CHEMICAL SCIENCES

PREPARATION OF COOLIGOMER-BASED CORROSION COATING COMPOSITION

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Abstract

The corrosion process is an environmentally and economically undesirable process, and worldwide scientific research into the complete solution of such an unwanted process is among the foremost research with relevance. Every type of corrosion process is multi-step. These steps are influenced by internal and external factors. For example, the nature, structure, surface condition, temperature, environment, ambient speed and pH of the metal from which corrosive equipment and devices are made, etc. Underground (in soil) and atmospheric corrosion, which are common types of corrosion, are urgent problems in the protection of pipelines exploited in the oil and extraction industry.

A variety of insulating coatings are used in electrochemical methods to protect the ground-based, metallic pipelines from corrosion. Spill and ingestion of pipelines operated in oil and gas extraction is caused by corrosion from both internal and external surface by the action of various aggressive compounds. As a result, it causes loss of transported products, consuming a lot of materials for repair, and other unwanted situations. If pipelines are submerged, they are corroded with different properties depending on soil moisture, the amount and type of mineral salts they contain. If the soil moisture content is 25-30%, then maximum corrosion is observed in equipment and appliances made of metal. Aggressive ions in the soil are Cl^- və SO_4^{2-}. At the same time, there are also CO_2 and O_2 gases dissolved in the soil. It is a photosynthesis process that causes a high amount of CO_2 gas in the soil.

The corrosion of pipelines used in the outdoor oil and gas extraction industry is severely affected by the air temperature, which means that the greater the atmospheric temperature, the more humidity builds up quickly on the surface of the metal and its connection to the metal is quickly cut off. When the air humidity in the atmosphere exceeds 60%, the rate of corrosion intensifies and goes deeper than that of the aggressive gases contained in the air. The rate of atmospheric corrosion can be reduced by reducing the humidity of the air in contact with the metal (by drying), providing insulation and passivation of the surface. In industrial and maritime regions, the rate of corrosion of metals depends on the SO_2 gas contained in the air. So if there is SO_2 gas in the atmosphere, then the corrosion rate of pipelines made of metal increases.

Many methods for corrosion protection are combined with non-metallic coatings (paint, varnish, processing, etc.), metal (zinc, tin, lead, nickel, chromium, etc.) coatings, electrochemicals (anode and cathode), i.e., the cathode of the protecting metal constant current source, and the anode of the source to any iron part. At this time, the constant current source receives electrons from the anode and delivers them to the cathode and is reduced in the oxidizing cathode [1-3].

Keywords: polycondensation, cooligomer, corrosion, coating, composition

Introduction

The use of cooligomers modified by amino group organic compounds as coordinators to obtain a variety of purpose composition has been widely accepted. The process of obtaining cooligomers by copolicondensation has been studied in detail.

The mechanism of the copolicondensation process is phased and relatively complex compared to polycondensation. Therefore, emphasis should be placed on optimization and mathematical modeling in the process of copolicondensation. Undesired reactions during the process will and should be avoided.

In general, in the protection of corrosion equipment and devices operating at high temperatures, in aggressive environments, under conditions of mechanical tension, attention should be paid to the persistence of cooligomeric protective coatings modified by amino group organic compound.

When developing new protective coatings, it is important to consider environmental and regulatory compliance. The components used should be economical while making sure that they are not toxic or harmful to human health and the environment.

When using a corrosion coating, the following should be considered first. The main steps of surface preparation are wiping down the top of the surface and removing grease. Special chemical solutions are used in cleaning. Dislocations and other defects are eliminated. Environmental conditions must be provided with temperature, humidity, and ventilation to ensure that no unwanted situations occur. Preparation, cartridging, blending, grinding, or heating to specified temperatures may be covered in accordance with the production guidelines and technological recommendations.

It plays a key role in ensuring the strength, adhesion, and durability of the required surface coating, which ultimately affects the quality and aesthetic appearance of the modified macromolecule [4-5].

The properties of the coating composition may vary according to its type, composition, and purpose. While assessing the quality and effectiveness of the coating, there are some key features that are usually considered.

It is important that the corrosion coating composition has an attractive appearance, a smooth coating without defects such as bulges, cracks, or stripes. To protect environmental safety, care should be taken not to contain toxic substances in the coating, nor to harm the environment or human health during use and processing [4-6].

The use of functionalized cooligomer-based corrosion-resistant coating compositions in the preparation of substrates, in the corrosion protection of equipment and devices operated in various environments, has also given positive results.

Experimental part

In the study, a coating composition with a new composition was developed, which was used as a link between amino group organic compound and functionalized cooligomers. The primary purpose of functionalization is to develop an environmentally friendly cooligiomer-based and corrosion-resistant coating, reducing the amount of free monomers in the existing oligomer. As a result of the functionalization process, the fragility of the cooligomer has been eliminated, and its heat ability and adhesiveness have been improved [8-10].

