

MINISTRY OF HIGHER AND SECONDARY SPECIALIZED EDUCATION OF  
THE REPUBLIC OF UZBEKISTAN  
TASHKENT CHEMICAL TECHNOLOGICAL INSTITUTE

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RESEACH METHOD ON OBTAINING INHIBITORS OF SCALES AND  
PROPERTIES

DIPLOMA PAPER  
Speciality: 5320400 – Chemical technology ( production of  
organic substances)

Scientific advisor: senior teacher Tadjiyeva Sh A

Tashkent – 2016

TASHKENT CHEMICAL-TECHNOLOGICAL INSTITUTE  
FACULTY:CHEMICAL TECHNOLOGY OF FUELS AND ORGANIC COMPOUNDS  
DEPARTMENT: ORGANIC CHEMISTRY AND TECHNOLOGY OF THE MAIN  
ORGANIC SYNTHESIS

«CONFIRMED»

Chief of department doc.

\_\_\_\_\_ Qodirov.Kh.E

«\_\_\_\_\_» \_\_\_\_\_ 2016y.

**TASK**

On completing course diploma paper

**RESEACH METHOD ON OBTAINING INHIBITORS OF SCALES AND  
PROPERTIES**

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## CONTENTS

INTRODUCTION.....	4
CHAPTER I. LITERARE REVIEW .....	7
1.1. Sources of mineral scaling .....	7
1.2. Methods for reducing the intensity of deposit formation on heat transfer surfaces .....	15
1.3. Modern preparations of scaling.....	18
CHAPTER II. EXPERIMENTAL PART.....	32
2.1 Reactants physical-chemical properties .....	32
2.2. Preparation procedure zincate hydroxyetilidenediphosphonic acid in the presence of initiators.....	33
2.3. A method of production inhibitor of scaling.....	33
2.4. Method for determining the water hardness.....	35
2.5. Determination of alkalinity of the raw water and boiler water.....	37
2.6. Methods of determining the efficiency of inhibition .....	38
CHAPTER 3. THE DISCUSSION OF OBTAINED RESULTS.....	42
3.1. Synthesis of Zn-HEDP and their inhibitory properties.....	42
3.2. The technology of obtaining Zn-HEDP and scale inhibitors based on them .....	47
MATERIAL BALANCE OF THE PROCESS .....	49
GENERAL INDUSTRIAL REQUIREMENTS OF LABOUR IN THE PRODUCTION .....	51
CONCLUSION .....	64
LITERATURES .....	65

## INTRODUCTION

**Relevance of the work.** Nowadays, in a new level of industry the main tasks assigned to energy efficiency, the rational use of natural resources, particularly, water and the environment.

Especially important it is to solve these problems in energy - and water-intensive of water supplied chemical production.

The main problem of reducing water consumption and water disposal of environmental protection and energy saving way of life can be solved as a result of inhibition of scaling the improvement of water supply systems and the search for the optimal preparation to prevent anomal process is an actual problem.

Prevention of anomalies in the water supply is one of the important problems in the industry.

There are two methods of stabilization of water treatment: chemical and non-chemical. Non-chemical methods of water treatment are reduced to physical processes for its purification - distillation, ultrafiltration, osmosis and ion-exchange method. Their use is limited by high costs and is only justified when the use of chemical reagents inefficient.

Chemical methods of stabilization processing are characterized by low cost, make it possible, in general, reduce operating costs, including energy consumption, costs of maintenance and major repairs, reducing water consumption and increases the reliability and operation of the equipment as possible.

Currently, proposed many inhibitors of deposition of mineral salts. The need of a scale inhibitor is more than 5 thousand. Tonnes per year. Due to the lack of production scale inhibitors in the Republic last brought from - other countries for hard currency. In developed countries, the use of inhibitors found deposits of mineral salts such as IOMC-1 (the price of 1 ton of 4 thousand dollars.), OEDFK (- 7 thousand US dollars.) NTF-3. Helamin (16-18 thousand. USD per ton), and others. With targeted research carried out to develop a new import, export inhibitors deposition of mineral salts on the basis of commercially-available raw

materials by us.

In there are all the necessary raw materials and equipment for the production of mineral salt deposition inhibitors same time in the country. more than 600 thousand annually produced in the Republic. m. of urea, 1,000 tons. thiourea, 7 thous. tons of formaldehyde, uniflok, KFZH et al., which can be used as the main raw material production of mineral salt deposition inhibitors.

**The Object of the work.**

- the development of production technology of new import-substituting environmentally friendly, resource-saving and export-oriented products based on local raw materials;

- study of the process of synthesis of chelating oksietilidendifosfonovoy kompleksonatov acid and based on them;

- synthesis, study of the properties and the development of new technologies of mineral salt deposition inhibitors.

**The object and subject of the study:** The object of this study is to oksietilidendifosfonovaya acid, phosphoric acid, zinc oxide, sodium hydroxide, zinc complex oksietilidendifosfonovoy acid, polyhydric alcohols, bottoms of vacuum distillation residue of monoethanolamine, poliaminokrotonol.

**Methods of investigation:** The stirring and temperature control, the ratio kosmponentov, washing, filtering, drying, separation, elemental analysis, chromatography, spectroscopy, mathematical modeling, design of experiments.

**The scientific novelty of the work:**

- - The reaction of obtaining zincate-oksietilidendifosfonovoy acid in presence of the initiators - polyols: glycerol and ethylene glycol, and citric acid;
- New compositions have been developed based on zincate-oksietilidendifosfonovoy adding monoethanolamine (vacuum distillation bottoms monoethanolamine) and poliaminokrotonola that effectively protects against nakipobrazovaniya vodopodogotovke and in oil production. It is found that their effectiveness is 90% or higher.

The mechanism of formation of zincate-oksietilidendi-phosphonic acid, the

structure and the structure is determined by modern analysis methods: IR and NMR-spectroscopy, elemental analysis.

**The practical value of the work:**

Based on the results of a study to develop a new method of synthesis of zincate-oksietilidendi-phosphonic acid. Installed optimalnye complexonate production parameters: reaction time, the influence of the quantity and nature of the initiator, the effect of the duration of the final product and the drying temperature, etc. are established, the process parameters of the investigated processes.

**Aprobation of the work.** The main results of the study were reported and discussed at the republican scientific conference:

Turaev NA, Kadirov JE, new chemical reagent used for corrective treatment of water. Current issues in the field of technical and socio-economic sciences. Tashkent 2014 Part 1 str.178.

Turaev NA, Kadirov JE Comparison of the effectiveness of the protection of steel from different scaling inhibitors. Proceedings of XXIV - scientific and technical conference of young scientists, graduate and undergraduate students. Tashkent 2015, p.162

Turaev NA, Kadirov JE, Synthesis zincate-oksietilidendi-phosphonic acid. Proceedings of XXIV - scientific and technical conference of young scientists, graduate and undergraduate students. Tashkent 2015, p.168

**Publication of the results.** On the topic of master's thesis published 3 abstracts at various conferences.

**The structure and scope of the thesis.** The thesis is stated on the pages of the typewritten text, consists of introduction, literature review, experimental part, discussion of results, conclusions, literature index of 65 titles and applications.

## CHAPTER I. LITERARE REVIEW

### 1.1. Sources of mineral scaling

The resulting layer materials can be called scale, when its thickness reaches a size that cause dangerous overheating of the metal walls or when the presence of these substances reduces the efficiency of the heating process. It should be noticed that it is often called a scale layer only those substances that are formed from dissolved or suspended in water compounds. Compounds with incoming water can make 2 different complex: limescale or sediment [2]. Limescale is formed from the interaction of water or a reagent with a heat transfer surface of the metal, as well as a result of separation of different substances dissolved in water at its boiling, heating and evaporation.

Produced in the steam generators according to the classification scale can be divided in its composition into 5 groups:

- alkaline, i.e. compounds consisting of Ca and Mg. Thus, depending on the anion is a calcium scale divided into sulfate ( $CaSO_4$ ), silicate ( $CaSiO_3$ ), carbonate ( $CaCO_3$ ) and phosphate [ $Ca_3(PO_4)_2$ ]; magnesium scale divided into hydroxide [ $Mg$ ;  $Mg(OH)_2$ ] and phosphate;

- copper scale, consisting mainly of copper metal;

- iron scale, which are divided into silicate, ferro silicate [ $Fe_3(PO_4)_2$ ,  $NaFePO_4$ ] and oxide [ $Fe_3O_4$ ];

- alumina ferrite silicate and silicate with a predominance of properties  $SiO_2$ ;

- Scale of soluble salts:  $NaPO_4$ ,  $Na_2HPO_4$ ;

Chemically predominant deposits component can be classified into silicon, sodium, magnesium, calcium, iron, copper, etc.

It is known that phosphorus  $Ca_3(PO_4)_2$  is allocated to surface of heating in the form of scale, while very little different from it on the composition of hydroxyapatite  $Ca[Ca_3(PO_4)_2]_3(OH)_2$  is always crystallized in the water to form individual particles, does not stick to the heating surface. It is also known that some hydroxo metal oxide falls in the scale, while others form a scum.

Silica deposits occur in the flow of the steam turbine; they are composed of amorphous silica and crystalline  $SiO_2$  ( $\delta$ -silica) doped with various sodium silicates.

Sodium deposits, more commonly called salted, occur in the steam boilers and turbine tubes, sometimes high pressure boilers. They consist of various sodium compounds: in superheaters - phosphates, silicates; on the turbine blading - chloride silicate, ferrite and soda; once-through boilers in - a mixture of these oxides, salts of iron, copper, and calcium and magnesium compounds.

Calcium deposits are divided into carbonate, sulphate, silicate and phosphate, are formed in the raw water preheater, a steam turbine condenser tubes, in the engine cooling devices and so on. In all of these devices is formed mainly scale, mainly consisting of  $CaCO_3$  usually mixed with basic magnesium carbonate, silica, alumina and iron oxide, manganese carbonate and sometimes other compounds.

Calcium phosphate scale observed in the high-pressure heaters and water economizer.

Iron scale is divided into iron oxide, ferriferous and iron phosphate. Iron oxide deposits formed in steam boilers, main highways, reverse the capacitor wires, pipes, purified water.

Iron phosphate deposits, as well as copper, scale found in steam kotla. The thermal conductivity of scum in the tens and often hundreds times less than the thermal conductivity of steel material of the heat exchangers. Therefore, even a thin layer of scale creates a large thermal resistance, which leads to the heat pipes and their rupture [3].

The solid deposition formed on the interior walls of the tubes of steam boilers, superheaters, evaporators and other heat exchangers, in which there is water, and heating equipment contain certain salts. The currently main component of scaling in the steam economy system is copper and iron oxides with a more or less significant admixture of silicic acid and zinc oxide. In boiler water usually contains various calcium compounds:  $CaSO_4$ ,  $CaSiO_3$  other, disintegrating in an

aqueous solution on the ions  $Ca^{2+}$ ,  $SiO_3$  - an extension types of scaling shows the connection between the processes of corrosion feed circuit and condensing tubes with one hand, and descaling by a rather different . Occurrence of copper iron scale in the steam generators, not only leads to the formation of ulcers and fistulas, but also causes corrosion of metal.

#### *Physico-chemical basis of scale formation*

The most characteristic mode factors influencing the process of scaling are hydrodynamics, gas content and alkalinity of the warmed solution. The effect of temperature on the scale formation in pure water and industrial solutions of different [4]. The strongest influence on the process of scaling properties of the water used. The set of properties of the water due to the presence therein of presence of various salts: predominantly  $Ca^{2+}$  cations (calcium hard water) and  $Mg^{2+}$  (magnesium hard water). The sum concentration of  $Ca^{2+}$  and  $Mg^{2+}$  called water hardness. The first is caused by the presence of hydrocarbons in water with  $Ca$  and  $Mg$  at reflux decompose  $CaCO_3$  and  $Mg(OH)_2$  with  $CO_2$  release, the second - the presence of sulfates, chlorides, silicates, nitrates, phosphates of these metals. One possible source of these salts are rocks (sands, dolomite), which dissolve in contact with natural water and soils. Water hardness is expressed in mEq/L: carbonate hardness corresponds to that part of the cations  $Ca^{2+}$  and of  $Mg^{2+}$ , which is equivalent to a multiple of the water contained in the anonymous  $HSO_3^-$ , non-carbonate - anions  $SO_4^{2-}$ ,  $NO_3^-$  and others.

Increased hardness contributes to enhanced scaling in boilers, radiators and household metal utensils, which significantly reduces the heat transfer rate leads to higher fuel consumption and overheating of the metal surfaces.

The water is used in industry, typically contains clay and sand slurry - about 8-19 mg/L, organic substances (algae colloid, humic substances from fertile soil - about 5 mg/l), salts - earth metal (sodium, potassium (4-15 mg/l)), hardness salts (calcium, magnesium, silicates - 8-95 mg / liter), dissolved oxygen (5-12 mg / l), carbon dioxide (100-700 mg / l).

Inorganic contaminants in the water are mainly in the form of ions:  $Na^+$ ,  $Ca^{2+}$ ,  $Mg^{2+}$ ,  $K^+$ ,  $Cl^-$ ,  $SO_4^{2-}$ ,  $HSO_3^-$ .

Physical and chemical bases of processes of dissolution of scale and sediment determined by the type and scale deposits formed. Table. 1.1 shows the different types of deposits which may form in the steam-water cycle.

