала противостоять воздействию коррозии в определенной среде при определенных условиях эксплуатации, давлении, температуре и скорости текучей среды. Обычно устойчивость к коррозии выражается в показателях скорости коррозии. Устойчивость металла к коррозии может быть повышена с помощью методов предотвращения коррозии. Для защиты от коррозии используют специальные средства, которые ее замедляют — ингибиторы. Они изменяют состояние поверхности металла — образуют труднорастворимые соединения с катионами металла.*

Целью упражнения было определить влияние ингибитора на скорость водородного охрупчивания с помощью теста на прочность, а именно испытания на изгиб и определить эффективность используемого ингибитора.

Эффективность действия ингибиторов коррозии можно оценить по двум показателям: степени защиты (Z, %) и коэффициенту торможения коррозии γ (защитный эффект ингибитора). Эффективность тардиола 89,8%, под действием ингибитора скорость коррозии уменьшается в 9,85 раза сравнивая с водным раствором серной кислоты (VI). Опираясь на табличные данные можно дать оценку «отлично» ингибирующему средству.

Ключевые слова: *коррозия, металлы, защита от коррозии, ингибитор, сталь, тардиол, водный раствор серной кислоты(VI), противокоррозионные свойства.*

ТАРДИОЛ ИНГИБИТОРУНУН ЭФФЕКТИВДҮҮЛҮГҮН ИЗИЛДӨӨ

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Аннотация. *Бул макалада коррозияга каршы аралашмалардын эффективдүүлүгү изилденген. Коррозия айлана-чөйрөнүн таасиринен улам материалдын (айрыкча*

металлдардын жана эритмелердин) кыйратуучу жана байкабай бузулушу катары аныкталат. Тилекке каршы, металлдар үчүн дээрлик бардык чөйрөлөр кандайдыр бир деңгээлде дат басышы мүмкүн, анткени дат баскан абал туруктуу. Коррозияга туруштук берүү-бул металлдын же жалпысынан материалдын белгилүү бир иштөө шарттарында, басымында, температурасында жана суюктуктун ылдамдыгында белгилүү бир чөйрөдө коррозияга туруштук берүү касиети. Адатта, коррозияга туруштук берүү дат басуу ылдамдыгында көрсөтүлөт. Металлдын коррозияга туруктуулугун коррозияны болтурбоо ыкмалары менен жогорулатууга болот.Коррозиядан коргоо үчүн аны жайлатуучу атайын каражаттар — ингибиторлор колдонулат. Алар металлдын бетинин абалын өзгөртүшөт-металл катиондору менен оңой эрибей турган бирикмелерди түзүшөт.

Көнүгүүнүн максаты ингибитордун суутектин морттук ылдамдыгына тийгизген таасирин күч сыноосу менен аныктоо, тактап айтканда, ийилүү сыноосу жана колдонулган ингибитордун эффективдүүлүгүн аныктоо болгон.

Коррозия ингибиторлорунун иш-аракетинин натыйжалуулугун эки көрсөткүч боюнча баалоого болот: коргоо даражасы (Ика, %) жана коррозияны ингибирлөө коэффициенти (ингибитордун коргоочу таасири). Тардиолдун эффективдүүлүгү 89,8%, ингибитордун таасири астында коррозия ылдамдыгы күкүрт кычкылынын (ОЖ) суудагы эритмеси менен салыштырганда 9,85 эсе төмөндөйт. Таблицалык маалыматтарга таянып, "эң сонун" ингибитор агентти баалоого болот.

Өзөктүү сөздөр: *коррозия, металлдар, коррозияга каршы, ингибитор, болот, тардиол, күкүрт кислотасынын суу эритмеси (VI), коррозияга каршы касиеттери.*

INVESTIGATION OF EFFECTIVENESS OF THE INHIBITOR TARDIOL

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Abstract. *In this article was investigated the effectiveness of anti-corrosion additives. Corrosion is defined as the destructive and unintentional destruction of material (particularly metals and alloys) caused by the environment. Unfortunately, for metals, almost all media can cause some degree of corrosion because the corroded state is more stable. Corrosion resistance is the property of the metal or, in general, of the material to withstand the effects of corrosion in a certain medium under certain operating conditions, pressure, temperature and fluid rate. Corrosion resistance is usually expressed in corrosion rates. Metal corrosion resistance can be improved by corrosion prevention methods. To protect against corrosion use special means that slow it - inhibitors. They change the state of the metal surface - they form difficult soluble compounds with metal cations.*

The aim of the exercise was to determine the effect of an inhibitor on the rate of hydrogen embrittlement using a strength test (bending) and to determine the effectiveness of the inhibitor used. The effectiveness of corrosion inhibitors can be assessed by two indicators: the degree of protection (Z%) and the coefficient of corrosion inhibition γ (inhibitor protective effect).