Copolicondensation was carried out in a laboratory reactor (figure 1). At the beginning, 82g of phenol, then 108 ml of 37% formalin, are placed in three throat bushels. Then, a 25% alkali alcohol solution (catalyst) is gradually added, and an alkaline environment is created (pH>7). Since the modifier contains the amino group (functional group), the modifier is given gradually so that the build reaction does not occur ahead of time. Copolicondensation reaction occurs at 80-90^{0}C. Once a modifier is added, the process accelerates at the expense of functional groups. Water droplets are observed in the collarbone during the sopolicondification process. The process lasts for 50 minutes at a temperature of 91.5^{0}C and the mixture is transferred from sausage to porcelain casserole, washed to a neutral reaction, and vacuum dried in a dryer until it reaches a constant weight. At the end of the process, 2 layers are formed - a brown-red cooligomer on the bottom and water on the top.

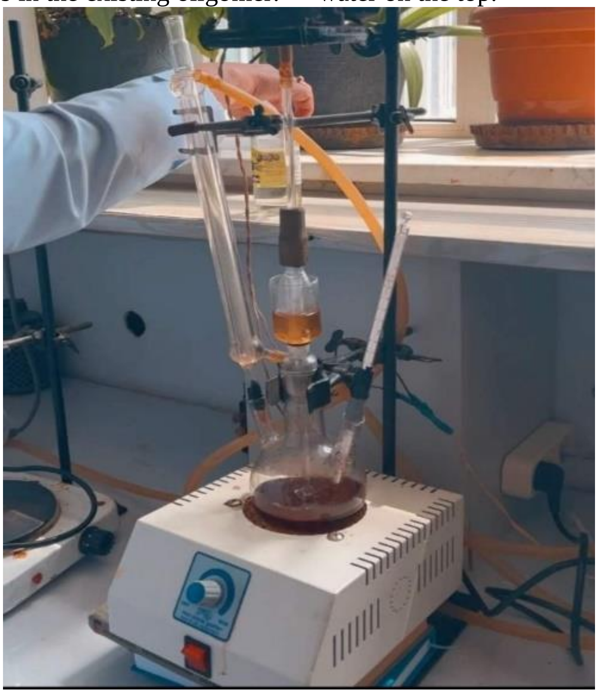

Fig. 1 Synthesis of cooligomer

Cooligomer is a compound of light color, powdered, well soluble in acetone, dioxane, tetrahydrofuranda, dimethylformamide, molecule mass - 900-1110, softening temperature - 85-90^{0}C, density-1220-1230 kg/m^3, and adhesion strength - 2.4-2.8 MPa.

The cooligomer used as a link is first grated, cartilaged, and then dissolved in a solvent (acetone).

A bauxite slug was used as a filler when preparing the coating composition. Bauxite slag is a waste of aluminum manufacturing process. Contains oxides of aluminum, silicon, iron, and other elements.

The composition of the coating composition based on the functionalized environmentally friendly cooligomer contains cooligomer-70-80%, bauxite slurry- 5-10%, and solvent - 15-20%. When preparing the coating composition, first a solution of cooligomer in 50% acetone is prepared, then a powdered bauxite slurry is added in the calculated amount gradually and stirred for a period of 30 minutes.

Fig. 2 Metal and wood finish composition

The coating composition is applied in two layers on a clean metal surface, then heated gradually at the thermostat (100^0C for 1 hour, 120^0C for 1 hour, 130^0C for 1 hour, and 140^0C for 4 hours). The physical and mechanical performance of the obtained coating composition was investigated.