Table 1.1

Phase composition of deposits

The name of deposits formed in a steam environment	Formula
Hydroxyapatite	$Ca_5[OH(PO_4)_3]$
Volvit	$(Fe^{2+}, Mn^{2+})_2[OH/PO_4]$
Arroyadit	$Na_2(Fe^{2+}, Mn^{2+})_5[PO_4]$
Carbonate hydroxyapatite	$Ca_5[OH](PO_4, CO_3OH)_3$
Triploids	$(Mn^{2+}, Fe^{2+})_2[OH/PO_4]$
	$Al_2(PO_4)_3 \cdot 2H_2O$ $Cu_3(PO_4) \cdot 2H_2O$
	$Mg_3(PO_4)_2$ $K_3PO_4$ $MgHPO_4$ $Na_3PO_4$
	$Na_4P_2O_7 \cdot 12H_2O$ $Fe - Mn - phosphate$
	$Ca - Mg = Fe - phosphate$
	$Fe - Ca - Na - phosphate$ $Na - Al - phosphate$
	$Fe^{3+}, PO_4 \cdot 2HO - phosphate$
	$Fe - hydroxyapatite$
	$Na - Fe - hydroxyapatite$
Magnetite	$Fe_3O_4$
Basic oxide	$FeOOH$
Delafosse	$CuFeO_2$
Brucite	$Mg(OH)_2$
Cristobalite	$SiO_2$ with the inclusion of $K-Fe MnO$
Calcite	$CaCO_3$

Cuprite	$Cu_2O$
Iron silicate	$Fe_2O_3 \cdot 6SiO_2 \cdot Na_2O$

Limescale is mainly the adjustable  $Ca^{2+}$  and  $Mg^{2+}$ , bicarbonates formed first, and then the insoluble carbonates of these metals. Gypsum crystallizes from natural water in the form of calcium sulfate dihydrate  $CaSO_4 \cdot 2H_2O$ . When heated to 100 ° C, it goes into less soluble hemihydrate  $CaSO_4 \cdot 0,5H_2O$ , and when the temperature rises to 130 ° C - even less soluble  $CaSO_4$ .

When boiling hydrocarbons turn into poorly soluble carbonates:



The intense heat, the more intense are the reactions (see. Table 1.2). The content of  $Ca(HSO_3)_2$  is increased in a solution in case of violation of technological process, and also depends on the pH of the solution. calcium hydrogen carbonate in the solution is in an unstable condition and any external influence accelerates the crystallization of hydrocarbons.

Table 1.2

The content of  $Ca(HCO_3)_2$  in the solution after heating (%)

The time, minutes	75 °C	90 °C	100 °C moderately	100 °C Moderately
5	85	45	33	9
10	68	27	10	4
15	57	25	4	3
20	47	23	3	3
30	35	20	2,3	2,3
40	30	17	2,3	2,3

magnesium bicarbonate behave very similar in behavior of  $Ca(HCO_3)_2$ , but poorly soluble carbonate decomposition into carbon monoxide goes a half times slower. In certain  $Mg(HCO_3)_2$  physicochemical conditions 2 becomes hardly soluble hydroxide -  $Mg(OH)_2$ . Carbonates  $CaCO_3$  and  $MgCO_3$  behave differently. Thus with increasing temperature, but at a constant pressure of rastorimost decreases, and with increasing the temperature and pressure of rastorimost

decreases and solubility increases sharply (see. Table 1.3.) By increasing the temperature and pressure, and  $MgCO_3$  soluble intense than  $CaCO_3$ , and when high temperatures and it is hydrolyzed solution losing  $CO_2$  passes into  $Mg(OH)_2$  [4].

Table 1.3

Carbonates solubility dependence on temperature and pressure

Temperature, °C	Pressure, MPa	Solubility, mg / l	
		CaCO <sub>3</sub>	MgCO <sub>3</sub>
50	0,05	15,0	10,0
100	0,10	17,0	20,0
150	0,50	21,7	25,0
175	0,90	23,6	29,7
200	1,60	25,5	35,5

Thus, there is a temporary removal of water hardness, constant hardness can not be removed by boiling.

The iron in the boiler water is concentrated to a lesser degree than the readily soluble salts (chlorides, sulfates, sodium, etc.), due to the fact that much of it is consumed in the formation of scale. The process of iron oxide scale formation does not depend on the rate of formation of copper deposits. The speed of each of them is determined by the thermal load. The rate of copper deposition significantly heat load value. The rate of copper deposition rate is much smaller deposits of iron oxide compounds. It podvezhdeno research results are presented in Table. 1.4. Ferrum oxide scale formation occurs during surface boiling, and its rate is dependent upon the subcooled liquid to the boil. By increasing the subcooling decreases scaling speed. In the absence of the formation of surface boiling ceases iron oxide deposits.

Table 1.4

Effect of copper on the rate of iron oxide deposits  $q = 350 \text{ kWh} / \text{m}^2$  [300

$\text{mkal}/(\text{m}^2\text{h})$ ];  $C_{Fe} = 5 \text{ mg} / \text{kg}$   $PO_4 = 100 \text{ mg} / \text{kg}$ ,  $\text{pH} = 10,8$

The copper concentration in mg / kg	Characteristics of deposits			
	The amount of iron, mg	iron deposits rate, mg / (sm <sup>2</sup> ch)	The amount of copper mg	copper deposits rate, mg / (sm <sup>2</sup> ch)
Footprints	3,5	0,0188	0,02	0,0001
0,05	3,2	0,172	0,12	0,0005
0,5	3,7	0,0199	0,19	0,0010

5	3,4	0,0185	0,27	0,0014
10	3,6	0,0193	0,29	0,0015
15	3,8	0,02	0,32	0,0017

The main component of iron oxide scale are allocated to the heating surface in the form of  $Fe_3O_4$ . The amount of iron oxides in these sediments is 70 - 90%. Metallic copper is often also present in the iron oxide scale, but its content is usually not more than 5 - 6%.

Scaling speed does not depend on the valence of iron: ferrous boils as intensively as in the trivalent steam circuit [5]. Heat transfer is accompanied on microregions most heat of the heating surface, the increased concentration of electrons. The value created in this building is determined by the thermal load. The positively charged part of iron oxide should in this case settle on a negatively charged parts of the heating surface and is fixed to them. Particle velocity as the kick is dependent on the iron content in the water and the heat load from the surface [5].

Some power plants operating at a steam pressure of  $98 \cdot 10^5$  Pa , cases ferrum phosphate deposits formation was observed, which include sodium, ferrous iron and phosphoric acid in an amount corresponding to formula  $NaFePO_4$ . The formation of such a structure of scale associated with a significant concentration of iron and phosphate in boiler water with a lack of its alkalinity. The high content of silica in drinking water and boiler combined with considerable local thermal loads of heating surface or impaired circulation causes the formation of silica-alumina and iron oxide scum. They have a structure like:

- natrolite ( $NaO_2 \cdot Al_2O_3 \cdot 3SiO_2 \cdot 2H_2O$ )
- analcime ( $NaO_2 \cdot Al_2O_3 \cdot 4SiO_2 \cdot 2H_2O$ )
- nozelita ( $4NaO_2 \cdot 3Al_2O_3 \cdot 6SiO_2 \cdot SO_3$ )
- anilita ( $NaO_2 \cdot Fe_2O_3 \cdot 4SiO_2$ ).

Scaling can be the result of the following processes:

- 1) crystallization of substances on the heated surface;
- 2) Adhesion or sticking particulate matter;

3) Deposition of soluble salts, and a variety of complex compounds from the concentrated boiler water;

4) Formation of deposits composed of corrosion products.

Scale may be made from the water when it is heated or boiling; occur due to the corrosive effects of water or of dissolved metal impurities; released from the steam and overheated when the water by evaporation. Consideration hold scaling process with respect to calcium compounds, considering that in overwhelming majority of water generally exceeds calcium magnesium content. However, it should be noted that the basis for scaling magnesium is magnesium hydrate, which has low solubility, whereas calcium hydrate has higher solubility and scale is not the adjustable.

According to behave differently and silicates of **Ca** and **Mg**: the first - the adjustable scum, and the second - no. The rate of formation of calcium and magnesium of scale is significant and depends on the concentration of scale and the adjustable value of the local heat load of the heating surface. The wide range of changes in pH values (7 to 11) it can be described by the equation:

$$A_{(Ca + Mg)} \rightarrow 1,3 \cdot 10^{-13} C_{(Ca + Mg)} q^2,$$

where  $A_{(Ca + Mg)}$  - rate of formation of deposits of calcium and magnesium, mg / (cm<sup>2</sup> h);

q - the magnitude of the heat load of the heating surface, W / m<sup>2</sup>;

$C_{(Ca + Mg)}$  - the concentration of calcium and magnesium in water, mg / kg.

Effect of heat stress on the process of loss of hardness salts heating surface indicates the generality of the formation of different types of scale. deposition rate in all cases determined by the same factor - the local thermal load.

Thus, the main factors affecting the process of scaling are temperature, pressure, composition of the water, hydrodynamics. The effect of temperature on the scale formation in pure water and industrial solutions of different. The strongest influence on the process of scaling a property of the water used. The set of properties of the water therein due to the presence of various salts:

predominantly  $Ca^{2+}$  cations (calcium hard water) and  $Mg^{2+}$  (magnesium hard water).

## **1.2. Methods for reducing the intensity of deposit formation on heat transfer surfaces**

One serious problems encountered in the operation of heating equipment, heating systems and hot water networks, high water hardness (8-12 mEq / dm<sup>3</sup>). For this reason, there is an intensive formation of scale on heat transfer surfaces both or only on the inner surfaces of equipment and pipes of heating and hot water supply networks, devices up to consumers of heat energy and hot water taps. Scaling layer comprises a metal inclusion of corrosion products. Layer formation of scale and corrosion products leads to a number of undesirable consequences:

- reduce the heat transfer coefficient and efficiency of thermal power equipment;
- reduction of the working surface area and reduce the efficiency of the vacuum deaerator;
- increase energy costs for the water supply pumps and the difficulty of water supply to the consumers;
- incomplete removal of long-standing deposits;
- the need for organization of works on washing in the off-season with the interruption of hot water;
- the impossibility of cleaning the external and intra-house heating and hot water supply networks [6].

In order to prevent scale formation, there are various methods of struggle: manual clean, chemical dissolution acids, ultrasonic cleaning, the use of membrane filters, magnetic water treatment, application of ion exchange, the use of technology complexone.

### *Chemical dissolution with acids*

In industry, the most economical and acceptable at present is a method for purifying an acidic heat transfer surfaces. Using sulfuric, hydrochloric, phosphoric

acid, oxalic acid, and a mixture of oxalic and phosphoric acid, the latter is the most effective to dissolve the scale at 60 ° C for 5 minutes at a concentration of 5% [5].

Known purification methods descaling of heat exchanger tubes by treating it with hydrochloric acid by the addition of inhibitors, such as hexamine. However, the use of such inhibitors in hydrochloric acid purification method of irrational, since the descaling process with heat exchange tubes overcome to heating surface at a temperature corresponding to the set mode with temperature (75-125 ° C).

Thermally inert organic deposits are removed by washing with acidic aqueous solutions, then heated to a temperature of 300-500°C, purged with oxygen-containing gas to complete their oxidation, and the remaining scales inorganic acid is removed by repeated washing solutions.

Known method of cleaning heat exchangers carbonate scale flow of cleaning solution, in which a pre-administered acid and wherein the ratio by volume of compressed air fed pulse and the cleaning solution is maintained in the range from 1: 5 to 1: 2. For the removal of organic deposits from the surface equipment can be applied life based compositions Trilon B (5-10 g/l) in combination with citric or tartaric acid (5-10 g/l) or a mixture of the latter two. As corrosion inhibitor is recommended in 2 mernoptobeztazol with concentration 1 g / l and 0.17 g / l respectively.

When using hydrazine solutions acidified with hydrochloric or sulfuric acid, the cleaning effect is achieved by activating solution heated to 100 - 120°C. The action of hydrazine protective film forming on the cleaned surface, acids supplemented regeneration part, moreover, according to some hydrazine reduces iron oxides and thus promotes their dissolution.

Mechanical methods of cleaning of heating equipment.

In addition to chemical methods of cleaning of heating equipment used mechanical. In particular, for cleaning shell and tube heaters DHW systems (boilers), applied drilling special drill pipes 4 m in length, filling the vacuum deaerator (ring Rashika) was purified by mechanical shaking. Mechanical cleaning is very time-consuming process.

It is impossible to effectively clean the external and in-house heating networks. periodic replacement of pipes [6] Therefore, practiced.

#### *Application of Ion Exchange Methods*

Reduce the tendency for scale formation on heat transfer surfaces usually resort to using water treatment ionite filters. The process of ion exchange is withdrawn from the solution impurity ions and replace them with other ions ( $H^+$  or  $Na^+$ ) does not affect the water quality. This process takes place on the surface of materials, called ion exchange [4].

Ions present in the solution suitable for the surface of the ion exchange material, which are easily-movable structure ions. Ion exchange takes place, is present in solution at an ionic group that is part of an ion exchange resin. The ionic groups originally included in the resin into solution, and the ions present in the solution, are chemisorbed on the surface of a polymer material [7].

There are two kinds of ion exchange resins - one resin capable of exchanging cations, others - to exchange anions. Resins which are capable of exchanging cations, called cation exchange resins, and the process that takes place with their participation, - cation exchange.

There are two varieties of cation exchange processes: H-cation exchange (cation exchange resins, which are present in the solution to hydrogen ions) and Na-cation exchange (ion exchange resins, which are present in the solution, sodium ions).

The polymeric materials that are capable of exchanging anions, called anion exchange resins, and the process that takes place with their participation, - anioning.

