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АНАЛИЗ КАЧЕСТВЕННЫХ ПОКАЗАТЕЛЕЙ КОРРОЗИОННОЙ СТОЙКОСТИ ПИЩЕВОГО ТЕХНОЛОГИЧЕСКОГО ОБОРУДОВАНИЯ

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Аннотация: *В статье рассматривается воздействие ингибиторов на повышение коррозионной стойкости оборудования пищевой отрасли в технологических средах. Сделан литературный обзор Оценивалась противокоррозионная эффективность ингибиторов на основе растительного сырья – РС на основе рапса и ГС на основе горчицы. Испытания проводились гравиметрическим методом, использованы образцы стали Ст 3 в виде пластинок.*
Ингибиторы вводятся в коррозионно- активную среду в небольших количествах, снижают скорость коррозии и уменьшают ее опасные последствия. Применение ингибиторов, по сравнению с другими методами защиты от коррозии, имеет ряд преимуществ, так как не требует перестройки существующей технологической схемы производства и больших капитальных вложений, а также позволяет использовать дешевые конструкционные металлы вместо специальных.

Проведено изучение противокоррозионной активности ингибиторов ГС, РС и их концентрата на эффект воздействия в определенных средах пищевых производств с различной агрессивностью.

Ключевые слова: *коррозионная стойкость, технологическое оборудование пищевых производств, ингибитор, сталь, эффект воздействия, антикоррозионная защита.*

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ANALYSIS OF THE QUALITATIVE INDICATORS OF THE CORROSION RESISTANCE OF FOOD TECHNOLOGICAL EQUIPMENT

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Abstract: *The article examines the effect of inhibitors on increasing the corrosion resistance of food industry equipment in technological environments. A literary review was made. The anticorrosive effectiveness of inhibitors based on plant raw materials - PC based on rape and GS based on mustard was evaluated. The tests were carried out by the gravimetric method, using samples of steel St 3 in the form of plates. Inhibitors are introduced into the corrosive medium in small quantities, reduce the rate of corrosion and reduce its dangerous consequences. The use of inhibitors, in comparison with other methods of corrosion protection, has a number of advantages, since it does not require the restructuring of the existing technological scheme of production and large capital investments, and also allows the use of cheap structural metals instead of special ones. The study of the anticorrosive activity of GS, RS inhibitors and their concentrate on the effect of exposure in certain environments of food production with different aggressiveness was carried out.*

Key words: *corrosion resistance, technological equipment for food production, inhibitor, steel, impact effect, anti-corrosion protection.*

Introduction

Currently, the problem of corrosion of metal structures and equipment in contact with neutral water environments is very relevant for kazakhstan, as well as for the CIS countries as a whole. At the same time, the rate of internal corrosion of pipelines is from 0.2-0.8 mm / year, without the use of protective measures, their service life is less than 10-12 years. for typical structural steels without protection, the corrosion rate is 0.2-0.5 mm / year. The cost model of metal structures and mechanisms or their parts, the cost of corrosion resistant metals and alloys used in place of materials having the same mechanical properties, but not resistant to corrosion, the cost of various types of corrosion protection, as well as the costs associated with downtime during the replacement of the machine or apparatus destroyed by corrosion contamination corrosion entail economic losses [1].

There are several ways to solve this problem. Inhibitors are introduced into the corrosive medium in small quantities, reduce the rate of corrosion and reduce its dangerous consequences. The use of inhibitors, in comparison with other methods of corrosion protection, has a number of advantages, since it does not require the restructuring of the existing technological scheme of production and large capital investments, and also allows the use of cheap structural metals instead of special ones. Corrosion inhibitors are widely used:

- For acid washing of equipment from various kinds of mineral deposits, scale, which can significantly increase heat transfer;
- In the industry during cleaning of the equipment of sugar factories, containers intended for storage and transportation of dairy and other food products;

- In cooling systems of equipment and vehicles, for protection against atmospheric corrosion of mechanical engineering products, during hydraulic tests [1].

Food processing equipment is used under the influence of a corrosive environment with constantly changing physical and chemical properties, abrasive particles and a variety of technological factors, such as temperature, pressure, speed of movement of the medium, mechanical and hydrodynamic loads.

In connection with the above, structural materials are subject to corrosion and abrasive wear, which contributes to a sharp reduction in the life of the equipment, causes huge irretrievable losses of steel and high costs, they are associated with labor-intensive repair work. Indirect losses associated with the violation of technology and the loss of processed products in production significantly exceed the costs due to the loss of destroyed metal, the need for regular repairs, the cost of certain types of food equipment [2].