The tardiol efficiency of 89.8%, under the action of an inhibitor, the corrosion rate decreases by 9.85 times compared with an aqueous solution of sulfuric acid (VI). Based on the tabular data it is possible to estimate «excellent» inhibiting agent.

Keywords*: corrosion, metals, corrosion protection, inhibitor, steel, tardiol, aqueous solution of sulfuric acid(VI), anticorrosion properties.*

Introduction. The problem of corrosion is much more serious than it is often given importance. Its relevance is especially manifested in enterprises that use metal structures, equipment, machinery, tools and vehicles with significant wear and tear of their service life. Corrosion processes have a different nature of their occurrence, but they all have one thing in common - they appear as a result of contact and interaction of metals with the environment (physico-chemical and chemical). It mainly flows in liquid and gaseous media.

The problem of corrosion control has recently become increasingly important. This is due to the following reasons: an increase in economic losses from corrosion, which in developed countries are commensurate with capital investments in certain sectors of the economy, and a decrease in the durability and reliability of building structures, products, machinery and equipment.

The relevance of the topic and the formulation of tasks. Protection of the material part of industrial enterprises from rust and other corrosive processes is an urgent issue today in terms of ensuring industrial safety. The fight against corrosion of building materials is a struggle for their reliability and durability. Despite the fact that it is not possible to influence the thermodynamic stability of metal and concrete, nevertheless, by revealing the basic laws of the corrosion process, it is possible to have a significant impact on the corrosion rate and slow it down.

Steel is a metal that is an alloy of iron and carbon with the addition of other components. The share of the latter is up to 2.14%, with the exception of special types of alloys with a high carbon concentration (up to 3.14%). Thanks to him, the metal becomes durable, malleable, durable - its quality improves, which expands the scope of destination. However, the level of its plasticity and viscosity decreases. In construction, steel is used for the manufacture of structures, reinforcement of reinforced concrete structures, roofing, scaffolding, fences, forms of reinforced concrete products, etc.

Experimental procedure

Material: 30 steel samples

Environment: 0,5M H_2SO_4

Inhibitor: Tardiol

The aim of the exercise was to determine the effect of an inhibitor on the rate of hydrogen embrittlement using a strength test (bending) and to determine the effectiveness of the inhibitor used. For testing, we prepared steel wires of uniform dimensions, cleaned them thoroughly, rinsed them with water, and degreased them. After drying, determined the bending strength of at least three specimens, noted the number of bends needed to completely break the specimen. We placed 12 specimens (cleaned and degreased) in an aqueous solution of sulphuric acid(VI), the same amount immersed in a solution of sulphuric acid (VI) with inhibitor (tardiol). After 15, 30, 45 and 60 minutes ,we removed an appropriate number of

samples from each solution. Test their bending strength by determining the number of bends required to completely break the samples after exposure to sulfuric acid (Z_H) and the samples after exposure in sulphuric acid with inhibitor (Z_I). We have recorded the results into Table 6.1. Wire samples from Part A), were intended to be exposed for 60 minutes before being placed in the corrosive solutions, are additionally weighed on an analytical balance and their surface area determined. After the 60-minute exposure in the sulphuric acid solution and in the sulphuric acid solution with inhibotor,we removed the samples, cleaned with a brush, dried and weighed. We have recorded the results in Table 2. The bidirectional wire bending test involves repeatedly bending the specimen clamped in the jaws of the gauge and moving through the hole in the guide. From the vertical starting position, the specimen is bent by a lever 90° to the right to the bumper and back to the starting position, counting this bend as the first bend. Second and subsequent bends alternately left and right, each to the bumper and back to the starting position, are performed until the specimen breaks. The test shall be carried out until the number of hinges specified in the standards concerned has been reached or a crack is visible without the use of magnifying devices. Hogging, during which the specimen breaks, should not be counted in the number of hoggings. The hinge should be carried out at a constant speed not exceeding one hinge per second. If necessary, the hogging speed should be reduced so that the heating of the specimen does not affect the result of the test. The test shall be carried out at an ambient temperature between 10°C and 30°C. Tests under controlled conditions should be carried out at a temperature of 23 ± 5°C.