The apparent advantage of ion-exchange water treatment method is the ability to produce at the output of pure water with very low concentrations of residual impurities. In some cases, the residual concentration of ions is not more than a few micrograms per liter. A disadvantage of the method is the large consumption of regeneration reagents and receiving a significant amount of regeneration effluent solutions. As a result of the review of existing methods of

struggle with scale can identify a number of inconveniences that we have using these methods:

- chemical dissolution acids: stop and downtime, the presence of acid, flushing, disposal, replacement of damaged parts acid, the cost for payment of works;

- mechanical cleaning: stop and downtime, the need to purchase tools (chisel, hammer, cone), replacing accidentally damaged items, the cost of payment of works;

- Ultrasonic cleaning: stop and downtime, the need for ultrasonic cleaning machine, vibration, micro-cracks, replacement of damaged parts, the cost of works payment;

- Membrane filters: limited resource work at a sufficiently high value;

- installation of omagnetic: if long-term treatment of water by permanent magnets it is produced "immunity" to the magnetic fields of certain types and ceases to contribute to the deposition of hardness salts on the surfaces of the heat;

- ion exchange methods: high equipment cost, the complexity, significant replacement costs and ion exchange resins, the instability, high consumption of regeneration reagents and receiving a significant amount of regeneration effluent solutions, sewage.

Among the most effective methods of water treatment can be attributed complexes to water treatment, the essence of which consists in treating the water with special substances - chelators, slowing down, and in some cases prevent the process of corrosion and scale formation.

### **1.3. Modern preparations of scaling**

For water treatment in the management of correctional complexed water-chemistry using preparations produced by the domestic industry, specifically designed for use in the heating system and have installed certificates. The use of foreign-made products, as well as newly developed products in the domestic thermal power plants in the Russian Federation can only be subject to agreement of technological modes of the relevant territorial regional energos Department of

State Energy Supervision.

In the complexed water-chemistry mode in the new draft or recommended heat and power systems designer is bonded to provide and justify the choice of not only the main preparation for the treatment of water, but also the preparation of reserve in case of overload or stop production capacity for the main product. At the same exact customer specifications with an indication of manufacturers, both primary and backup products and certificates on the primary and backup are an integral part of the preparation of project documentation. The project, comprising kompleksonami water chemistry and thus does not contain addresses and details of company-producers of primary and backup products should not agree bodies TEL and the State Energy Supervision.

Domestic chemical industry produces for use in thermal power generation products based on hydroxyethylidene-diphosphonic acid (HEDP) NTMP (NTMP) and polyethylene polyamine-N-methylphosphonic acid (PMPA).

In terms of the impact on the human body HEDPA refers to the 3rd class of dangerous, that the substance is moderately dangerous. MPC 1-hydroxyethylidenediphosphonic acid in drinking water and in water reservoirs of drinking and cultural-domestic water use is  $0.6 \text{ mg/dm}^3$ , water reservoirs fishery -  $0.9 \text{ mg/dm}^3$ , limiting health hazard indicator - the organoleptic (taste). MPC hydroxyethylidenediphosphonic acid in the air of the working area -  $2 \text{ mg / dm}^3$ , relatively safe exposure level (TSEL) in the ambient air of populated places -  $0.04 \text{ mg/dm}^3$ . HEDPA is irritating to the skin and mucous membranes. After contact HEDPA and containing its preparations on the skin or eyes affected area should be washed with plenty of water. After washing the affected area of the skin it is recommended to treat with a 2% sodium hydrogencarbonate solution, used for treating eye -th 0.5% sodium bicarbonate solution.

Commodity preparation is available HEDPA "ХимПром" (Novocheboksarsk) under the brand name "HEDP-MA" technical THAT 6-09-5372-87 conditions. HEDP-MA is a white powder with a grayish or yellowish tint, comprising at least 97% HEDPA and not more than 2% moisture. The product is

flammable; its auto-ignition temperature is 177°C. In case of fire burning preparation HEDP-MA should extinguish atomized water, foam, dry sand. Transportation and storage of the preparation carried out in sealed original packaging, protecting the preparation from the effects of moisture, in covered dry warehouses. Shelf life - 12 months.

The main purpose of the preparation HEDP-MA is a chemical treatment of the heat power equipment from scale deposits and corrosion products. Along with this HEDP-MA is used as a scaling inhibitor. The water containing large amounts of multiply charged cations (particularly calcium and magnesium), HEDP-MA at a concentration up to 50 mg / dm<sup>3</sup> is capable of inhibiting corrosion of iron and its alloys, but the degree of protection at this small ( $Z = 30\%$ ). Introduction to the heat and power systems HEDPA water lowers the pH of the aqueous medium, which is undesirable from the standpoint of "technical operation Regulation" [2]. Furthermore, in the case of administration in HEDPA water boilers, its concentration will increase due to the evaporation of water. This increased concentration may cause enhanced HEDPA korrziyu boilers. Therefore, the use and HEDPA HEDPA preparation as scaling and corrosion inhibitors can be justified only in the heating and hot water systems, in cases when while preventing the formation of new deposits must implement a gradual purification system of existing scale deposits, and corrosion products. In most cases, this problem arises when translating in complexed water chemistry reconstruction of heating systems or hot water, to the reconstruction work in other water chemistry or raw water. Recommended in this case the preparation dosage HEDP-MA in water depending on the carbonate index calculated according to the formula (1.33) are shown in Table. 1.5.

Table 1.5

Recommended dosage HEDP-MA in the processing of water heating systems and hot water, depending on the carbonate water index

Carbonate water index $I_k$ , (mg-Eq/dm <sup>3</sup> ) <sup>2</sup>	Recommended dosage HEDP-MA preparation mg/dm <sup>3</sup>
0...1	0,5±0,25
1...3	1,0±0,5
3...7	2,0±1,0
7...11	4,0±1,5
11...15	6,0±2,0
15...20	8,0±3,0

Note: The high dosage within tolerance corresponds to higher water temperatures at the boiler outlet (AC heater).

HEDPA as a 20% aqueous solution produced ООО НПО "Травец" (Moscow), which is working on a partnership with the Research Institute IREA, under the brand name "Aminat OD-1". This preparation is a colorless liquid with a strong sour taste, density of 1100 ... 1180 kg/m<sup>3</sup>.

"Aminat OD-1" is aggressive with respect to iron and its alloys, so the transportation and storage of the preparation should be carried out in a sealed container made of chemically resistant plastics [8]. The freezing point of the preparation, about 6°C. In the case of freezing "Aminat OD-1" after thawing of the preparation of its properties are completely restored. Guaranteed shelf life of the product - 12 months.

"Aminat ML-1" is used as an inhibitor of scale formation and dissolution of existing scale in membrane osmotic water purification plants. Table 2.1

The recommended dosage of the preparation "Aminat OD-1" in the water, depending on the total hardness of water and iron content are given in Table. 1.6. In some cases, the preparation "Aminat OD-1" is also used as a corrosion inhibitor and scaling pipes and heat exchange equipment circulating heating and domestic hot water. However, this application should be considered impractical because of

the relatively high cost of the preparation.

Table 1.6

The recommended dosage of the preparation "Aminat OD-1" in the processing of water in the membrane-osmotic units, depending on the total water hardness and iron content

Total hardness of water in, mg-Eq/dm <sup>3</sup>	Recommended dosage formulation, mg/dm <sup>3</sup> (sm <sup>3</sup> /m <sup>3</sup> ), if they contain iron, mg/dm <sup>3</sup>		
	0,0...0,1	0,1...0,2	0,2...0,3
0...2	0,5±0,25 (2,25±1,0)	1,0±0,5 (4,5±2,0)	2,0±0,75 (9,0±4,0)
2...4	1,0±0,5 (4,5±2,0)	2,0±0,75 (9,0±4,0)	4,0±1,0 (18,0±4,5)
4...6	2,0±0,75 (9,0±4,0)	4,0±1,0 (18,0±4,5)	6,0±1,5 (27,0±7,0)
6...8	3,0±1,0 (13,0±4,5)	5,0±1,5 (23,0±7,0)	7,0±2,0 (32,0±9,0)
8...10	4,0±1,0 (18,0±4,5)	6,0±1,5 (27,0±7,0)	8,0±2,0 (36,0±9,0)

For these purposes, a more rational use the preparation "Aminat OD", also produced by LLC "NPF" Traverse "(Moscow). "Aminat ML" represents a 20% aqueous solution of acidic sodium or ammonium salts HEDPA - liquid light yellow color with a strong sour taste, a density of 1150 ... 1200 kg / m<sup>3</sup> and a pH = 2 ... 5. "Aminat OD" as well as "AminatOD-1", aggressive with respect to iron and its alloys, so the transportation and storage of the preparation should be carried out in a sealed container made of chemically resistant plastics. The freezing point of the preparation "Aminad OD" about -4°C. In the case of freezing of the preparation after thawing properties "Aminat OD" fully restored.

The recommended dosing preparations "Aminat OD" and "Aminat OD-1" in the water, depending on the total water hardness and iron content are given in

Table. 1.7. MPC preparations "Aminat OD" and "Aminat OD-1" in drinking water is 0.6 mg / dm<sup>3</sup> in terms of HEDPA. Accordingly, in order to keep the water hot water systems meet the requirements for drinking water, volumetric dosing preparations "Aminat OD" and "Aminat OD-1" in the water hot water systems should not exceed 2.4 cm<sup>3</sup>/m<sup>3</sup>. In the use of these preparations to inhibit scale formation in domestic hot water systems is only useful when the carbonate index  $I_k \leq 3$  (mg-Eq/dm<sup>3</sup>)<sup>2</sup>. It should also be remembered that the preparations "Aminat OD" and "Aminat OD-1" are capable of inhibiting corrosion of iron and its alloys only in water containing a sufficient amount of hardness salts ( $J_o \geq$  mg-Eq/dm<sup>3</sup>).

Table 1.7

The recommended dosing preparats "Aminat OD" and "Aminat OD-1" in the processing of water heating systems and hot water, depending on the carbonate water index

Carbonate water index $I_k$ , (mg-Eq /dm <sup>3</sup> ) <sup>2</sup>	Recommended "Aminat OD" and "Aminat OD-1" Dosage, mg/dm <sup>3</sup> (cm <sup>3</sup> /m <sup>3</sup> )
0...1	0,5±0,25 (2,2±1,0)
1...3	1,0±0,5 (4,5±2,0)
3...7	2,5±1,0 (12,0±4,0)
7...11	4,0±1,5 (18,0±6,0)
11...15	6,0±2,0 (27,0±8,0)
15...20	8,0±3,0 (36,0±10,0)

These preparations should not be injected into the feedwater of steam

generators to prevent corrosion of steel strengthened by increasing the concentration HEDPA and its acid addition salts by evaporating water in the boiler.

Among the products on the basis of HEDPA most effective for inhibiting corrosion and scale formation in the heating and hot water systems, and the steam unit hydroxyethylidenediphosphonic-zincate sodium (brand names - zincate HEDP, ZnHEDP, Zinc complex HEDP, Zinc complexes HEDP, etc.) manufactured by LLC "NPF" Travers "(Moscow). The chemical formula of sodium hydroxyethylidenediphosphonic acid abbreviated form can be written as  $[ZnHEDP] HNa_2 \cdot H_2O$  [9]. Molecular weight  $[Zn-HEDP] HNa_2$  equal to 313 amu, which corresponds to 313 g/mol. The preparation is available as a 25% aqueous solution, which is liquid from yellow to light brown with a density of 1200 ... 1300 kg/m<sup>3</sup> and odorless, with a characteristic metallic taste. The preparation has a neutral or slightly alkaline reaction (pH = 6.5 ... 10). When using sodium hydroxyethylidenediphosphonic acid should be noted that the activity of the preparation dramatically and irreversibly declines when freezing (freezing point around -7°C) followed by thawing. In this, the preparation should be transported and stored in winter in heated vehicles and stored in heated rooms. Guaranteed shelf life of 12 months. The product is non-flammable and non-explosive [10,11].

According to numerous studies, hydroxyethylidenediphosphonate-zincate sodium is an active corrosion inhibitor [12] and scaling [6], with a degree of protection increases with concentration up to 30 mg/dm<sup>3</sup>. At a concentration of 30 mg/dm<sup>3</sup> protection against corrosion of carbon steel in neutral media it is not less than 81% and the degree of inhibition of crystallization of sparingly soluble salts, alkaline earth metal - about 99%. A further increase in concentration does not lead to a significant increase in the degree of protection. However, increasing the concentration of sodium Zn-HEDP to 5000 mg/dm<sup>3</sup> not lead to accelerated corrosion of iron and its alloys.

In terms of effects on the body of sodium oksietilidendifosfonatotsinkat

refers to the 3<sup>rd</sup> class of danger that is moderately dangerous. MPC Zn-HEDP sodium in using water and in water reservoirs of using and cultural-domestic water use is 5.0 mg/dm<sup>3</sup>. limiting health hazard indicator - the organoleptic (taste). The content of the preparation in water reservoirs fishery is limited to the maximum allowable concentration of Zinc - 0.01 mg/dm<sup>3</sup>. In contact with skin and mucous membranes sodium Zn-HEDP cause slight irritation. In case of contact with sodium Zn-HEDP skin or eyes affected area should be washed with plenty of water.

Zn-HEDP sodium is used as a corrosion inhibitor and scale formation in heat and power systems for various purposes. The optimum dosage of sodium zincate hydroxyethylidenediphosphonate-complexone in the management of water-chemical mode of heating and hot water systems, depending on the carbonate water of the index are shown in Table. 2.4. With the introduction of this preparation into the water hot water systems should be aware that the water is hot water systems must meet the requirements for drinking water quality. Therefore, the dosage of sodium zincate hydroxyethylidenediphosphonate should not exceed 5.0 mg / dm<sup>3</sup>, which corresponds to the commercial dosage formulation 17 cm<sup>3</sup> / m<sup>3</sup>.

Considering Table. 1.8, it can be concluded that by maintaining the concentration of the preparation in the water network MAC not higher, can provide an effective inhibition of scale formation in an open draw-networks (WAN systems) carbonate in the index 15 (mg-Eq / dm<sup>3</sup>)<sup>2</sup> inclusive.