An important reserve for strengthening the corrosion resistance of steel used for the production of technological food equipment is the search, research, development, and implementation of anti-corrosion inhibition. Since the devices, machines, mechanisms and communications of food production after cleaning, disinfection are affected by corrosive technological environments, while the maintenance of inhibitory additives in food products is excluded due to special requirements regulated by state standards for the manufacture of products and sanitary norms, the influence of corrosion inhibitors is of great importance by maintaining a protective effect for a long time after the surface of the steel is treated.

The analysis of corrosion inhibitors proposed for use in the food industry, such as CHM, CS, HOSP - 10 "Unicol", KPI-3 to reduce the aggressiveness of disinfectants and detergents in the process of processing equipment, was carried out, which showed that most of them do not fully meet the requirements of sanitary hygiene and environmental safety in terms of toxicological indicators. The development of corrosion inhibitors based on raw materials of biological origin is an urgent problem.

The aim of the work is to study the effect of inhibitors based on vegetable raw materials on increasing the corrosion resistance of food industry equipment in technological aggressive environments.

Materials and methods of research

The object of research - is corrosion resistance of food equipment.

Research methods theoretical, method of comparison and analysis of qualitative and quantitative indicators.

International 10271: 1993 (E) requires that the metal standards ISO/TR10271:1993 (E) require that metal products used in internal and external contact with the human body must be tested for the level of release of metal ions into the simulated environment.

Table 1 - Components of corrosion-resistant wear-resistant steel

№	Components	Wt.%
1	Carbon	0,03-0,1
2	Silicon	0,01-0,08
3	Manganese	14-19
4	Chrome	14-17
5	Nickel	0,2-1,0
6	Copper	0,8-1,2
7	Molybdenum	0,5-1,5
8	Nitrogen	0,17-0,26
9	Iron and impurities	The rest

Low-carbon steel of the St 3 grade is used, which is one of the most widely used structural materials for the manufacture of various types of food processing equipment. The most common steel grade is widely used in the production of sugar and confectionery products: blades and bodies of diffusion apparatuses, grids and frames of disk filters, pipes for the supply of diffusion syrup and juice; in this production of alcohol and alcoholic beverages in the form of tanks for storing alcohol, fermentation vats, sorting and pressure vats, pipelines for the supply of alcohol, molasses mixers, etc. At the same time, St 3 steel is a material with low corrosion resistance in a number of food production environments, so corrosion protection is often required.

The study used solutions of organic acids, such as citric, tartaric, acetic, and hydrochloric acid as a disinfectant, ethyl alcohol, grape wine, sugar syrup. Evaluated the effectiveness of the corrosion inhibitors based on vegetable raw materials-RS on the basis of rapeseed and GS based on mustard. These inhibitors are environmentally friendly, raw materials is sufficient is available, there are O-, N- and compounds in the raw materials, able to form complexes with oxides and atoms of gelatin, for creating conditions for the formation of the passive state of the steel surface.

Tests were carried out by the gravimetric method, samples of St 3 steel in the form of plates with a size of 51.3 x 25.3 x 3.2 mm were used.

The corrosion rate was estimated by the following formula:

$$Ct = (m1-m2)/St,$$

Where: Kt - corrosion rate, g/(m^{2}H); m1 – weight of specimen before test, g; m2 – mass of sample after test, g; S – area of the sample surface, m^2; t – duration of a study hour.

The temperature of the solutions was 293^0-333^{0}K. The temperature of the solutions was maintained using a TSU thermostat, the error was ±0.5^{0}S.

Results

Steel plates of the St 3 brand were treated with a disinfecting solution of 1 n hydrochloric acid with the addition of inhibitors in the optimal concentration: gs -0.3 g/l. RS - 0.2 g / l, in terms of the active substance in a certain period of time. the disinfected plate was immersed in a corrosive working medium without an inhibitor, then withstood. the plate was washed with water, weighed, and then the degree of corrosion protection was calculated. the anticorrosive effect is manifested on the basis of the presence of a film on the surface of the steel, which was formed during the adsorption of the inhibitor. The results of studies of efficiency of inhibitors of GS and MS at 293°K in 1 n solutions of acid exposure for 2 hours are presented in table 2 and figure 1.

The highest possible degree of protection was evident after exposure of samples of steel St 3 in inhibited solution of sanitizer during hours, as the increased exposure is not a large effect on impact.

