

# Development of high-efficiency equipment for wastewater treatment from difficult-to-oxidize organic compounds and suspended solids

A S Tarasov and A L Wasiliew

Nizhniy Novgorod State Architectural and Construction University, 65, Ilinscaya ave.,  
Nizhniy Novgorod, 603950, Russia

E-mail: k\_viv@nngasy.ru

**Abstract.** The most important problem in the modern developing world - is the problem of industrial wastewater treatment, while there is a need to create a simple to manufacture, efficient, simple and reliable in operation treatment equipment to prevent the ingress of chemical pollutants into water bodies. The main task in the design and development of new equipment for industrial sewage treatment plants is to obtain technically feasible, environmentally efficient equipment for wastewater treatment of textile industries, which will meet the requirements of environmental regulations of the legislation of Russia. A great danger to the aquatic microflora are hard-oxidized organic compounds, residues of dyes, Synthetic surfactants, acids, alkalis are widely used in the flax processing industry.

## 1. Introduction

In the process of manufacturing and production of linen fabrics uses large amounts of clean water, it is necessary for almost all operations of the process from washing the raw material, flax fiber, finishing coloring, washing linen thread or rinsing finished fabric after use in the process such water are contaminated industrial wastewater. Textile waste water is an intensely colored liquid with a pungent odor and high turbidity [1].

The main and quite serious problem of industrial wastewater treatment of textile factories on the example of JSC "Yakovlevskaya" is that industrial wastewater contains in its composition difficult to oxidize organic compounds, have a high residual temperature of the order of  $T=60\div70^{\circ}\text{C}$ , because all the water used in the technological process of making linen threads and dressing the finished linen cloth has a temperature of  $T=70\div80^{\circ}\text{C}$ . Part of the chemicals used in the process remains on the manufactured linen threads and the finished fabric, part in the process of washing and rinsing passes into the wastewater.

According to the requirements, the temperature in the aerobic biological treatment facilities should not be below  $10^{\circ}\text{C}$  and above  $37^{\circ}\text{C}$ , in the presence of large values, it is necessary to provide for temperature adjustment by a temperature lowering device.

The study of the peculiarities of the manufacture of linen threads and fabrics showed that the technological process has a certain cyclicity, water consumption and sanitation is not uniform in time, in order to purify such a quantity of waste water, it is necessary to install an averaging tank with a mixing device, to equalize the indicators of pollution both quantitatively and qualitatively [2,3].



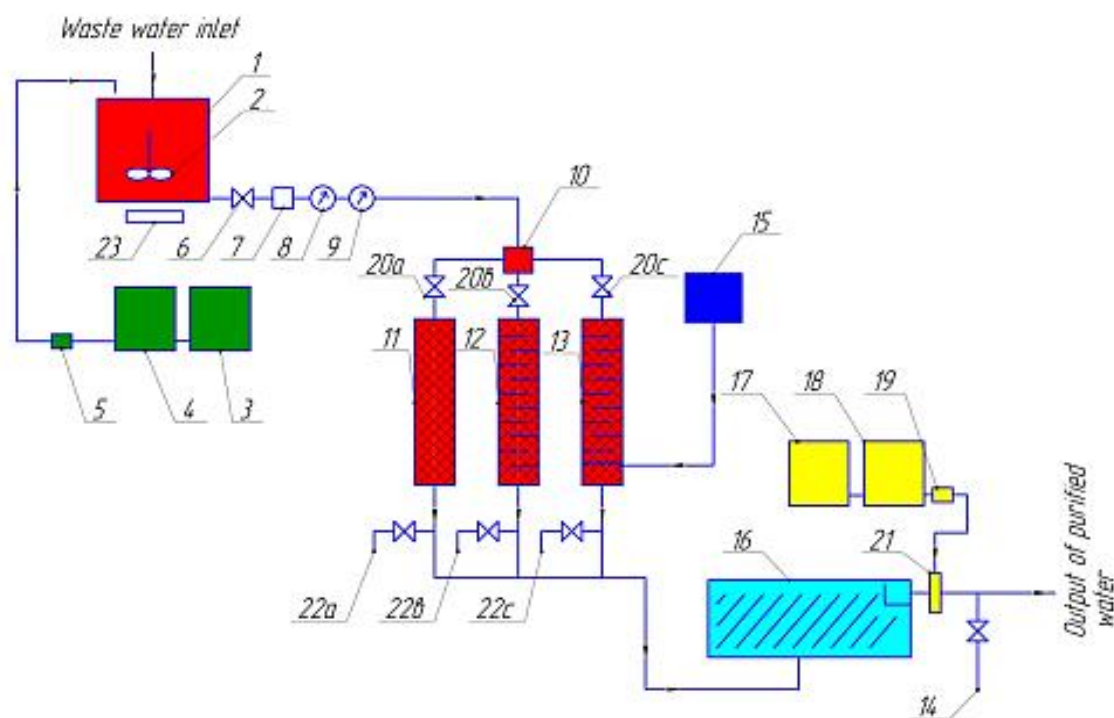
Conducted laboratory chemical analysis of wastewater textile factory JSC "Yakovlevskaya" showed that the problem of discharge is not sufficiently treated wastewater with a high content of hard-oxidizing organic compounds and synthetic surfactants has a strong negative impact on the water receiving facility of the river Shacha is a tributary of the Volga river.

## 2. Results and Discussion

For comparative studies was collected laboratory installation Fig. 1, consisting of an averaging tank with mixing and heating device, equipped with instrumentation, automatic pH meter, flow meter, thermometer.

There is equipment for the preparation and dosing of acid and alkali solutions, built-in pH meters allow controlling the pH parameters of the treated wastewater.