Table 1.8

The optimum dosage of sodium Zn-HEDP when processing water heating systems and hot water, depending on the carbonate water index

Carbonate water index I <sub>k</sub> , (mg-Eq / dm <sup>3</sup> ) <sup>2</sup>	The optimum dosage [HEDP Zn] HNa <sub>2</sub> mg / dm <sup>3</sup> (cm <sup>3</sup> / m <sup>3</sup> )
0...1	0,75±0,25 (2,5±1,0)
1...3	1,5±0,5

	(5,0±2,0)
3...7	2,5±1,0 (8,0±3,0)
7...11	5,0±1,5 (17,0±6,0)
11...15	7,0±2,0 (25,0±7,0)
15...20	9,0±3,0 (30,0±10,0)

Note: The high dosage within tolerance correspond to higher temperatures of water exiting the boiler (heater power).

Sufficiently high thermal stability  $[\text{Zn-HEDP}]\text{HNa}_2$  and the fact that the increase in the concentration of the preparation does not cause corrosion strengthen steel, allows the use of this preparation to maintain complexons of water chemistry boilers of low pressure. The optimum dosage  $[\text{Zn-HEDP}]\text{HNa}_2$  in the make-up water steam generating plants and the recommended relative value of the total purging depending on the total hardness of make-up water is given in Table. 1.9.

Table 1.9

The optimal dosage of the preparation and on the total value of the purge in the processing of feed water steam generating plants hydroxyethylidenediphosphonate sodium, depending on the total water hardness

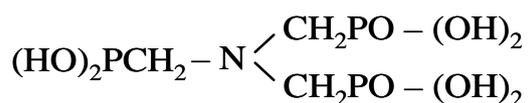
Total hardness of water in mg-eq / dm <sup>3</sup>	The optimum dosage [HEDP Zn] HNa 2 mg / dm <sup>3</sup> (cm <sup>3</sup> / m <sup>3</sup> )	Recommended relative value of the total purge%
0...1	0,75±0,25 (2,5±1,0)	2,5±0,5
1...2	1,0±0,3 (3,5±1,0)	4,0±1,0

2...3	1,5±0,5 (5,0±1,5)	6,0±1,5
3...5	2,5±1,0 (8,0±3,0)	8,0±2,0
5...7	3,5±1,2 (12,0±3,5)	11,0±2,5

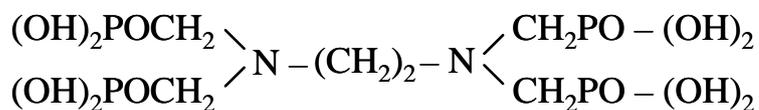
Note: The high dosage chelator and purge values within the tolerances correspond to higher water temperature in the boiler.

The main obtained results are given in the use of inhibitors with mineral salt deposits [13-31].

The derivatives of phosphonic acids - aminomethylphosphonate intended for the prevention and dissolution of scale, produced by the company "Albright and Wilson" under the tradename Brikvest a mixture of the acid and its sodium salts with different degrees of substitution and by "Saldon Sorroration" as a mixture of acid and salt polyvalent metal. On the basis of firms aminometilenphosphonic acids developed the following types of commodities reagents [2].



Brikvest 301 - 50 A 50% solution of acid



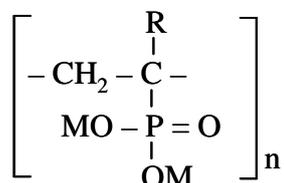
It has also been proposed as a scaling inhibitor Brikvest 422-25; 543-50A, 231-253, Trikvest ADRA-60A, and others.

Currently in the industry on a wide scale use of mineral salt scaling inhibitor, conventionally called "IOMS 1". IOMS-1 is an aqueous solution of the sodium salt aminometilenfosfonovoy density of 1,35-1,41 kg / m<sup>3</sup>, obtained by reacting a reagent with ammonium chloride and phosphorous acid with formalin. [32]

Samborski IV . Et al receives proposed inhibitor of deposition of mineral salts - a mixture of organic aminophosphonates obtained by phosphorylation with formaldehyde and phosphorous acid mixture of polyethylene polyamine, monoethanolamine, urea, hexamethylene diamine, ammonium chloride in an acidic medium followed by neutralization [33].

A high degree of mineral salt deposition prevention is achieved when using a composition consisting of ethylene glycol, polyethylene polyamine-N-metilmethylphosphonic acid or its salt.

Proposed as an inhibitor of the formation of carbonate sediments, sulfate and calcium phosphate polymer with an elementary link:



Wherein M = H or monovalent metal cation: R-alkyl C<sub>1</sub> - C<sub>6</sub> (preferably -CH<sub>3</sub> and C<sub>6</sub>H<sub>13</sub>). This inhibitor protects against scale-formation at a concentration of 0.5 - 500 mg / dm<sup>3</sup>.

As the mineral salt deposition inhibitor was proposed to use an inhibitory composition comprising fosfonkarbonovuyyu acid of the general formula (HO) 2P(O) C(R) CH<sub>2</sub>COOH) COOH group, such as 2-fosfonbuten-1,2,4-tricarboxylic acid [34].

To prevent corrosion and salt deposits provides compositions comprising a water soluble copolymer of acrylic acid and allilgidroksipropilsulfanata with monomer ratio of from 30: 1 to 1:20 and a water soluble zinc compound phosphonate [35].

It is established that the effectiveness of inhibitors of salt deposits depends essentially on the nature of the sediments, the degree of supersaturation of the solution, the temperature, pressure and pH.

Currently, the practice of water supply and water treatment as an inhibitor of scale found wide applications phosphorus chelators. In [36] proposed as scale inhibitor and corrosion used organic phosphonates with Na tripolyphosphate.

Composition at a concentration of 20-30 mg / l and a ratio of 1: 1 is an inhibitor of complex operations against corrosion and scaling. Although, in the industry have been successfully used as a scale inhibitor organic phosphonates -. HEDP, NTMP, IOMS-1, the DFT-1 and others are inherent in them significant drawbacks - the use of toxic deficient compounds - phosphorus trichloride and phosphorous acid. In the production of organic phosphonates mainly phosphorus trichloride is used as the phosphorylating agent. As a result of phosphorylation of one molecule of phosphorus trichloride is allocated 3 moles of very corrosive hydrochloric acid is capable of, which requires the use of expensive equipment. Furthermore, the temperature range of most organic phosphonates do not exceed 120 ° C, which limits their widespread use.

As scale inhibitors provides the use of anionic polymers containing - vinyl-2-pyrrolidone or other vinyl amides and maleic anhydride or maleic acid with a molecular weight 5 - 40 million, comprising 40 - 50 mol%. N-vinyl-2-pyrrolidone or N-methyl-N-vinylacetamide and 20-25% Methacrylate [37].

The inhibitor is used at a concentration of 0.5 - 100 mg / dm<sup>-3</sup> at pH 8.5 M. Qamhah et al. Investigated the dependence of the phase composition of scale inhibitor concentration in the solution [38]. It is shown that the scale inhibitors have different effects on the phase composition of scale. Developed composite compositions. Some, along with a high inhibiting capacity sedimentation processes have improved performance [39]. To prevent precipitation, including calcium phosphate, proposed to be introduced into the water 0.1 -. 200g inhibitor per million parts of water, the copolymer composition consisting of 50-90% acrylic acid, methacrylic acid or salts thereof 50 to 60% itaconic dialkyl ether acid [40].

In aqueous systems having and proposed installations parogenirirouyuschi used as deposition inhibitors, water-soluble polymers [41].

To remove carbonate scale proposed to use sulfanilic acid [42]. Defined technological parameters of purification. It is found that the sulfanilic acid can be used for cleaning metal surfaces from scale to 50C and at a concentration of less than 10%.

A method for preventing the formation of mineral deposits on the heat exchange surface by formation inhibitors dosing polymeric sulfonates or sulfates, or mixtures thereof, such as cellulose sulfate, polivinilsulfonovye acid polistirolsulfaty copolymer of styrene and maleic anhydride in a temperature range of 20 – 85°C, and the inhibitor concentration 10-80 mg / l [43].

It is established that, when introduced into the water mixture of zinc chloride (34-40%) sulfuric acid (12-20%) in an amount of 0.5 - 3.0 mg / l zinc chloride, the degree of prevention of scaling is 31% [44].

One of the basic ways of inhibiting deposition of mineral salts, is to slow the process of transformation of hydrocarbons calcium to calcium carbonate, calcium carbonate difficulty stage mass transfer from the liquid phase into the solid [45].

As an inhibitor of calcium phosphate deposition in aqueous systems predlozhenf use polymer acrylic acid or methacrylic acid or their water soluble salts for inhibitor concentrations of less than 2 mg / dm<sup>3</sup> [46].

V.B. Sherblinnym studied the mechanism of action of inhibitors on motor surfaces [47]. It was found that the carboxyl inhibitors prevent the formation of deposits, generally by forming a metal absorption film on the surface and reduce the deposition of the adhesion strength thereto. Silicon organic inhibitors prevent the formation of deposits due to the stabilization of the solution supersaturation, reducing the rate of crystallization of calcium sulfate, increasing the induction effect. Polymers based on maleic anhydride copolymer thereof with N-alkyl-N-vinyl amide or -N-vinillaktonami been used as calcium deposit inhibitors fosfanata [48].

As scale inhibitor is a composition consisting of polymer (polymaleates, polyacrylates copolymers akrilmetakrilaty, akrilmetakrilatitakoniates et al.) And aliphatic polyamines of the formula R - [NH - (CH<sub>2</sub>)<sub>3</sub>]<sub>n</sub> where aliphatic radical having 12 - 18 carbon atoms, n = 1 - 6 [49].

As an inhibitor of deposition of mineral salts was used N-phosphonomethylglycine or its salts [50].

To prevent scaling consisting of barium sulfate, or their use proposed

removal composition: citric acid (I), polycarbonic acid (II), alkilenpoliaminokarbonkarboxile acid (III). Value II, III from 0.5: 1 to 1: 1, II, III 0.002: 1 to 0.2: 1, the pH -9,5-10 [51].

As inhibitor Ca-phosphoric acid proposed to use copolymers of acrylic acid 3-akrioloamido-3-methylbutanoic acid [52]. With a molecular weight of 5 - 100 thousand, additive amount of about 10 mg / l.

As an inhibitor of wide application salt deposits found water-soluble poly vinyl [53], copolymers of acrylic and methacrylic acid and methacrylate morfalina [54], phosphorous containing chelators [55], a copolymer of alkenes with unsaturated dicarboxylic acids or their anhydrides, [56], a mixture of carboxymethyl cellulose and its sodium salt, gluconic acid [57], a mixture of aliphatic hydroxy acids containing 2-5 carbon atoms, sodium silicate and water [58,59], and NTF nitriltrimetilmetylenfosfonic acid hydroxyetylidenedifosfonic acid (HEDP), amino containing sulfonate, oxidized polysaccharides [60] water-soluble polymers [61-63], cationic organic alkanes [64].

A composition for preventing scale deposition based on N-vinylformamide polymers, or N-vinylacetamide having a molecular weight of from 2,000 to 1 million composition is proposed to prevent scaling on the basis of inorganic HEDPA -. 25-38%, 20-31% alkanolamine, CH<sub>3</sub>OH or C<sub>2</sub>H<sub>5</sub>OH - 8 -18%, and water - the rest. A mixture of pyrophosphoric acid and copper sulfate in a molar ratio of 1: 1.15 - 1:25 proposed as inhibitors of hardness salts deposits. The mixture of copolymers of maleic anhydride, 2-acrylamido-2-metilpropansulfo new and 2-acrylamido-2-metilpropanfosfonovyh acids used as scaling inhibitor.

As scaling inhibitor provides a composition comprising 2.5-8% of a monocarboxylic acid, a dicarboxylic acid, 13-58% sodium adipate and component - the rest [65].

## CHAPTER II. EXPERIMENTAL PART

### 2.1 Reactants physical-chemical properties

1. *1-Hydroxyethylidenediphosphonic acid (HEDP) TC Uz. 6.1-53-95.*

2. Zinc oxide - colorless crystals.

The empirical formula	- ZnO
The molecular weight, u.e.	- 81,37
Specific weight, g / cm <sup>3</sup>	- 5,5 – 5,6
Melting point, ° C	- 2000 (52 атм.)
Boiling point, ° C	- 1050 (ВОЗГОН)
Solubility in water	- $1,4 \cdot 10^{-4}$ (28°C)

3. *Sodium hydroxide - colorless crystals.*

The empirical formula	- NaOH
The molecular weight, u.e.	- 40,14
Specific weight, g / cm <sup>3</sup>	- 5,5 – 5,6
Melting point, ° C	- 1400 (52 атм.)
Boiling point, °C	- 1050 (ВОЗГОН)
Solubility in water	- $1,4 \cdot 10^{-4}$ (28°C)

4. *Monoethanolamine - brand "technical". With a mass fraction of 98%. TC Uz. 6.1-76-92.*

6. The extraction phosphoric acid - TC 6.6-21: 2008

The evaporated extraction phosphoric acid contains in its composition: 26.52% -N<sub>3</sub>RO<sub>4</sub>; 0,356 - CaO; 1.2 - MgO; 0.54 - Al<sub>2</sub>O<sub>3</sub>; the rest - water (TU 6.6-21: 2008).

