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**MASHINASOZLIK  
ILMIY-TEHNIKA JURNALI**

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**МИНИСТЕРСТВО ВЫСШЕГО ОБРАЗОВАНИЯ, НАУКИ И ИННОВАЦИЙ  
РЕСПУБЛИКИ УЗБЕКИСТАН  
АНДИЖАНСКИЙ МАШИНОСТРОИТЕЛЬНЫЙ ИНСТИТУТ**

**НАУЧНО-ТЕХНИЧЕСКИЙ ЖУРНАЛ  
МАШИНОСТРОЕНИЕ**

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Ushbu jurnalda chop etilgan materiallar tahririyatning yozma ruxsatisiz to‘liq yoki qisman chop etilishi mumkin emas. Tahririyatning fikri mualliflar fikri bilan har doim mos tushmasligi mumkin. Ilmiy-texnika jurnalida yozilgan materiallarning haqqoniyliги uchun maqolaning mualliflari mas’uldirlar.

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Таким образом, в результате проведенных исследований установлено ряд закономерностей протекания реакции комплексообразования выбранных аминопроизводных ацетиленов с ионами  $\text{Cu}^{2+}$  и выяснены некоторые свойства полученных при этом продуктов.

На основе вторичного  $\alpha$ -ацетиленового спирта 1-гексин-3-ол синтезированы комплексные соединения 1-морфолино-2-гептин-4-ол, 1-пиперидино-2-гептин-4-ол, 1-анабазино-2-гептин-4-ол, 1-цитезино-2-гептин-4-ол с ионами  $\text{CuCl}_2 \cdot 2\text{H}_2\text{O}$ . Изучены их антибактериальные и гербицидные свойства.

**Заключение.** Процесс образования комплексных соединений с ацетиленамино-спиртами с ионом  $\text{Cu}^{+2}$  протекает легко. Полученные комплексные соединения обладают антимикробными и гербицидными свойствами.

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### STUDYING THE SOLUBILITY OF THE SYSTEM ZINC SULFATE – AMMONIUM SULFATE – WATER

### ИЗУЧЕНИЕ РАСТВОРИМОСТИ СИСТЕМЫ СУЛЬФАТ ЦИНКА – СУЛЬФАТ АММОНИЯ – ВОДА

### РУХ СУЛЬФАТ – АММОНИЙ СУЛЬФАТ – СУВ ТИЗИМИНИНГ

## ЭРУВЧАНЛИГИНИ ЎРГАНИШ

### ANNOTATION

The visual-polythermal method was used to study the solubility of components in the  $ZnSO_4 - (NH_4)_2SO_4 - H_2O$  system over the temperature interval of  $-22.0^\circ C$  to  $+36.1^\circ C$ . The phase description delineates the areas of ice crystallization,  $(NH_4)_2SO_4$ ,  $ZnSO_4 \cdot (NH_4)_2SO_4 \cdot 6H_2O$ , and  $ZnSO_4$ . A solubility diagram was drawn and a new compound,  $ZnSO_4 \cdot (NH_4)_2SO_4 \cdot 6H_2O$ , was isolated. The new compound was identified by chemical, X-ray phase, thermogravimetric and IR spectroscopic analyses.

### АННОТАЦИЯ

$ZnSO_4 - (NH_4)_2SO_4 - H_2O$  тизимидаги компонентларнинг  $-22,0^\circ C$  дан  $+36,1^\circ C$  гача бўлган ҳарорат оралигида эрувчанлигини ўрганиш учун визуал-политермик усулдан фойдаланилди. Фаза тавсифи музнинг кристалланиши,  $(NH_4)_2SO_4$ ,  $ZnSO_4 \cdot (NH_4)_2SO_4 \cdot 6H_2O$  ва  $ZnSO_4$  соҳаларини белгилайди. Эрувчанлик диаграммаси чизилди ва янги бирикма  $ZnSO_4 \cdot (NH_4)_2SO_4 \cdot 6H_2O$  ажратиб олинди. Янги бирикма кимёвий, рентген фазаси, термогравиметрик ва ИҚ спектроскопик таҳлиллар орқали аниқланди.

