Increasing the environmental safety of the initiating explosives production

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Abstract. The possibility of wastewater treatment from the initiating explosives production by physicochemical methods is shown by examples: lead trinitroresorcinate, diazodinitroquinone, kalium salt of 4,6-dinitrobenzofuroxan. Discovered, that the improvement of wastewater treatment methods of these industries allows to achieve high performance (treatment efficiency is more than 95%).
The production of standard IE - lead trinitroresorcinate and promising - diazodinitroquinone, kalium salt of 4,6-dinitrobenzofuroxan were considered in the studies. [1-10].

The specialty of standard IE is that at the stages of their production and use, compounds containing heavy metals are formed. This problem can be solved by new perspective IE that do not contain heavy metal ions. However, they are not going to completely abandon the staffing IE soon. In this regard, the task of treating wastewater from the above-mentioned industries becomes urgent.

In the work process it has been investigated that different decontamination approaches of wastewaters from the production those substances, initiating explosives of kalium salt of 4,6-dinitrobenzofuraxane (KDF) and diazodinitroquinone (DDQ) - promising eco-friendly compounds and standard IE - lead trinitroresorcinate (TNRS).

After the target product was isolated, the wastewater was treated with an excess of sodium sulfite in order to exclude the possibility of the ingress of initiating explosives (KDF, DDQ, TNRS) into the purification system.

Wastewater from the production of KDF after the reagent treatment had a brown color and the following indicators: COD = 45672 mg O/dm$^3$; pH = 10.2; optical density (D) - 1.3; light transmission (T) - 5.9%. the results are presented in Table 1. Analysis of the effluents in the UV spectrum showed the presence of nitrophenols and their derivatives, with substituents in the meta- and para-positions, and aromatic compounds with a five-membered ring.

| Parameter       | Dimension | Value       |
|-----------------|-----------|-------------|
| COD             | mgO/dm$^3$ | 45672       |
| pH              | –         | 10.2        |
| Optical density (D) | –         | 1.3        |
| light transmission (L) | %          | 5.9       |
| Dry residue    | g/ dm$^3$ | 16.3        |
| Calcined residue| g/ dm$^3$ | 15.0        |

Wastewater from the production of DDQ is orange, which, according to the results of the studies, had the following indicators: COD = 18750 mg O/dm$^3$; pH = 0.01; optical density (D) – 0.15; light transmission (T) – 71.2%, the results are presented in Table 2.

| Parameter       | Dimension | Value |
|-----------------|-----------|-------|
| COD             | mgO/dm$^3$ | 18750 |
| pH              | –         | 0.01  |
| Optical density (D) | –         | 0.15  |
| light transmission (L) | %          | 71.2  |
| Dry residue    | g/ dm$^3$ | 22.3  |
| Calcined residue| g/ dm$^3$ | 17.2  |

The effluents contain organic compounds of the aromatic series, which is confirmed by the presence in the UV spectrum of wastewater of two peaks with $\lambda = 253$ nm, $\lambda = 320$ nm, which correspond to the absorption regions of aromatic compounds and their nitro-substituted products.

Waste liquid produced by TNRS, had a bright yellow color, according to the results of physicochemical analyzes, it has the following indicators: COD = 16480 mg O/dm$^3$; pH = 8.94; optical density (D) – 0.69; light transmission (T) – 21%, the results are presented in Table 3.
Table 3. Physicochemical parameters of the source waste water from the TNRS production.

| Parameter          | Dimension    | Value  |
|--------------------|--------------|--------|
| COD                | mgO/dm³      | 16480  |
| pH                 | –            | 8.94   |
| Optical density (D)| –            | 0.69   |
| light transmission (L)| %     | 21     |
| Dry residue        | g/ dm³      | 24     |
| Calcined residue   | g/ dm³      | 20     |

The optimal neutralizing agent (Na₂CO₃) was selected to neutralize waste streams from production of DDQ, such availability is linked its use in production technology. It was noted that the color of the liquid changed from orange to dark brown as a result of neutralization.

Wastewater containing nitro products before being fed to biological treatment plants requires pre-chemical treatment. Oxidation is a chemical treatment method of wastewater which is widely used.

Recently, in the practice of wastewater treatment has found wide application the Fenton process which is widespread and represents particular interest among the oxidative methods of wastewater treatment. This process uses a combination of ferrous compounds, most often iron (II) sulfate, and hydrogen peroxide.