## **2.2. Preparation procedure zincate hydroxyethylidenediphosphonic acid in the presence of initiators**

Assuming that the polyhydric alcohols in an aqueous alkaline solution readily forms monoalkanolates that in the presence of a strong acid is given to a metal ion, restoring the original structure, as initiators selected these products available. The process is carried out as follows: to a reactor equipped with a mechanical stirrer and jacketed water is poured in an amount of 50 ml and 0.2-2.0 g of the polyhydric alcohol, is then added the calculated amount of hydroxyethylidenediphosphonic acid (10.6 g). Thereafter, the zinc oxide is added in an amount of 4.2 g and stirred until complete dissolution and to obtain a clear liquid. Then the reaction mixture was added (4.3 g) calculated amount of micronized sodium hydroxide and stirred vigorously. When this temperature is controlled within 23 - 25 ° C. The yield at least 98%.

## **2.3. A method of production inhibitor of scaling**

The process is carried out in the following sequence. The reactor was equipped with a mechanical stirrer and a jacket, the mixture was poured consisting of 50 wt% water and 50 wt% glycerol, and then added the calculated amount of hydroxyethylidenediphosphonic acid. Zinc oxide is added in portions and stirred until complete dissolution and to obtain a clear liquid. After the reaction mixture was added a calculated amount of 40% sodium hydroxide and stirred vigorously. When this temperature is controlled within 23 - 25 ° C. Continuing stirring bottoms residue of monoethanolamine.

The advantage of the proposed inhibitor is:

- high efficiency;
- low cost;
- availability of raw materials;
- lack of waste;
- simple equipment design.

The proposed method is as follows:

Experiment 1. In a reactor equipped with a jacket, a mechanical stirrer,

dropping funnel, thermometer interfere with 147 g of glycerin and 100 g of water under vigorous stirring, 238 g HEDPA. After complete dissolution HEDPA thereto is added 81 g of zinc oxide, with temperature control in the reactor with a thermometer (<25 ° C) directing the cold water in the reactor jacket. After added 40% aqueous sodium hydroxide solution in an amount of 210 g and stirring was continued until complete dissolution of the component. Then the reaction mixture was added to the residual oil 241.5 g of monoethanolamine in a ratio of 2: 1 to the total mass. Stirring was continued for 8-10 minutes.

Get moving liquid mass, readily soluble in water. When storing the self-education phase is not observed.

Experiment 2. In a reactor equipped with a jacket, a mechanical stirrer, dropping funnel, thermometer and prevent 735g glycerol 500g of water under vigorous stirring, 1190 g HEDPA. After complete dissolution HEDPA thereto was added 405g of zinc oxide, with temperature control in the reactor with a thermometer (<25C), directing the cold water in the reactor jacket. After added 40% aqueous sodium hydroxide solution in an amount of 1050g, and stirring until complete dissolution of the component. Then the reaction mass is added 1207,5g bottoms monoethanolamine in a ratio of 2: 1 to the total mass. Stirring was continued for 8-10 minutes.

Corrosion efficiency resulting product fluctuates in the aisles of 80 - 99%, and the inhibition efficiency of 80 - 95%.

Experiment 3. In a jacketed reactor, with mechanical stirrer, dropping funnel, thermometer interfere 100 cm<sup>3</sup> and 100 cm<sup>3</sup> of glycerol water with vigorous stirring, 238g HEDPA. After complete dissolution HEDPA thereto is added 81g of zinc oxide, with temperature control in the reactor with a thermometer (<25C), directing the cold water in the reactor jacket. After added 40% aqueous sodium hydroxide solution in an amount 200sm<sup>3</sup> and stirring was continued until complete dissolution of the component. Then the reaction mixture was added to the residual oil 241.5 g of monoethanolamine in a ratio of 2 : 1.

Corrosion efficiency resulting product fluctuates in the aisles of 80 - 99%,

and the inhibition efficiency of 80 - 95%.

#### **2.4. Method for determining the water hardness**

Called hardness of water therein total content of calcium and magnesium compounds dissolved in water.

The method is based on the ability of calcium and magnesium cations to yield Trilon B more stable compounds than the indicator complexes  $\text{Ca}^{2+}$   $\text{Mg}^{2+}$  and destroys them with indicators, restoring the free indicator color.

For the preparation of titrated solutions produced fiksanaly Trilon B (disodium edetate) in boxes consisting of ten vials. Each vial is intended for the preparation of 1 liter. 0,1 N solution.

The volumetric flask is inserted into a special funnel with "brisk" and investing in a vial funnel fiksanaly hitting the "striker" end the deepening of the ampoule, then pointed his wand break the glass lateral groove and density transfer the contents of the vial in a volumetric flask. After that, wash with distilled water from a wash vial wall inside the funnel and "striker", washing away all the lingering crystals reagent in volumetric flask. The flask contents were stirred until dissolution of the crystals and bring the volume of solution in the flask to the mark. The solution in the flask was stirred again, after which it becomes unfit for consumption. In the absence taken fiksanaly 18.6 g sample of dry powder and Trilon B was dissolved in 1 liter of distilled water, obtain 0.1N. solution. The titer of the resulting solution is set 0.1N.  $\text{MgSO}_4$  solution.

Ammonium buffer mixture is used to determine the stiffness trilonometric indicator XTC (hromtemnosiny). Dissolve in distilled water g. 20 Ammonium chloride ( $\text{NH}_4\text{Cl}$ ), 100 ml of 25% ammonia ( $\text{NH}_4\text{OH}$ ) and the volume adjusted to one liter with distilled water.

Indicator XTC, acid chrome dark - blue 0.5 g of the reagent was dissolved in 10 mL of ammonium buffer mixture with adjusting the volume to 100 mL alcohol color change from pinkish - lavender in hard water to blue - purple in soft water.

An indicator chromogen black, Eriochrome Black ET - 00.

0.5 g of the reagent was dissolved in 10 mL of ammonium buffer mixture with adjusting the volume to 100 mL alcohol color change at the end of the titration hardness lilac - red to blue - blue.

Progress in determining

Measuring cylinder, measure 100 mL of sample, it is poured into a conical flask of 250 ml, 5 ml of ammonia - buffer solution, 6 - 7 drops of indicator and titrate colored pink zhestk5ost 0.1N. Trilon B solution to change its color to blue - purple or (blue for low stiffness) with vigorous stirring of the sample.

Is calculated according to the formula:  $X_{06} = A \cdot K \text{ mg-Eq} / L$

where Jobe - total hardness analyzed soda mg - equivalent / l.

A - expense of 0.1N. Trilon B in the titration, in mL.

K - coefficient calculation decinormal Trilon B.

At low water contents stiffness (after sodium cation filters of stage II) titration are 0.01 n. Trilon B, and the calculation is made according to the formula:

$$X_{06} = 0,1 A \cdot K \text{ МГ} - \text{ЭКВ/Л}$$

where A - expense of 0.01. Trilon B.

K - coefficient of normality of Trilon B.

In this study, laboratory experiments using water deposits at Northern Urtobulak UK "Mubarekneftegaz" whose analysis is given in Table. 2.1.

Table 2.1

**Analysis\* of the water at the North Urtabulak UDP "Mubarekneftegaz"**

Cations	Contents per liter			Other definitions	
	mg/l	mg-eq/l	%-eq/l		
Na <sup>+</sup>	21332	927,50	65	Hardness mg-eq/l Total	505,00
K <sup>+</sup>	30	0,77	-	Disposable	
NH <sub>4</sub> <sup>+</sup>	150	2,42	-	Carbonate	4,30
Ca <sup>2+</sup>	8000	400,00	28	non-carbonate	500,70
Mg <sup>2+</sup>	1276	105,00	7	pH	7,20
Fe <sup>3+</sup>	<0,3			CO <sub>2</sub> free. mg/l	н/о
Fe <sup>2+</sup>	<0,3			CO <sub>2</sub> agr. mg/l	н/о
Total		1435,69	100	Oxidability mg O <sub>2</sub> /l	
Anions	Contents per liter			SiO <sub>2</sub> mg/l	н/о
	mg/l	mg-eq/l	%-eq/l	H <sub>2</sub> S mg/l	7,16

Cl <sup>-</sup>	49644	1400,00	98	PO <sub>4</sub> mh/l	
SO <sub>4</sub> <sup>2-</sup>	1230	25,63	2	Hard scale of experiment	84614
NO <sub>2</sub> <sup>-</sup>	<0,01			Calculated.	82150
NO <sub>3</sub> <sup>-</sup>	357	5,76	-	Physical properties: Transparency	позрач.
CO <sub>3</sub> <sup>-</sup>	–			Taste	рассол
HCO <sub>3</sub> <sup>-</sup>	262	4,30	-	Color	бесцветная
Total		1435,69	100	Smell	

*\*Analysis of the water was carried out by the State Committee of the Republic of Uzbekistan on Geology and Mineral Resources of SE SPC "Geology of hydro resources."*

As seen from the table, the water Urtabulok North PDP is particularly hardness (505.0 meq / l), the precipitate composition of mineral salts (Na<sup>+</sup> = 32.5%; Ca<sup>2+</sup> = 14%; Mg<sup>2+</sup> = 3,5%, Cl<sup>-</sup> = 54; SO<sub>4</sub><sup>2-</sup> = 1 (% eq / l)), and the content of mechanical impurities and hydrogen sulfide. The presence of SO<sub>2</sub>, H<sub>2</sub>S, and Cl<sup>-</sup> ions, NH<sub>4</sub><sup>+</sup>, etc. Several times to increase the aggressiveness of the reservoir fluid used.

### **2.5. Determination of alkalinity of the raw water and boiler water**

The method is based on the titration of alkaline substances contained in the boiler water and raw, titrated normal acid solutions.

The alkalinity of natural waters, both surface and subsurface, usually caused by the presence in it of bicarbonates and humates. Alkalinity boiler water therein due to the presence of alkali, phosphates and silicates as well humates. The alkalinity number is expressed milligram equivalents of alkaline substances in the water analyzed liter (mEq / L).

*Ware and Reagents: Cylinder measuring 100 ml in accordance with GOST 1770-74.*

Conical Flask Kn 250 ml according to GOST 25336-82.

Burette 25 ml according to GOST 20292-74.

0,1n hydrochloric acid solution.

Indicators - phenolphthalein and methyl orange.

*Analysis:* In a conical flask with a capacity of 250-300 ml taken 100 ml of the analyzed water, add 2-3 drops of phenolphthalein alcohol solution, and when a

magenta dye is titrated with 0.1 N acid consumed for the titration with phenolphthalein indicator. Then add 2 drops of methyl orange indicator solution and continue titration until the color changes from yellow to orange. Record the consumption of acid spent on titration with methyl orange indicator. Titration was carried out at continuous stirring and the acid is added dropwise.

*Processing of the results*

The alkalinity of the water in mg-Eq / l is calculated using the following formulas:

$$III_{\phi\phi} = \frac{a \cdot K \cdot 1000 \cdot N}{V}$$

$$III_{mo} = \frac{b \cdot K \cdot 1000 \cdot N}{V}$$

$$III_{\text{общ}} = \frac{(a + b) \cdot K \cdot 1000 \cdot N}{V}$$

Where: Off, Schmo - alkalinity of the water, respectively when titrated to phenolphthalein and methyl orange, mg-Eq / L;

Schobsch total alkalinity of water, mg-Eq / L;

and - at the expense acid to phenolphthalein titration in ml;

b - expense acid to methyl orange titration, ml;

N - normality of standard acid solution;

K - coefficient of titrated acid solution;

V - volume of water taken for analysis of the sample, ml.

For the result of the analysis used the arithmetic mean of the results of two parallel determinations, the relative discrepancy between them does not exceed the allowable discrepancy of 20% at a confidence level of P = 0.95.

**2.6. Methods of determining the efficiency of inhibition**

Determination of inhibition efficiency by using an indicator of salt deposits - ISO-1

Equipment, tableware, reagents and solutions. LED salt deposits ISO-1, a copyright certificate USSR № 1536325 from 25.10.89.

Laboratory balance General purpose of the second class of GOST 24144 - 80E with a limit weighing up to 200 grams, weighing permissible error of  $\pm 0.25$  mg, 0.05 mg price division.

Glass GOST 25336-82.

Cylinder 1-1031-25, 1-100: 1-1000 GOST 1770-74 E

Burette 06.02.10 GOST 2025-74 E

Pipette 2-1-2: 1-1-1, 2-1-5: 02/02/50 GOST 20297-74 E

GOST 4328-77 sodium hydroxide, the solution concentration  $C(\text{NaOH}) = 0.1 \text{ mol / dm}^3$

The hydrochloric acid concentration  $C(\text{HCl}) = 0.1 \text{ mol / dm}^3$ .

Distilled water GOST 6709-72.

Disodium salt of ethylenediamine - N, N, N, N - tetraacetic acid solution concentration of  $0.025 \text{ mol / dm}^3$ .

Murexide (LED) TU 6-03-05-161-74

*Preparation for the test*

Preparation of inhibitor solution IOMS - extra. 0.025 g of commercial inhibitor was dissolved in distilled water in a volumetric flask of 100 cm<sup>3</sup> and the volume is brought up to the mark with water.

*Carrying out the test*

The heat-resistant glass beaker 250 - 500 cm<sup>3</sup> prevent lead electrode and pour 250 cm<sup>3</sup> of water analyzed. The glass of water placed on an electric hot plate and heated to temperature 70-75°C.

The glass electrode is lowered, X18H9T made of steel so that the rotating electrode surface is below the upper liquid level by 5-7 mm.

Lead electrode connected to the positive terminal and the rotating electrode to the negative terminal.

Consistently turning off the motor and switch on the instrument panel. With variable resistance microammeter set at 17 mA current.

The electrode is rotated depending on the extent of mineralization within 30 min. When the water temperature  $90 \pm 5^\circ\text{C}$ .

After the exposure is turned off include the power supply and the motor from the mains.

Raise the rotating electrode and washed it with distilled water.

