Some features of the synthesis and coagulation treatment wastewater from the TNRS production

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Abstract. Experiments were carried out to study the influence of the conditions of TNRS synthesis on the formation of the crystal. The possibility of wastewater treatment of TNRS production using aqueous solutions of coagulants was studied. It was found that with increasing dosages of reagents, the volume of sediment increases, and the COD values of filtrates decrease. It was found that the highest degree of purification was achieved using iron (II) sulfate at a dosage of 10 g/dm³ and was not less than 87.

The problem of industrial wastewater treatment and preparation of water for technical and household drinking purposes is becoming more and more significant every year. The main source of pollution of water bodies, which leads to the deterioration of water quality and disturbance of the normal living conditions of hydrobionts, are discharges of industrial wastewater.

Wastewater from the production of initiating substances is sent to the drain pits, where the decomposition of toxicants goes on for a long time. The increasing environmental standards for industrial enterprises lead to the need for the formation of technologies [1-10] for the local wastewater treatment of the energy-saturated materials production.

Figure 1. TNRS, reverse pour out, stfininic acid № 2, gravimetric density 1.40 g/cm³.
Lead trinitroresorcinate (TNRS) with satisfactory characteristics was synthesized in laboratory conditions and wastewater treatment by coagulation method was studied. Stifninic acid, obtained with the use of sulfuric acid (stifninic acid № 1) and without the use of sulfuric acid (stifninic acid № 2), was used as the starting substance in the production of TNRS. A comparison of the dosage sequence of the solutions (reverse pour out - a solution of lead nitric acid is dosed into a solution of magnesium stypnate, direct pour out - a solution of magnesium stypnate is dosed to a solution of lead nitric acid) showed that the TNRS obtained from stifninic acid No. 2 by reverse drain (Figure 1) has a higher gravimetric density, compared to the TNRS (Figure 2) obtained from stifninic acid № 1 – 1.40 g/cm³ and 1.26 g/cm³, respectively.

![Figure 2. TNRS, reverse pour out, stifninic acid № 1, gravimetric density 1.26 g/cm³.](image)

Conducting additional syntheses of TNRS with different concentrations of the initial solutions of magnesium stypnate and lead nitric acid confirmed the advantage of reverse pouring out in comparison with direct pouring out.

Wastewater from the production of TNRS is a bright yellow liquid, the characteristics of which are presented in Table 1.

| Parameter               | Dimension  | Value  |
|-------------------------|------------|--------|
| COD                     | mgO/dm³    | 16480.0|
| pH                      | –          | 8.9    |
| Optical density (D)     | –          | 0.69   |
| light transmission (L)  | %          | 21.0   |
| Dry residue             | g/ dm³     | 24.0   |
| Calcined residue        | g/ dm³     | 20.0   |

As can be seen from the results presented in Table 1, the source wastewater has a high COD value, primarily due to the presence of organic compounds of the aromatic series and fine particles.

Many substances that cause turbidity and chromaticity of water are in the wastewater in a colloidal state. For clarification and discoloration of water in this case, physicochemical methods are used, based on the use of reagents (coagulants), which ensure the transfer of colloidal and dispersed pollutants to the
Coagulants are compounds that can hydrolyze in water to form various coagulation structures with high adsorption and adhesion properties. Colloidal particles of pollution, colliding with flakes of hydrolyzed coagulant, adhere to them or are mechanically captured by loose aggregates of flakes and together with them precipitate. On the surface of the flakes, along with the adhesion of colloidal particles, molecular adsorption of colored organic impurities, as well as chemisorption of contaminants, can occur. The density and speed of water clarification depends both on the properties of the coagulant and on the properties of pollutants that pollute the water.

The possibility of wastewater treatment produced by TNRS with using coagulants was investigated. The most common and available reagents – Fe(II), Fe(III), and Al(III) salts were used as the latter.

The coagulant was used as a 10% solution in distilled water. The dosage of the reagents was 1, 3, 5 and 10 g/dm³ in recalculation of the dry substance of the reagent. A typical experiment was as follows: a solution of one of the coagulants in the appropriate dosage was added to 100 cm³ of the waste liquid in a measuring cylinder. The addition of coagulant solutions led to the instantaneous formation of a precipitate in the entire volume of the purified liquid, which eventually sedimented.

It was determined that with an increase in the dosage of the coagulant solution, the volume of the sediment increases, the most intense compaction of the sediment is observed during the first 60 minutes of settling.

The resulting sediment was filtered, dried and weighed, and the filtrate was analyzed for changes in the following parameters: pH, COD, light transmission (L), dry and calcined residue mass. The physicochemical parameters of the filtrates after the removal of the sediment, as well as the mass of the resulting dry mass of sediment, are shown in Table 2.

**Table 2. Physicochemical parameters of the treated wastewater from the TNRS production.**

| Coagulant | The dosage of the coagulant, g/dm³ | Sediment mass, g/dm³ | L, % | pH | COD, mgO/dm³ | Dry residue, g/dm³ | Calcined residue, g/dm³ |
|-----------|-----------------------------------|----------------------|------|----|---------------|--------------------|----------------------|
| FeSO₄     | 1                                 | 3.2                  | 6    | 8.47 | 14420        | 28                 | 24                   |
|           | 3                                 | 4.0                  | 8    | 3.64 | 6695         | 26                 | 22                   |
|           | 5                                 | 4.4                  | 11   | 3.44 | 5665         | 28                 | 20                   |
|           | 10                                | 8.8                  | 17   | 1.44 | 2060         | 44                 | 26                   |
| FeCl₃     | 1                                 | 2.0                  | 21   | 8.77 | 13493        | 22                 | 22                   |
|           | 3                                 | 3.6                  | 15   | 2.37 | 12360        | 26                 | 22                   |
|           | 5                                 | 4.8                  | 4    | 2.08 | 9270         | 30                 | 24                   |
|           | 10                                | 6.4                  | 1    | 1.86 | 7210         | 40                 | 30                   |
| Al₂(SO₄)₃ | 1                                 | 1.2                  | 21   | 8.80 | 15450        | 24                 | 22                   |
|           | 3                                 | 2.8                  | 25   | 4.52 | 13390        | 24                 | 22                   |
|           | 5                                 | 4.4                  | 24   | 4.27 | 9870         | 36                 | 32                   |
|           | 10                                | 5.2                  | 27   | 3.84 | 8240         | 42                 | 36                   |

Conducted research to determine changes in COD values during physicochemical treatment showed a smooth dynamics of their decrease with an increase in the dosages of coagulants. The lowest value of the named parameter – 2060 mgO/dm³ is observed when adding a solution of Fe(II) salt at a maximum dosage of 10 g/dm³ in terms of the dry substance of the reagent. The minimum values of COD when
using Fe(III) and Al(III) salts at the maximum dosage of the reagents were 7210 mgO/dm³ and 8240 mgO/dm³, respectively. It was found that the Fe(II) salt has the best coagulating properties. At the same time, the efficiency of purification of COD value was not less than 87%.

Thus, the following is shown:
- the expediency of changing the order of pouring out solutions in the synthesis of THRS;
- the possibility and efficiency of physicochemical wastewater treatment of TNRS production with the use of coagulants. The best results were obtained in the case of wastewater treatment with a solution of iron (II) salt in a dosage of 10 g/dm³.

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