Experiments have been conducted with different ratios of the above reagents. It was found that more intensive wastewater treatment from the production of kalium salt of 4,6-dinitrobenzfuraxane occurs in an acidic environment in the presence of iron (II) sulfate, the COD values decrease to 6590 mg O/dm³ (the efficiency of COD reduction is 86%), the results are presented in Table 4.

Table 4. Physicochemical parameters of the treated waste water from the KDF production.

| Parameter          | Dimension    | Value  |
|--------------------|--------------|--------|
| COD                | mgO/dm³      | 6590   |
| pH                 | –            | 6.4    |
| Optical density (D)| –            | 0.24   |
| light transmission (L)| %     | 57     |
| Dry residue        | g/ dm³      | 14     |
| Calcined residue   | g/ dm³      | 12     |
| Efficiency         | %            | 86     |

A similar downward tendency in COD has been observed during the oxidation of wastewater produced by DDQ, the COD value decreased to 3080 mgO/dm³ (efficiency of COD reduction is 85%), the results are presented in Table 5.

Table 5. Physicochemical parameters of the treated waste water from the DDQ production.

| Parameter          | Dimension    | Value  |
|--------------------|--------------|--------|
| COD                | mgO/dm³      | 3080   |
| pH                 | –            | 2.5    |
| Optical density (D)| –            | 0.22   |
| light transmission (L)| %     | 60.5   |
| Dry residue        | g/ dm³      | 16     |
| Calcined residue   | g/ dm³      | 10     |
| Efficiency         | %            | 85     |
During the oxidation of wastewater produced by TNRS under the conditions of Fenton reaction, intensive oxidation of the organic substances also occurred, the COD value decreased to 1930 mg O/dm³ (the efficiency of COD reduction is 88%), the results are presented in Table 6.

**Table 6. Physicochemical parameters of the treated waste water from the TNRS production.**

| Parameter                  | Dimension          | Value  |
|----------------------------|--------------------|--------|
| COD                        | mgO/dm³            | 1930   |
| pH                         |                    | 2.35   |
| Optical density (D)        |                    | 0.32   |
| light transmission (L)     | %                  | 48     |
| Dry residue                | g/dm³              | 18     |
| Calcined residue           | g/dm³              | 16     |
| Efficiency                 | %                  | 88     |

Therefore, based on research, the following conclusion may be stated: there have been found the key stages of the wastewater treatment processes of the described three industries, that can significantly reduce the toxicity of effluents, increase the environmental assessment of the production technologies and using of special purpose products. The similarity of wastewater treatment technologies for these industries suggests the possibility of its application for similar technological processes for obtaining high-energy compounds.

**References**

[1] Zainullin A M, Shaikhiev I G, Fridland S V, Musin R Z and Rizvanov I H 2007 *Chemistry for Sustainable Development* vol 15 4 427-35

[2] Zainullin A M, Shaikhiev I G, Fridland S V 2009 *Bezopasnost’ zhiznedeatel’nosti* 1 38-9

[3] Vahidova I M, Shaikhiev I G, Gilmanov R Z, Husainov R M, Zainullin A M and Vahidov R M 2013 *Bezopasnost’ zhiznedeatel’nosti* 9 9-13

[4] Vahidova I M, Zainullin A M, Shaikhiev I G, Gilmanov R Z, Husainov R M, Vahidov R M, Galihanov M F and Bobreshova E E 2010 *Water treatment* 11 34-8

[5] Shaikhiev I G, Gatina F I, Zainullin A M and Nazmutdinova G M 2015 *Bulletin of the Technological University* vol 18 16 316-17

[6] Shaikhiev I G, Zainullin A M and Shafigullina G M 2016 *Bulletin of the Technological University* vol 19 12 176-79

[7] Shaikhiev I G, Gatina F I, Zainullin A M and Nazmutdinova G M 2015 *Bulletin of the Technological University* vol 18 14 220-22

[8] Aleksandrov A, Devisilov V, Sharai E and Kiselyova D 2018 *Herald of the Bauman Moscow State Technical University* 77 23–38

[9] Aleksandrov A A, Devisilov V A and Sharai E Yu 2020 *Herald of the Bauman Moscow State Technical University* 88 32-45

[10] Abutalipova E M, Aleksandrov A A, Lisin Yu V, Pavlova I V and Shulaev N S 2017 *Herald of the Bauman Moscow State Technical University* 71 118-28