The beaker is poured 50-100 cm<sup>3</sup> 10 cm<sup>3</sup> of 0.1 N hydrochloric acid. The glass sink rotating electrode and include the motor. Exposure time - 1-2 minutes. Again, the electrode was washed with distilled water. Draining is collected in the same beaker. electrode surface is rubbed with a tampon moistened with distilled water and washed with distilled water again.

Neutralize the acid solution in the beaker 100 cm<sup>3</sup>, 1 N NaOH alkali solution, and the solution quantitatively transferred to a titration flask.

Then the sample is added an additional 5 ml of 0.2 NaOH solution to create an alkaline environment.

Calcium ions (Mg) titrated 0.025 N solution of Trilon B in the presence of an indicator - murexide until the color from pink to lilac - purple.

The amount of deposits on the electrode (in terms of CaCO<sub>3</sub>) was determined by the formula

$$P_{CaCO_3} = V \cdot N \cdot 50$$

Where V – the amount that went to the titration of Trilon B, ml.

N – normality of Trilon B solution

50 – CaCO<sub>3</sub> equivalent.

Water can be considered stable, if the volume difference of 0.025 n Trilon B solution that went to the titration does not exceed 0.5 cm<sup>3</sup>.

Determination of the effectiveness of the calculation processing of aquatic systems.

The new portion of water was added required amount of test reagent in a 0.1% solution.

Efficiency of chemical treatment was calculated using the formula.

$$\Theta = \frac{P_1 - P_x}{P_1} \cdot 100$$

where  $P_1$  - the amount of deposits in the experiment without reagent mg.

$P$  - the amount of deposits in the experiment with a reagent mg.

Water is considered stable and effective treatment if the calculated value is not less than 90%.

## CHAPTER 3. THE DISCUSSION OF OBTAINED RESULTS

### 3.1. Synthesis of Zn-HEDP and their inhibitory properties

Patent works analysis shows that in the preparation of Zn-HEDP plays a significant role sequence of operations: HEDP added to a solution of metal oxide provide exposure for 0.5 - 1.5 hours, and the alkali added after a finely divided powder or a solution. As noted by the authors, the order of introduction of reactants violation leads to contamination of the desired product or impossibility to obtain them in a crystalline form. For example, adding alkali to the solution results in the formation HEDP disubstituted salts of HEDP acid which precipitates in the form of sticky clumps precipitate unable to cooperate fully hereinafter with powdered metal oxides, which envelop surface with lumps. The need exposure after the addition of metal oxides to HEDP is because immediately after the addition of the metal oxide to HEDP formed metastable complex and the introduction of alkali solution to this complex, due to the increase of pH, is partially converted to a water-insoluble tetra-substituted metal complex pollutant the desired product.

We have a process for producing Zn-HEDP in the presence of an initiator. Assuming that the polyhydric alcohols in an aqueous alkaline solution readily forms monoalkanolaty that in the presence of a strong acid is given to a metal ion, restoring the original structure, as initiators selected these products available. The process is carried out as follows: to a reactor equipped with a mechanical stirrer and jacketed water is poured in an amount of 50 mL and 0.2 - 2.0 g of a polyhydric alcohol, then add the calculated amount of HEDP acid (10.6 g). Thereafter, the zinc oxide is added in an amount of 4.2 g and stirred until complete dissolution and to obtain a clear liquid. Then the reaction mixture was added (4.3 g) calculated amount of micronized sodium hydroxyl and stirred vigorously. When this temperature is controlled within 23 - 25 ° C. The yield at least 95%.

The effect of the ratio of the initiator: water on yield and reaction formation of Zn-HEDP (Table 1).

Table 3.1

Effect initiator ratio: water on product yield and reaction forming Zn-HEDP

№	Initiator	Ratio initiator : water, g/g	Duration, minutes	Yield Zn- HEDP, %
1	Ethylene glycol	0,4:19,6	120 – 130	91,0
		0,8:19,2	140 – 145	93,0
		1,2:18,8	> 150	94,0
		1,6:18,4	> 150	-
		2,0:18,0	> 150	-
2	Glycerol	0,4:19,6	60 – 65	96,0
		0,8:19,2	30 – 35	97,0
		1,2:18,8	20 – 25	97,0
		1,6:18,4	< 20	-
		2,0:18,0	< 20	-
3	Lemon acid	0,4:19,6	20 – 22	96,0
		0,8:19,2	15 – 18	94,0
		1,2:18,8	10 – 12	90,0
		1,6:18,4	< 10	89,0
		2,0:18,0	< 10	81,0

As can be seen from Table 1, the use as initiator polyol is glycerol reaction time 30 - 35 min, and the initiator ratios: 0.8 water: 19.2 g / g, the final product yield in this case is not less than 97%.

The composition and structure of the resulting product found by elemental and spectral analysis and gas chromatography-mass spectrometer.

To determine the elemental composition of the product, we carried out a spectral analysis instrument ICP-MS (mass spectrometer inductively coupled plasma) AT 7500a.

Laboratory tests IOMS, and Zn-HEDPA HEDP carried out in the temperature range 70 - 90 ° C and concentrations of 3 - 5 g / m (Fig. 3.3-3.5).

An analysis of the data obtained, it should be noted that during the laboratory testing period there is a slight efficiency IOMS-1. Maximum efficiency antinakupnogo complexone action at 90 ° C is reached at a dose of 5 mg / kg = 68.0%. When dosing IOMS-1 with a concentration of 3 mg / kg and 4 mg / kg total water hardness does not change, because of which it follows that at a given temperature, there is no need to dose 1 IOMS nyzhe a concentration of 5 g / m.

The maximum decrease in total hardness at 80 ° C, occurs when dosed IOMS 1 to 5 g / m, the maximum efficiency of action antinakupnogo IOMS-1 is achieved while 86.0%. However, the effectiveness of this complexone is a low index, which can not provide beznakupnoy thereby and safe mode of thermal power equipment.

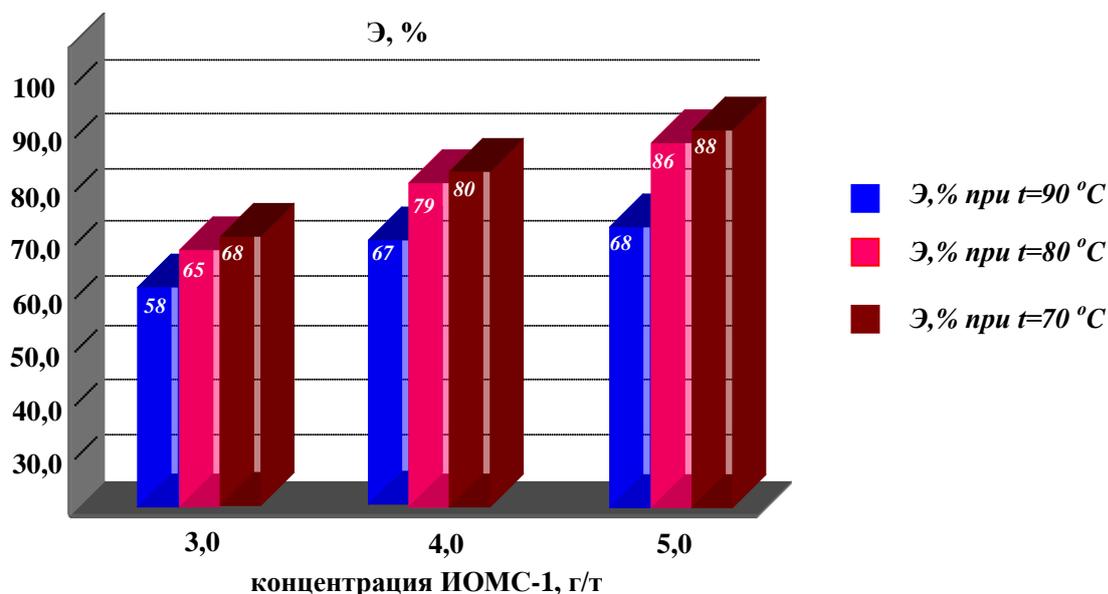


Figure 3.3. Efficacy IOMS-1, depending on the temperature

At a temperature of 70 ° C maximum efficiency is achieved when dispensing IOMS-1 at a concentration of 5 g / t = 88.0%. It should be noted that at 70 ° C additional experiments with higher concentration IOMS-1, for evaluation of properties were carried nakipeobrazuyuschih. The result is that at higher dosing IOMS-1 at a concentration of 5.5 g / t inhibitor efficiency decreases, indicating that the complexone inexpedience dosing of more than 5 g / m.

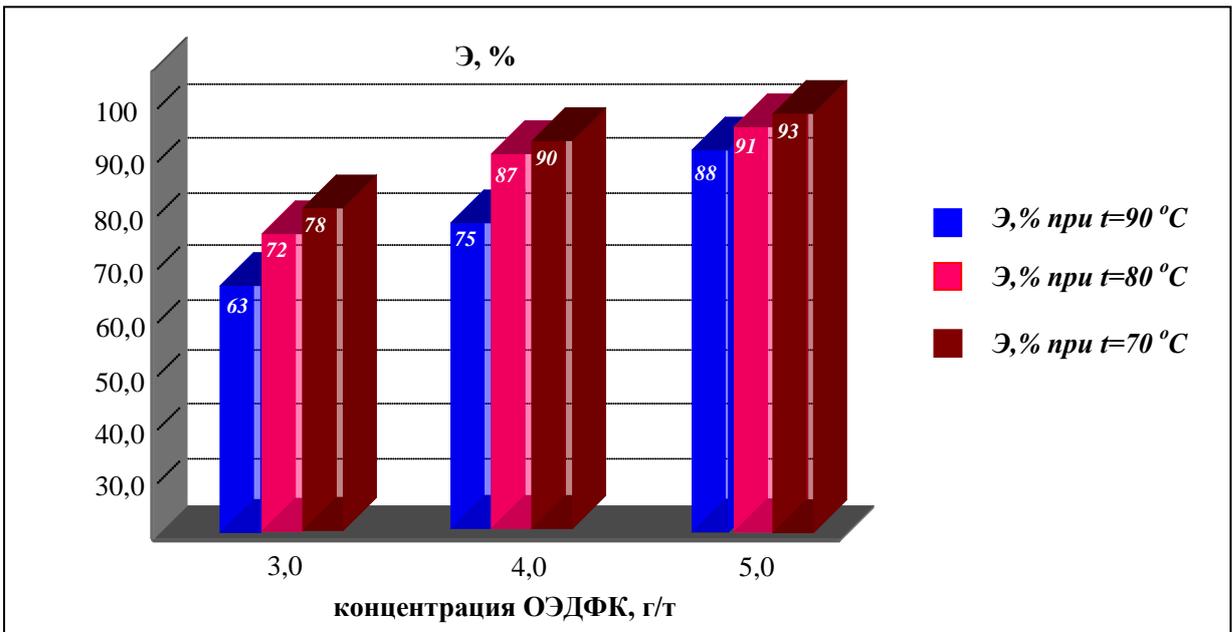


Figure 3.4. HEDP Effectiveness versus temperature

From the results of laboratory tests (Fig.3.4) that HEDPA effectiveness as an inhibitor of scale increases with increasing chelator concentrations in water at a concentration of 5 g / m provides protection against scale deposition at the temperature of 70 ° C - 93.0% at 80 ° - 91.0%, at a temperature of 90 ° C - 88.0%. The optimum concentration of initial water HEDPA amounted to 5 g / m. When processing HEDPA water can note a stable constant reduction of the total hardness. When a given chemical composition and temperature of water in the range 70-90oS reagent inhibiting effect to prevent scale formation can be considered satisfactory.

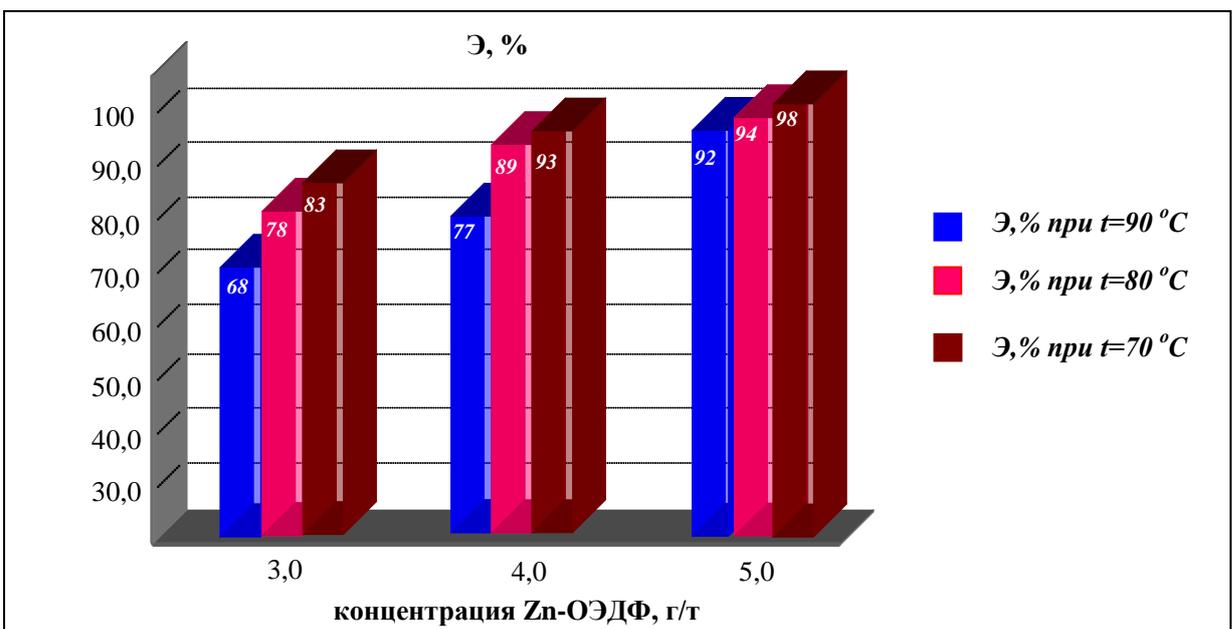


Figure 3.5. DU-X Effectiveness versus temperature

As shown in the graph (Figure 3.5) Zn-HEDP efficiency increases with increasing concentration and with 5 g / tonne provides protection at the temperature 70 ° C - 98.0% 80 ° C - 94.0% and at 90 ° C - 92.0% . Kompleksonatov high efficiency can be explained by the fact that the chelating agent forms stable complexes with almost all cations including cations of alkali and alkaline earth metals, were very effective for preventing fouling of sparingly soluble compounds such as carbonates, sulfates and calcium phosphates. In particular, Zn-HEDP effective for calcium carbonate is relatively ineffective in the case of calcium sulphate and is one of the most effective inhibitors of calcium phosphate precipitation. Moreover, of Zn-HEDP is used not only to correct water chemistry, but for the washing of water heating equipment and pipelines from the previously formed deposition.