Object and methodology

Inhibition is a method in which the rate of corrosion decreases if compounds are introduced into an aggressive environment that significantly slow down the corrosion process. One of the inhibition mechanisms is the adsorption of the inhibitor on the surface of the protected product. Inhibited papers and films are used for long-term storage.

Results

Table 1. *Results of bending strength by determining the number of bends required to completely break the samples after exposure to sulfuric acid (Z_H) and the samples after exposure in sulphuric acid with inhibitor (Z_I) .*

Time of exposure of the corrosive environment to the material	Solution of H_2SO_4		SK	Solution of H_2SO_4+Inhibitor		SK
	Number of bends			Number of bends		
	Results of individual measurements	Average		Results of individual measurements	Average	

0 (wire left in the air)	11	13	11	Z_0=11,7	---	---	---	---	---	----
15	7	6	6	Z_H=6,3	46,1	9	10	7	Z_1=8,66	26
30	6	4	6	5,3	54,7	10	11	10	10,3	12
45	5	4	4	4,3	63,25	11	8	9	9,33	20
60	5	4	3	4	65,81	12	11	12	11,67	25

Table 2. *Results of mass of samples before and after exposure, exposure time, sample surface area, average corrosion rate, effectiveness of the inhibitor.*

Environment	Mass of samples [mg]		Mass loss Δm [mg]	Sample surface area, S [cm^2]	Exposure time t [h]	Average corrosion rate, V [mg/cm^2h]	Effectiveness of the inhibitor
	Before exposure	After exposure					
H_2SO_4	7150	7133	17	12,217	1	V_0=1,28	Z=89,8 γ =9,85
H_2SO_4	6993	6980	13	12,217	1		
H_2SO_4	6918	6901	17	12,217	1		
H_2SO_4+ inhibitor	7114	7112	2	12,217	1	V_I=0,13	
H_2SO_4+ inhibitor	7077	7076	1	12,217	1		
H_2SO_4+ inhibitor	7060	7058	2	12,217	1		

Discussion of the results

We carried out calculations and determined the quantitative index of hydrogen embrittlement, mass loss and the effectiveness of the inhibitor. I calculated the degree of hydrogen embrittlement (SK) for each exposure time in the corrosion solution that contains and does not contain the inhibitor, corrosion rate (V), corrosion inhibition capacity of the inhibitor (Z) and protection factor.

The number of bends of the samples with the inhibitor was 1.5-2 times greater, which indicates the effectiveness of the inhibitor. Then, after the elapsed time, we measured the mass and, using the data, calculated the mass loss and determined the average corrosion rate.

The effectiveness of corrosion inhibitors can be assessed by two indicators: the degree of protection (Z, %) and the corrosion inhibition coefficient γ (protective effect of the inhibitor).

The formula for determining the degree of protection

$$Z = [(V_0 - V_I)/V_I] \cdot 100\% \quad (1)$$

where V_0, V_I is the rate of corrosion (dissolution) of metal in an environment without an inhibitor and with it [g/(m2•h)];

The Z value is 100% when the metal is completely protected, the corrosion rate is reduced to 0.

The protective effect of the inhibitor is calculated by the formula:

$$\gamma = V_0 / V_I \quad (2)$$

The braking capacity coefficient shows how many times the corrosion rate decreases under the action of the inhibitor. There is a relationship between the braking coefficient and the degree of protection, determined by the formula:

$$Z = (1 - 1 / \gamma) \cdot 100. \quad (3)$$

The effectiveness of tardiol 89.8% under the action of an inhibitor, the corrosion rate decreases by 9.85 times compared with an aqueous solution of sulfuric acid (VI).

Table 3. System of criteria for evaluating the effectiveness of corrosion inhibitors

The degree of protection Z, % (laboratory condition)	Industrial grade of the inhibitor
$Z \geq 90$	Excellent
$75 \leq Z < 90$	Good
$50 \leq Z < 74$	Medium
$Z < 50$	Weakly

Conclusion. This new Polish-made product has really proved and justified its anticorrosive properties. The tardiol efficiency of 89.8%, under the action of an inhibitor, the corrosion rate decreases by 9.85 times compared with an aqueous solution of sulfuric acid (VI). Based on the table 3, it is possible to give an "excellent" rating to the inhibitory agent. Also from calculations we can notice that mass loss of steel with additions of solution of H_2SO_4 + Inhibitor is less than only with solution. So, we can say that this inhibitor have a

good anti-corrosion properties for using in building industry. The use of inhibitors reduces repair costs and improves the durability of the building.

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