### АННОТАЦИЯ

Визуально-политермическим методом исследована растворимость компонентов системы  $ZnSO_4 - (NH_4)_2SO_4 - H_2O$  в интервале температур от  $-22,0^\circ C$  до  $+36,1^\circ C$ . Фазовое описание ограничивает области кристаллизации льда:  $(NH_4)_2SO_4$ ,  $ZnSO_4 \cdot (NH_4)_2SO_4 \cdot 6H_2O$  и  $ZnSO_4$ . Построена диаграмма растворимости и выделено новое соединение  $ZnSO_4 \cdot (NH_4)_2SO_4 \cdot 6H_2O$ . Новое соединение было идентифицировано методами химического, рентгенофазового, термогравиметрического и ИК-спектроскопического анализов.

**Keywords:** Ammonium sulfate, zinc sulfate, zinc - ammonium sulfate hexahydrate, visual polytherm, X-ray phase analysis, IR spectrum, thermogravimetric analysis.

**Ключевые слова:** Сульфат аммония, сульфат цинка, гексагидрат сульфата цинка - аммония, визуальная политерма, рентгенофазовый анализ, ИК-спектр, термогравиметрический анализ.

**Калит сўзлар:** Аммоний сульфат, рух сульфат, рух - аммоний сульфат гексагидрат, визуал политерма, рентген фазали таҳлил, ИҚ спектри, термогравиметрик таҳлил.

In plant, animal, and human metabolism, each microelement [1,2] plays a specific role and its deficiency cannot be remedied by substituting another element [3-5]. The amount of nutrients in the soil determines the concentration of nutrients in plant parts and the amount of yield and greatly impacts the health of humans through the consumption of this plant. Globally, about one-third of arable soils are deficient in zinc, affecting the human nutritional system [6]. Consumption of micronutrient-deficient foods leads to factors that negatively affect human health, such as anaemia, reproductive health, reduced growth, and decreased cognitive and physical performance [7]. A majority of the population in developing countries suffers from deficiencies in micronutrients [8-10].

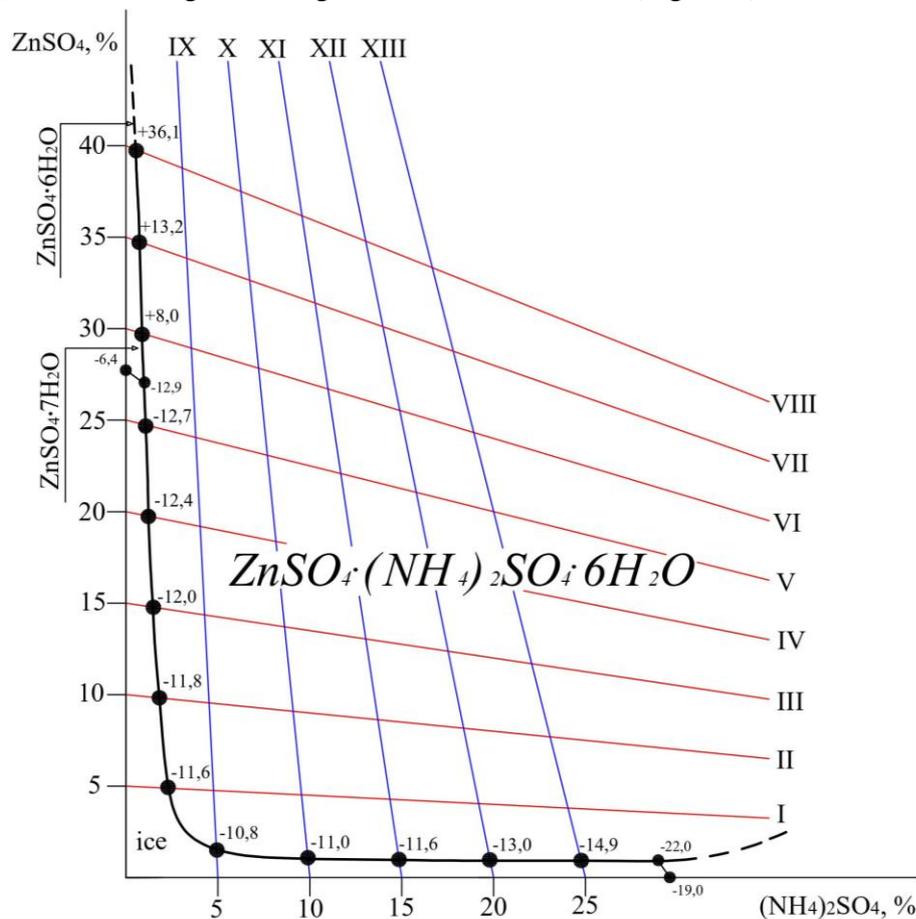
It is possible to eliminate microelement deficiency [11-13] by producing organic and inorganic fertilizers containing these elements and applying them to soils and plants [14-17]. For example, when microelements (Zn, Cu, Mn, Fe, Mo, B) and nitrogen fertilizer were applied to clay loam soils of Iran, it was noted that the grain yield of rice increased by 30% [18]. As a result of applying zinc and manganese microelements to corn at a ratio of nitrogen, phosphorus and potassium (NPK) 120:60:40 kg/ha, corn kernels and grain yield grew [19].