Thus, in these conditions, the test most effectively inhibit scale deposition inhibitor has Zn-HEDP. This preparation can be recommended for the protection of oil production and refining equipment.

### 3.2. The technology of obtaining Zn-HEDP and scale inhibitors based on them

Based on these results the technology of producing Zn-HEDP and scale inhibitors based on them is suggested (Fig. 3.6).

Process flow diagram of the production of an inhibitor of deposition of mineral salts

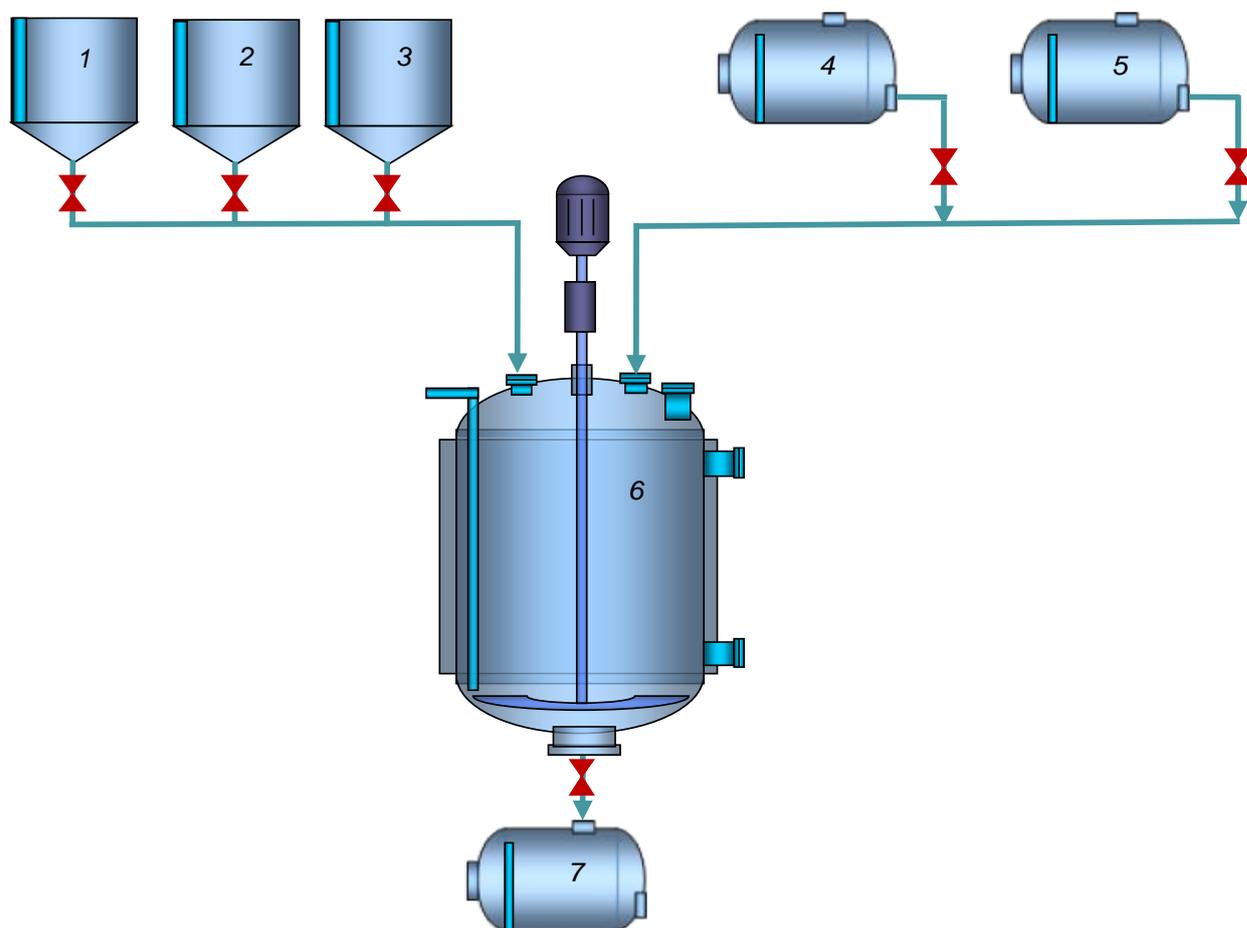


Figure 3.6. Process flow diagram of the production of an inhibitor of deposition of mineral salts.

1, 2, 3 - HEDPA bins, ZnO, glycerol; 4,5 - tanks for vacuum distillation bottoms monoethanolamine; 6 - reactor; 7 - tank for the finished product (an inhibitor of deposition of mineral salts)

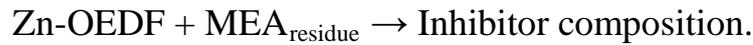
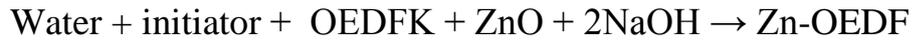
The reactor of item 1 pos.6 hopper receives a certain amount of water and glycerol. With vigorous stirring HEDPA. Stirring was continued until complete dissolution HEDPA, after which the reactor napravlyut zinc oxide. galvanizing reaction is continued until a clear thick liquid. Stirring is continued for 30 - 40

minutes. Then the reaction mixture was added 40% aqueous sodium hydroxide. The reaction mixture zagusteyti obtained kashetsu without stopping peremshivaniya monoethanolamine fed into the reactor - the bottoms of vacuum distillation residue of monoethanolamine, vazimodeystvie continued Thesen 40 - 50 minutes. The finished product is poured into the tank poses. 9.

## MATERIAL BALANCE OF THE PROCESS

Material balance of the technology of the production of inhibitors is calculated for  $G = 100 \text{ t / year}$ , which is the technology selected. In this process, the device periodically working reactors. Step-by-step process carried out in the same cycle of the device.

The product that made in the process is inhibitor composition, structure of inhibitor composition is as follows:



In this process, mass ratio of monoethanolamine : residue of MEA is 1:1. Water: initiate: OEDFK: ZnO: NaOH ratio is based on the results of the experiment, 50: 1.0: 10.6: 4.2: 4.3 ratio. According to this process, the amount of unwanted products.

$$G_{\text{composite}} = 100 \text{ t / year} = \frac{100 \cdot 10^3}{300 \cdot 4} \text{ kg / part} = 83,3 \text{ kg / part}$$

$$G_{\text{MEA}} = \frac{83,3}{2} \text{ kg / part} = 41,66 \text{ kg / part}$$

$$G_{\text{Zn-OEDF}} = G_{\text{MEA}} = 41,66 \text{ kg / part}$$

$$G_{\text{Suv}} = G_{\text{Zn-OEDF}} \cdot \frac{\omega_{\text{suv}}}{\sum \omega_i} = 41,66 \cdot \frac{50}{50 + 1,0 + 10,6 + 4,2 + 4,3} \text{ kg / part} = 29,71 \text{ kg / part}$$

$$G_{\text{initiator}} = G_{\text{Zn-OEDF}} \cdot \frac{\omega_{\text{initiator}}}{\sum \omega_i} = 41,66 \cdot \frac{1,0}{50 + 1,0 + 10,6 + 4,2 + 4,3} \text{ kg / part} = 0,603 \text{ kg / part}$$

$$G_{\text{OEDFK}} = G_{\text{Zn-OEDF}} \cdot \frac{\omega_{\text{OEDFK}}}{\sum \omega_i} = 41,66 \cdot \frac{10,6}{50 + 1,0 + 10,6 + 4,2 + 4,3} \text{ kg / part} = 6,3 \text{ kg / part}$$

$$G_{ZnO} = G_{Zn-OEDF} \cdot \frac{\omega_{suv}}{\sum \omega_i} = 41,66 \cdot \frac{4,2}{50 + 1,0 + 10,6 + 4,2 + 4,3} \text{ kg / part} = 2,5 \text{ kg / part}$$

$$G_{NaOH} = G_{Zn-OEDF} \cdot \frac{\omega_{suv}}{\sum \omega_i} = 41,66 \cdot \frac{4,3}{50 + 1,0 + 10,6 + 4,2 + 4,3} \text{ kg / part} = 2,56 \text{ kg / part}$$

Table 5

Material balance table of technological process

Raw materials:			Products		
№	Name	Quantity (kg/part)	№	Name	Quantity (kg/part)
1.	Water	29,71	1.	Inhibitor of scales	83,333
2.	Initiator (glycerol)	0,603			
3.	HEDP acid	6,3			
4.	ZnO	2,5			
5.	NaOH	2,56			
6.	MEA residue	41,66			
Total:		83,33	Total:		83,333

# GENERAL INDUSTRIAL REQUIREMENTS OF LABOUR IN THE PRODUCTION

## General provisions

### *Dangerous and harmful production factors*

In the production process workers can act dangerous and harmful production factors according to GOST 12.0.003.

### *Physical dangerous and harmful production factors:*

- \* moving machinery; moving part of the production equipment; moving products, preparations and materials; collapsing structures;
- \* increased dust and fumes in the air of the working area;
- \* high or low surface temperatures of equipment and materials;
- \* Increased go low air temperature of the working area;
- \* high level of noise in the workplace;
- \* increased vibration levels;
- \* elevated levels of infrasonic waves;
- \* elevated levels of ultrasound;
- \* high or low humidity;
- \* high or low air mobility;
- \* high or low air ionization;
- \* elevated levels of ionizing radiation in the work area;
- \* the increased value of the voltage in an electrical circuit, circuit which can pass through the human body;
- \* increased level of static electricity;
- \* elevated level of electromagnetic radiation;
- \* high voltage electric field;
- \* high voltage magnetic field;
- \* the lack or insufficiency of natural light;
- \* the lack of illumination of the working area;
- \* increased brightness of light;

- \* reduced contrast;
- \* direct and reflected reflection;
- \* increased pulsation of luminous flux;
- \* elevated levels of ultraviolet radiation;
- \* increased level of infrared radiation;
- \* radiation radionuclide contamination of the working area;
- \* sharp edges, burrs, roughness on the work-piece surfaces, tools and equipment;
- \* posting jobs at a considerable height with respect to the surface of the ground (floor);

***Chemical hazardous and harmful production factors;***

- \* toxic;
- \* annoying;
- \* sensitizing;
- \* carcinogenic;
- \* mutagenic;
- \* affect reproductive function.

This group includes pesticides, agrochemicals, fertilizers, gases, decomposition of organic substances, waste gases, welding sprays, increased concentrations of dust containing CO<sub>2</sub> and so on.

***Biological hazardous and harmful production factors:***

- \* pathogens (bacteria, viruses, rickettsia, spirochetes, fungi, protozoa) and their metabolic products;
- \* macro-organisms (plants and animals).

***Psychophysiological hazardous and harmful production factors***

- \* physical overload (static and dynamic);
- \* Neuropsychiatric overload (mental tension, overexertion, monotony of work, emotional overload).

***The sources of hazards can be:***

- \* external meteorological factors (wind, rain, storm, solar radiation, low or cold outside air temperature, ice, etc.);
- \* wrong modes of technological systems;
- \* moving vehicle;
- \* machinery technological systems for the treatment of soil, for the plants and animal care;
- \* utilities;
- \* equipment that works under pressure;
- \* used pesticides and agrochemicals;
- \* electrified equipment, tools and wiring;
- \* manual work, causing physical and neuro-psychological overload.

According to the Law of Uzbekistan “Labor protection” the owner is obliged to create in each structural unit and in the workplace working conditions according to the requirements of normative acts, as well as ensure that the rights of workers guaranteed by the legislation on labor protection.

***General measures to prevent negative effects on the environment.*** Given the close relationship between the health of workers and the environment, technology development, engineering machinery and equipment, as well as the organization of production processes in agriculture at all stages must be implemented subject to the minimum possible negative effects on the environment and should be achieved by:

- \* application tillage technology with minimal disruption it;
- \* Use pre-packaged in containers of small volume of mineral fertilizers;
- \* improve pesticide storage resources on farms and preventing them from entering into water bodies;
- \* eliminate leaks in the connections of fuel and oil lines of machinery and equipment;
- \* using special drives for the collection and temporary storage of used lubricants.

Activities farms for environmental protection should be governed by the Law of Uzbekistan "On Environmental Protection", Law of Uzbekistan "On Pesticides and Agrochemicals" DNAOP 0.03-3.01-71 (SNN<sup>o</sup>245-71), GOST 17.1.3.11, SanPiN 4630 -88, ONTP 8-85, these regulations and other applicable regulations.

The range, applications of pesticides, standards and frequency of treatments must meet DNAOP 0.03-1.12-98 and the List of pesticides and agrochemicals permitted for use in Uzbekistan, the annex to the list and the instructions for the safe use of pesticides, developed by the Ministry of Health institutions, agreed with the Ministry of Environmental and other interested organizations.