Table 2 - Effect of HS and RS inhibitors on St 3 steel samples in 1 n acid solution (with a holding period of 1 hour in an inhibited disinfectant solution)

Acid	Kt, g/(m^2h)			Zm, %	
	Without inhibitor	GS	RS	GS	RS
Salt	4,121	2,039	2,241	50,5	45,6
Wine	1,823	0,794	0,887	56,4	51,3
Lemon	1,795	0,766	0,863	57,3	51,9
Acetic	0,744	0,257	0,295	65,3	60,2

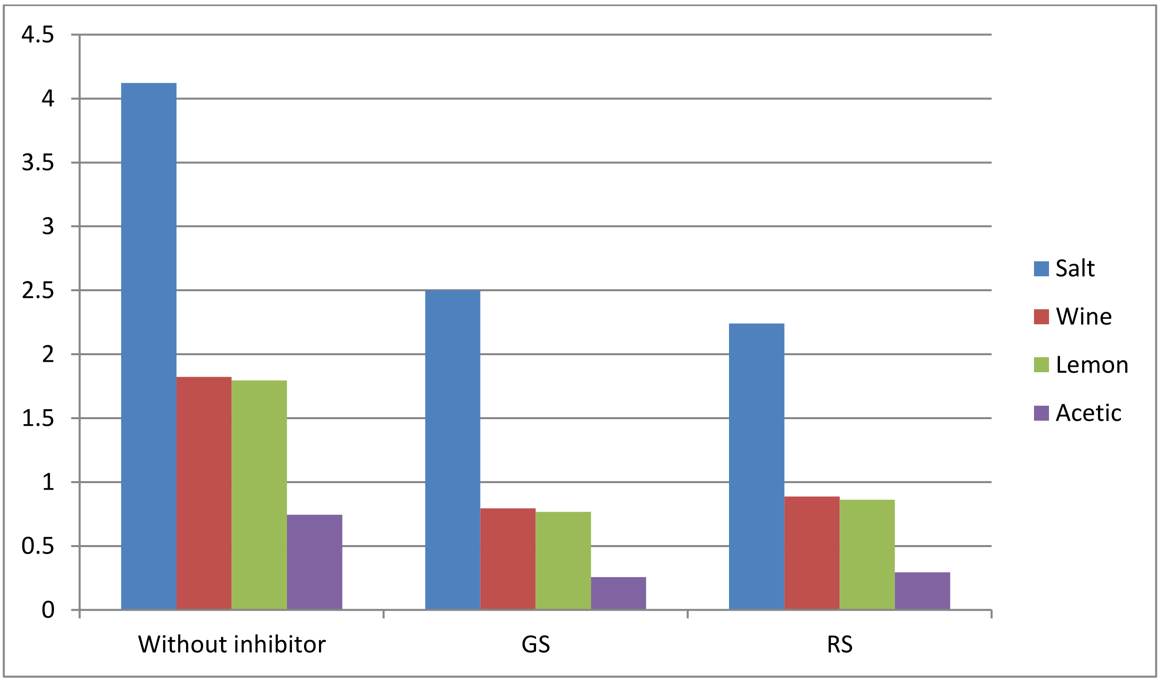

Figure 1 - Effect of HS and RS inhibitors on St 3 steel samples in 1 n acid solution

The GS inhibitor reduced the corrosion rate of steel by 2.02-2.88 times, depending on the acid used, and the RS inhibitor reduced it by 1.84 - 2.51 times. The highest level of protection of steel St 3 is observed in acetic acid, the lowest in hydrochloric acid.

Treatment of equipment with acid disinfectants at food industry facilities is carried out at different periods and with different intensity, it depends on the type of production processes, consistency, composition of the raw materials used for the production of finished products and the characteristics of the structural material from which the equipment was made. The disinfection treatment time is from 10 to 20 minutes. Analysis of the research results showed that in order to ensure the protection of food equipment in production conditions, based on technological requirements and regulations, it is necessary to increase the effectiveness of the protective effect after treating the steel surface with a disinfectant solution with HS and RS inhibitors.

A literature review showed that the use of inhibitory additives alone was less effective than the use of synergistic inhibitory compositions. mg inhibitor is a modified vegetable oil, it has biocidal and bactericidal properties, provides high efficiency of anticorrosive protection of structural steels in neutral and acidic environments (z % 3d 93.0-99.8%), is used to improve the protective physical and mechanical properties of coatings [3-5].