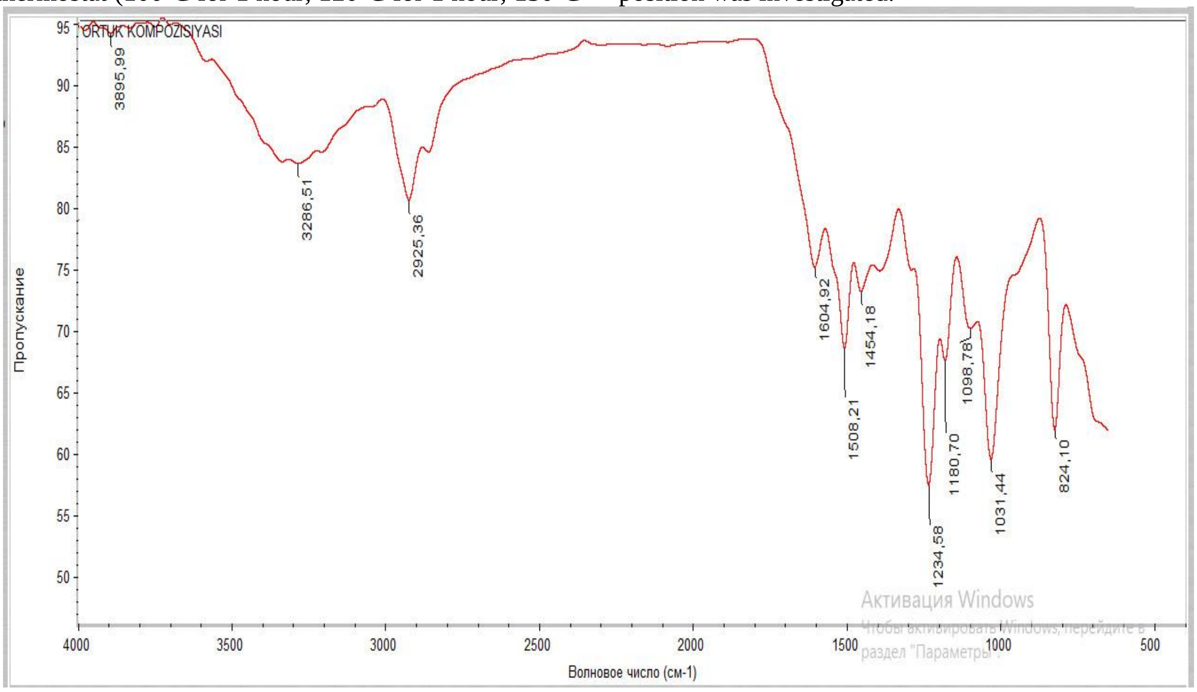

Fig. 3 IR-Spectrum of coating composition

As can be seen from Figure 3, the absorption strips appearing at certain wavelengths were observed in the IR spectrum of the coating composition. Short-term vibrations of 3286.51 sm^{-1} wavelengths and more intense absorption strips from 1604.92 sm^{-1} have been identified. The IR spectrum of the coating prepared in this way is indicative of the better chemical composition and properties of the modified cooligomer [11-12].

The results of the research work found that the basic physico-chemical and physico-mechanical indicators of phenolic-formaldehyde cooligomer modulated by amino group organic compound (with melamine) improved. At the same time, the amount of free monomers (phenol and formaldehyde) has decreased, its fragility has been eliminated, and adhesive capacity has increased.

Conclusion

The insufficient amount of oxides in the environmentally friendly (partial) cooligomeric bauxite slug resulting from functionalization and the formation of an adsorption connection with the cooligomer have a positive effect on its corrosion protection, as well as (because of waste) the lower coating cost.

References:

1. Яровлавцева О.В., Коррозия и защита металлов. Москва, Изд. Юрайм, 2022, 189 с.
2. Федосова Н.Л., Антикоррозионная защита металлов. Иваново, 2009, 187 с.
3. Авденко А.П. Коррозия и защита металлов. Справочное пособие. Краматорск ДГМА 2004, 112с.

4. Luca Valentini, Silvia ittolo Bon, Orietta Monticelli, Jose M.Kenny, Deposition of amino-functionalized polyhedral oligomeric silsesquioxanes on graphene oxide sheets immobilized onto an amino-silane modified silicon surface, J. Mater. Chem., 2012, 22, 6213-6217, 17 Feb 2012

5. Gaelle Trippe-Allard, Jean-Christophe Lacroix, Synthesis of nitro- and amino-functionalized π-conjugated oligomers incorporating 3,4-ethylenedioxythiophene (EDOT) units, Tetrahedron Volume 69, Issue 2, 14 January 2013, Pages 861-866, https://doi.org/10.1016/j.tet.2012.10.088

6. Ziyauddin S. Qureshi, Roshan D Souza, Ramakrishna Mallampati, Suresh Valiyaveettil, Synthesis of Amine-Functionalized Block Copolymers for Nanopollutant Removal from Water, Journal of Applied Polymer science Volume131, Issue20 October 15, 2014, 22 May 2014, https://doi.org/10.1002/app.40943

7. Nathanael, A. Joseph, and Tae Hwan Oh, Biopolymer Coatings for Biomedical Applications, Polymers 12, no. 12: 3061, 2020, https://doi.org/10.3390/polym12123061

8. Ризаев Р.Г., Билалов Я.М., Наибова Т.М. Исследование защитных свойств модифицированных фенолоформальдегидных олигомеров. Ж. Нефть и газ. Баку, 1991, №11-12, с.91-24

9. Караев С.Ф., Наибова Т.М., Билалов Я.М., Талыбов Г.М. Полимерные защитные покрытия на основе фенолоформальдегидных олигомеров, модифицированных пропаргиловыми бром эфирами. Ж. Физико-химия поверхности и защита материалов. Москва, 2010, Том 45, №4, с.393-397

10. Наибова Т.М., Агаев И.Ф. Азотсодержащие олигомеры как ингибиторы коррозии стального нефтепромыслового обарудования. Ж. Молодежный научный вестник. УГНТИ, г. Стерлитамак, 2018, с.144-148

11. Naibova T.M., Chemical technology of macromolecular compounds. Baku, Chachoglu, 2014, 376p.

12. Торопцева А.Т., Белгородская К.В., Бондаренко В.М. Лабораторный практикум по химии и технологии высокомолекулярных соединений. Л.:Химия, 1972, 411с.