Treatment plants, animals and objects of pesticides should be done taking into account the economic threshold of harm, the development of plant diseases and weeds, weather forecast.

### **Requirements for the territory, industrial premises and sites**

***Territory.*** The territory of the enterprise shall comply with DBN B.2.4-3-95, sanitary design standards and fire safety rules in Uzbekistan.

The area must be flat, planned so that the waste water has been provided to the drains of the buildings, grounds, driveways, walkways.

Access to the employees of the enterprise should be carried out through the communicating room. The passage of people through the gate is not allowed to transport.

For the storage of materials and goods in the territory of the enterprise must be provided a special area with racks and stands. Storage must exclude the fall of materials.

Firefighters ponds, ditches and other structures that were organized for the production needs, should close or fence, and at night to ensure their coverage. Do not use fire ponds for other purposes.

On the territory of the enterprise for the passage of transport and equipment

must be roads and pedestrian walkways paved (asphalt, concrete and so on). Carriageway roads and footpaths should be systematically cleaned from mud and snow, and in the dark - covered.

In the case of crossing railway tracks with pedestrian crossings and roads and crossings over the railway line must be arranged, equipped with warning signs, audible and visual alarm.

The width of the road with one-way traffic should be 1.8m, and at the bilateral - at a width of 2.7 m available on enterprise machines.

Reservoirs, tanks, and other containers for storage of fuels and lubricants should be placed in the designated areas as required by VBI and V.2.2-58.1-94 DNAOP 0.01-1.01-95.

Not allowed storage of materials, construction of various buildings, vehicles parking in the protected zone of the high-voltage power line without coordination with the organization that operates the line.

Danger zones on the territory of the enterprise, transportation routes, crossings, industrial premises and facilities, on-site, the workplace must be identified by the safety signs according to GOST 12.4.026 and fenced.

***Industrial premises.*** Space-planning and design solutions premises and facilities, equipment of water supply, sewerage, heating, ventilation, electrical facilities carried out according to the requirements of existing building codes and regulations, sanitary norms and standards for technological design of the undertakings (DNAOP 0.03-3.01-71, SNIP 2.09. 02-85, SNIP 2.09.04-87, SNIP 2.10.02-84).

According to the SNIP 2.10.02-84 height of buildings for storage and processing of agricultural products should be based on the dimensions of the equipment or the most allowed height of the storage product. Storage buildings for various kinds of agricultural products, to storage that apply uniform requirements, need to design a uniform height.

The height of the buildings should allow to place equipment and

communication so that in places where people pass regular height from the bottom of the equipment (communications) to the floor was no less than 2 m, and in places where people pass irregular – 1,8 m. The shortest distance from the top of the technological equipment up to the ceiling must be 0,4 m.

The width of the aisles in the areas between the racks, shelves and cupboards should be at least 1 m.

The rooms, depending on the sizes and directions of their use, the physical and chemical properties of the materials used, as well, depending on the maximum possible number of workers present should be equipped with primary fire extinguishing means and the required amount of signaling and safety devices in accordance with GOST 12.4.009, GOST 12.1.010 and fire safety rules in Uzbekistan.

Providing evacuation of industrial, warehouse and other buildings (the number and placement of emergency exits, the distance from the desktop to the exits, passageways sizes, corridors, doors and so on) Should be maintained in accordance with the requirements of SNIP 2.09.02-85.

Evacuation routes and exits shall ensure a fast and safe movement of workers in case of danger:

- \* not have foreign objects and other obstacles;
- \* provide a way out of the premises by the shortest route at any time;
- \* be marked with appropriate signs, drawn in such a way that they could be seen from the workplace;
- \* be equipped with emergency lighting that is automatically activated in the event of power outage in the total network
- \* lighting;
- \* exit door opening only to the outside (they should not be sliding or rotating and locked with a key or have constipation, complicating their opening).

For the evacuation of people at the gate to vehicular traffic is allowed to provide the door (no threshold or thresholds is not greater than 0.1 m in height), which is open in the direction of the exit of the building.

Taking into account the requirements of building regulations outputs can be arranged through the vestibule gateway.

The number, location and size of emergency passages and emergency exits are determined by the properties of the equipment used, the size and the number of jobs and the greatest possible number of employees in the change.

Doors and gates in industrial premises, their size and the materials used for the production are determined depending on the destination premises.

Gate premises for the storage and processing of agricultural products should be built, sliding or curtain.

door opening dimensions for the passage of trackless transport must exceed the dimensions of the loaded vehicle at a height of 0.2 m and a width of 0.6 m.

On transparent doors (gates) at eye height mark must be applied.

Gates, doors, windows, hatches and other devices must be easy to open up the entire width of the opening and locked in position.

Doorways of production and auxiliary facilities should not have rapids and ledges and doors should open outwards. The slope at the entrance should not exceed 5° (9%).

Gate of garages and storage facilities for trucks should be wider and higher than cars per 1 m.

in explosive and fire facilities Doors should have:

- \* border fire resistance of at least 0.6 hour;
- \* opened towards the exit of the room and be provided with self-closing devices;
- \* provide a way out of the premises by the shortest route at any time;
- \* be marked with appropriate signs, drawn in such a way that they could be seen from the workplace;
- \* be equipped with emergency lighting that is automatically activated in the event of power outage in the total network lighting;
- \* exit door opening only to the outside (they should not be sliding or rotating and locked with a key or have constipation, complicating their opening).

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Gate of garages and storage facilities for trucks should be wider and higher than cars per 1 m.

Doors in explosive and fire-hazardous areas must have a border of fire resistance of at least 0.6 hr., Opened towards the exit of the room and be provided with self-closing devices.

The premises for the processing of agricultural products the amount of space per employee in most large change must be at least  $13 \text{ m}^3$  and floor area - not less than  $4 \text{ m}^2$ . Allowed amount of space per employee decreased to  $11 \text{ m}^3$  while maintaining a floor area of standards and performance requirements of technology (SNIP 2.10.02-84).

In closed industrial premises microclimate must meet DNAOP 0.03-3.15-86. HVAC equipment must operate continuously, and in case of failure - to signal it.

Devices for ventilation of closed industrial premises shall not cause drafts.

Windows and glass partitions should have a sunlight shielding device, the type of which is regulated by the views of the work performed.

Transparent walls of industrial premises shall be made of safe glass material in the area of jobs designated by appropriate signs, fence, eliminating direct contact with their employees and the defeat of their possible fragments.

Along the perimeter of the exterior walls of buildings with a height up to the top of the cornice over 10 m, on the roofs need to install fencing of non-combustible material at least 0.6 m high. In buildings without internal gutters, these barriers should be barred.

Access to the premises of the roof, do not have sufficient resistance to stress, may be subject to the availability to them of devices that allow you to safely perform the work.

Windows space, skylights and ventilation devices window windows should ensure free opening, closing and securing them in the desired position. The windows in the open state should not create a hazard to personnel.

The surface of the building structures and floors of industrial premises should be smooth, resistant to chemically aggressive environments, easily handled during the disinfection and wet cleaning; floor must be excluded slide attendants.

Paul in the production facilities, which may be contaminated with fat, milk, etc., should be washed in hot water and soap or soda once per shift, and wall panels - on request.

The floor in the storage technology areas (as well as the surface of the open areas) should have a layout adapted waterproof paint or otherwise, and to indicate the place of art and driveways.

Rooms with pronounced differences in temperature and humidity, which communicate with each other, to be separated from each other lobbies, corridors, locks, curtains or air curtains.

Areas where in the production process are allocated dust, steam or gases must be isolated from other rooms.

Production and storage buildings and premises should be equipped with lightning protection according to RD 34.21.122-87.

The rooms must be provided for tools, primary fire extinguishing equipment, first aid kits, as well as posters, warning signs for occupational safety, fire safety and occupational health.

Do not store the equipment, tools, materials, and so on, That are not directly related to this production.

In refrigerators, warehouses and other premises used for the storage of materials, products, goods, signs posted on the walls, which indicate the permissible load on 1 m<sup>2</sup> of overlap.

The production facilities throughout the working hours, taking into account the technology used and the physical exertion of workers, should be supported by favorable to human body's temperature according to requirements DNAOP 0.03-3.15-86 and for recreational facilities, meals, duty, sanitary and sanitary areas - in accordance with the purpose of such premises.

***Water supply and sewerage.*** Internal water supply and sewerage of buildings and facilities for the storage and processing of agricultural products must comply with the requirements of SNIP 2.04.01-85.

Not allowed laying internal sewer networks under the ceiling (indoor and outdoor) in the premises for the storage and processing of food products.

Buildings and facilities for the processing of food products (potatoes, vegetables, fruits, milk, meat, animals, birds, and so on), As well as for wet processing of vegetable fibers (flax, hemp, and so on) Must be equipped with an internal water supply.

Enterprises should be provided with a sufficient amount of water needed to meet the drinking water needs according to the sanitary norms, the economic and industrial needs and fire fighting needs in accordance with SNIP 2.04.01-85, SNIP 2.04.02-84. The water quality must meet the requirements of GOST 2874.

Not allowed to join networks of domestic and drinking water pipes with water pipe network supplying water for technological needs.

Lead wash water into drains should be closed method with a jet break.

**Lighting.** Lighting facilities shall meet the requirements of SNIP II-4-79.

Workplaces must as far as possible be provided with sufficient natural light and be equipped with artificial lighting, ensuring safety and protection of employee health.

Workplaces in which danger can be created as a result of failure of artificial lighting devices must have emergency lighting system is automatically activated when power failure in the electricity grid.

Emergency lighting has to provide illumination of work surfaces at least 5% of norms set for general lighting system, but not less than 2 lux. In case of evacuation must be provided with floor lighting, the main passages and stairs not less than 0.5 lux.

Light Control must be done at least once a year and after each group replacement of the light sources. It must be carried out by measuring the ambient light in the workplace, to checking for compliance project for lighting types and number of lighting fixtures, as well as their position relative to the light openings and equipment.

Measuring the light level is held in the working surface of the plane according to DSTU B.V.2.2-6-97 requirements.

lighting equipment operation should be carried out according to the existing technical operation of electrical consumer and DNAOP 0.00-1.21-98.

All maintenance work or cleaning the lamps should only be carried out after removing the voltage supply and cooling.

Cleaning local lighting fixtures should be done when cleaning the employees of the workplace.

Cleaning luminaires in general purpose buildings should be conducted at least once every 3 months.

For luminaires of service should be applied to access funds to meet safety

requirements (ladders, mobile devices and installation).

Lighting emergency and evacuation lighting with mandatory distinctive designation is connected to the network, independent of the operating lighting network, or to another power source.

emergency lighting luminaires can be used as an evacuation.

In garages, workshops, points of maintenance sheds, canopies mounted network voltage 12-42 V for connection of portable lamps.

In hazardous areas, are used in explosion-proof lighting, and fire risk - lamps in enclosed design.

***Heating, ventilation and air conditioning.*** heating (cooling) and ventilation facilities for the storage and processing of agricultural products should be equipped according to the requirements DNAOP 0.033.01-71 and SNIP 2.04.05-91.

For heating of buildings and premises for food production should be used radiators with smooth surface and place them in places accessible for cleaning.

Provide hot water of buildings for storage and processing of agricultural products should be carried out in accordance with the requirements of SNIP 2.04.01-85, temperature and flow of hot water should be taken according to the norms of the process.

All premises should be equipped with forced ventilation in accordance with SNIP 2.04.05-91.

During operation of machines with internal combustion engines should be ventilation of industrial premises. General ventilation of the premises must ensure that such an exchange of air in which the concentration of harmful substances in the air of the premises would not exceed maximum allowable levels. The residence time in the manufacturing machine room internal combustion engine running should not exceed the time required to perform the process. Machinery must be fitted with silencer and spark arrester.

Ventilation interconnected buildings must prevent the inflow of air from the room with a higher concentration of harmful gases, vapors or dust in the room with less of these substances.

Systems of local and general ventilation should be separate.

Operator, lounges, shops, laboratories shall have independent ventilation.

Sources with a significant release of convection heat (heating furnace, heating and steaming chamber scalding tanks and others.) Should be insulated, so that the temperature of the heated surfaces of equipment and enclosures workplaces not exceed

45°C. In accordance with the requirements of DNAOP 0.03-3.01-71 (CH number 245-71) equipment, in which the temperature is at or below 100°C, should not to have a surface temperature above 35°C.

Sources significant release of vapors, gases, dust should be sealed and equipped with local suction.

Air and air curtains is calculated so that at the time of opening of gates, doors, and technological openings temperatures in permanent buildings workplaces according DNAOP 0.03-3.01-71 (CH Kg 245-71) was not less than:

- + 14°C - with light physical work;
- + 12°C - during the middle of gravity;
- + 8°C - with hard work.

In the absence of permanent jobs near the gates, doors, and technological openings allowed temperature drop in this area up to + 5°C.

Temperature control devices and relative humidity are set in prominent places in all production areas.

## CONCLUSION

1. Conducted research focused on the development, the study of the properties of Zn-HEDP. The reaction of obtaining Zn-HEDP in presence of the initiators - polyols: glycerol and ethylene glycol, and citric acid.

2. A mechanism of formation of Zn-HEDP, structure and structure is defined by modern analysis methods: IR and NMR-spectroscopy, elemental analysis.

3. The new compositions have been developed based on zincate-hydroxyethylidenediphosphonic acid adding monoethanolamine (vacuum distillation residue monoethanolamine) and poliaminokrotonola that effectively protects against nakipoobrazovaniya vodopodogotovke and in oil production. It is found that their effectiveness is 90% or higher.

4. On the basis of the obtained data, a flow diagram of the production of an inhibitor of deposition of mineral salts.

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# ATTACHMENT