When using a combined inhibitor in a ratio of 4 to 1, there is a higher efficiency of corrosion protection compared to GS and MG inhibitors. The results showed that there was a synergistic effect with the combined inhibitors of HS and MG,

The results of the study of the effect of the concentration of gs and mg inhibitors on st 3 steel in 1 n acid solutions are presented in table 3 and figure 2 (the holding time in the inhibited disinfectant solution was 20 minutes). when using the inhibitor concentrate, the corrosion rate of steel decreased by 3.12-5.09 times depending on the type of acid, and when using the mg inhibitor-by 1.39-1.71 times.

Table 3 – Effect of concentrate and mg inhibitors on St 3 steel samples in 1 n acid solutions (the exposure period was 2 hours, at a temperature of 293^0k)

Acid	Kt, g/(m^2h)			Zm, %	
	Without inhibitor	Concentrate	MG	Concentrate	MG
Salt	4,021	1,329	2,966	68,0	28,0
Wine	1,823	0,435	1,182	76,1	35,1
Lemon	1,795	0,433	1,137	75,8	36,6

Acetic	0,744	0,145	0,435	80,4	41,4

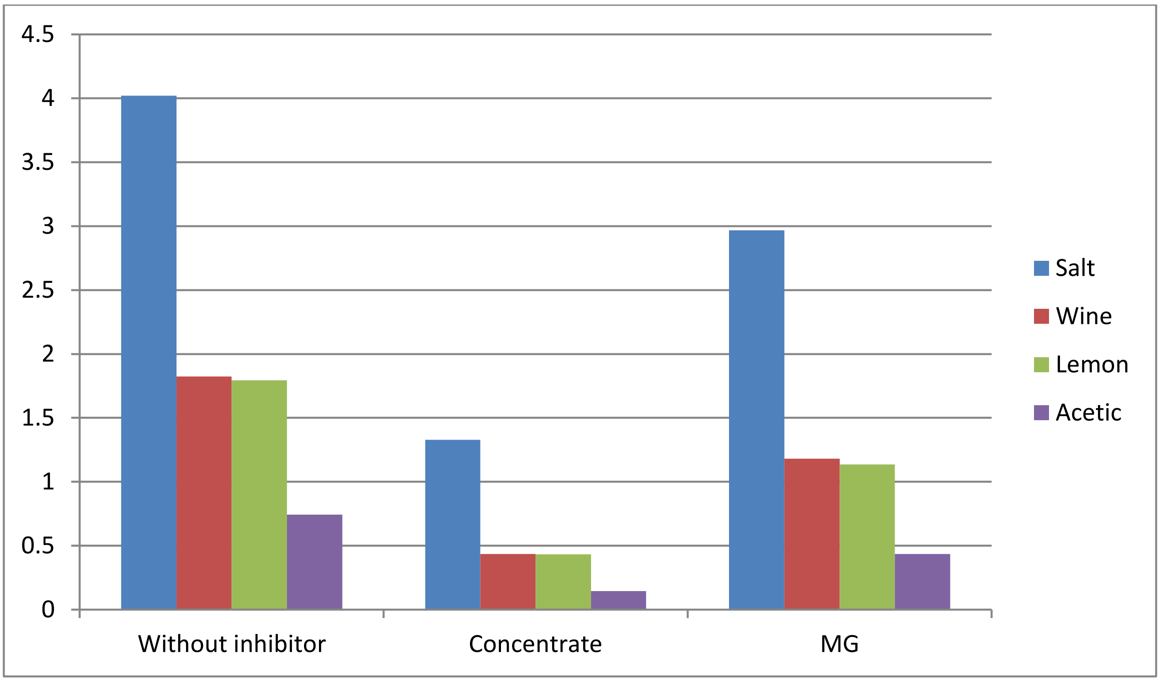

Figure 2 - Effect of concentrate and MG inhibitors on St 3 steel samples in 1 n acid solutions

Conclusion

Thus, the anticorrosive activity of HS, MS inhibitors and their concentrate on the effect of exposure in certain environments of food production with different aggressiveness was studied. In accordance with the technological regulations, after holding the samples in an inhibited hydrochloric acid solution for 20 minutes, the degree of anticorrosive protection of the concentrate inhibitor in food media is at a sufficiently high level, which allows us to recommend the concentrate for protecting the mechanisms of food industry enterprises from corrosion by introducing it into a disinfectant solution.

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