It is important to implement trace elements into NPK fertilizers and high-yielding varieties in

order to achieve high profits. Among these are zinc, iron, manganese, and boron [20]. Several factors can affect how micronutrient supplements affect fertilizers, including their nature, concentration, and method of application [21-24].

**Methods.** In the research work, water, ammonium sulfate and zinc sulfate were considered research objects, and we used chemically pure ammonium sulfate (GOST 3769-78) and zinc sulfate salt (GOST 4174-77). The phase equilibrium studies were performed using the visual polythermal method [25].

**Results and discussion.** Solubility and characteristics of the constituents of the  $ZnSO_4 - (NH_4)_2SO_4 - H_2O$  system at different temperatures and concentrations were studied to show the physicochemical interactions between zinc sulfate and ammonium sulfate. The system  $ZnSO_4 - (NH_4)_2SO_4 - H_2O$  was investigated using thirteen inner sections (Figure 1).



**Figure 1. Polythermal solubility diagram of  $ZnSO_4 - (NH_4)_2SO_4 - H_2O$  system**

From them, sections I-VIII were studied from the  $ZnSO_4$  side to the  $(NH_4)_2SO_4$  peak, and sections IX-XIII were studied from the  $(NH_4)_2SO_4 - H_2O$  side to the  $ZnSO_4$  peak. A polythermal solubility diagram of the  $ZnSO_4 - (NH_4)_2SO_4 - H_2O$  system was built in the temperature interval from  $-22.0^\circ C$  to  $+36.1^\circ C$  based on binary systems and inner cross sections. The crystallization areas of ice, ammonium sulfate,  $ZnSO_4 \cdot (NH_4)_2SO_4 \cdot 6H_2O$ , and zinc sulfate are limited in the phase diagram of the system state. These areas come together at two triple points of the system. At the double and triple points of the system, the equipose composition of solutions and crystallization temperatures were clarified.

The first three points correspond to 0.8% ammonium sulfate, 27.2% zinc sulfate, and 72.0% water with a crystallization temperature of  $-12.9^\circ C$ . In this state, the firm phase is comprised of ice, zinc sulfate heptahydrate, and zinc-ammonium sulfate hexahydrate.

The second triple point corresponds to 29.4% ammonium sulfate, 0.4% zinc sulfate, and 70.2% water at a crystallization temperature of -22.0°C, and the composition of the firm phase is comprised of ice, ammonium sulfate, and zinc-ammonium sulfate hexahydrate.

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**ZnSO<sub>4</sub> – KCl – H<sub>2</sub>O TIZIMIDAGI KOMPONENTLARNING O‘ZARO TA‘SIRINI  
O‘RGANISH**

**ИЗУЧЕНИЕ ВЗАИМОДЕЙСТВИЯ КОМПОНЕНТОВ В СИСТЕМЕ  
ZnSO<sub>4</sub> – KCl – H<sub>2</sub>O**

**STUDY OF INTERACTION OF COMPONENTS IN  
ZnSO<sub>4</sub> – KCl – H<sub>2</sub>O SYSTEM**

**ANNOTATSIYA**