The device consists of three glass cylinders of flow type  $D = 100\text{mm}$ , working volume  $V = 2000\text{ml}$ , with a built-in sampler in the lower part, the cross-sectional area of the neutralizing load is  $F = 0.007\text{m}^2$ , as a neutralizing load, Metalworking waste - steel chips were used, when loading the seal was made.



**Figure 1.** Laboratory installation for neutralization of highly colored wastewater: 1 – tank averager ; 2 – the agitator submersible; 3 – acid solution tank; 4 – acid supply tank; 5 – pump acid dispenser; 6 – stopcock; 7 – flow filter; 8 – flow meter; 9 – pH meter; 10 – control valve ; 11 – reactor №1; 12 – reactor №2; 13 – reactor №3; 14 – sampler; 15 – air compressor; 16 – block of thin-layer modules; 17 – alkali solution tank; 18 – alkali supply tank ; 19 – the dosing pump of alkali; 20 a. b. c - shut-off valve; 21 – mixer; 22 a. b. c - sampler tap; 23 – heater

It was determined that the maximum efficiency for the deposition of suspended solids 82.0-84.0 % in thin-layer sedimentation is provided at the flow rate of the waste liquid within  $5 \div 10 \text{ mm/sec}$  and at the angle of inclination of thin-layer elements  $55^\circ$  to the horizon. The specific load on the working area of thin-layer modules recommended by Building codes 2.04.03-85 Updated version of paragraph 6.64 is  $3.0\text{-}3.5\text{m}^3/(\text{m}^2 \text{ h})$ .

The averaging tank was filled with the initial waste water, a mixing device and a heater were switched on to simulate operating temperatures of  $60\text{-}70^\circ\text{C}$ , a shut-off valve was opened, the air

supply to the bubbling device was switched on, dosing pumps for dosing acid and alkali solutions were switched on, the treated waste water through the pipeline system enters reactors No. 1, No. 2, No. 3. The equipment is equipped with samplers for sampling.

**Table 1.** Experience number 1

№	Name polluting substances	Unit	Indicators of contamination before cleaning	The proposed device of the reactor
1	2	3	4	5
1	Temperature	°C	80÷90	20÷30
2	Chemical oxygen demand	mg.dm <sup>3</sup>	1080	295
3	Biological oxygen consumption	mg.dm <sup>3</sup>	315	84
4	Synthetic surfactants	mg.dm <sup>3</sup>	10	2
5	Chromaticity	grade	45	5
6	Suspended solids	mg.dm <sup>3</sup>	747	205

**Table 2.** Experience number 2

№	Name polluting substances	Unit	Indicators of contamination before cleaning	The proposed device of the reactor
1	2	3	4	5
1	Temperature	°C	80÷90	20÷30
2	Chemical oxygen demand	mg.dm <sup>3</sup>	1080	265
3	Biological oxygen consumption	mg.dm <sup>3</sup>	315	78
4	Synthetic surfactants	mg.dm <sup>3</sup>	10	2
5	Chromaticity	grade	45	5
6	Suspended solids	mg.dm <sup>3</sup>	747	210

**Table 3.** Experience number 3

№	Name polluting substances	Unit	Indicators of contamination before cleaning	The proposed device of the reactor
1	2	3	4	5
1	Temperature	°C	80÷90	20÷30
2	Chemical oxygen demand	mg.dm <sup>3</sup>	1080	280
3	Biological oxygen consumption	mg.dm <sup>3</sup>	315	80
4	Synthetic surfactants	mg.dm <sup>3</sup>	10	2
5	Chromaticity	grade	45	5
6	Suspended solids	mg.dm <sup>3</sup>	747	180

The tests were carried out by conducting three series of experiments to confirm the effectiveness of the proposed equipment. The results of substantiation of the efficiency of the proposed equipment for wastewater treatment of textile industries from hard-oxidized organic compounds and suspended solids are given in table 1.2.3.

Waste water from textile products is a complex physical and chemical system and contains high rates of biological and chemical oxygen consumption. Pollutants in wastewater are suspended solids, mineral oils, and halogen-containing organic substances resulting from the use of dyes during bleaching.

Waste water after printing processes is usually colored, has a high temperature and can contain heavy metals (chromium, copper, zinc, lead, Nickel) in high concentrations.

The complexity of wastewater treatment of textile industries is that they all have a residual color, contaminated with a large amount of organic substances, synthetic surfactants and textile auxiliary substances. All contaminants are biochemically resistant and are in the wastewater in a dissolved state.

### 3. Conclusion

It can be concluded that the discharge of not sufficiently treated industrial wastewater textile factory JSC "Yakovlevskaya" in the river Shacha, leads to a violation of the ecological balance.

To the receiving object river Shacha which is the right tributary of the Volga River, set maximum allowable concentration pollutant of fishery waters, on this basis was calculated and adopted standards of permissible discharge quality of treated industrial wastewater.

The impact of clean water abstraction and subsequent wastewater discharge on the surrounding water environment can be different in terms of environmental damage.

The intake of water from small rivers which is the river Shacha reduces its water content, which leads to an increase in temperature in the summer, thereby increasing the number of biological processes in the source, water quality deteriorates, increases the intensity of flowering;

The discharge of not sufficiently treated wastewater leads to the restructuring of the biocenosis with the development of tolerant forms resistant to a large number of hard-to-oxidize organic compounds, leads to the beginning of the rotting process and the complete death of anaerobic forms of microorganisms, the ability to reproduce various forms of fish-like;

It is necessary to carry out measures to increase the efficiency of existing sewage treatment plants, the introduction of modern technologies for deep purification of wastewater from pollutants, which will lead to large capital costs for the reconstruction of facilities, adjustment of the technological regime of treatment.

Method comparative studies have found that more efficient treatment of waste waters with a high content of complex organic compounds in comparison with existing analogues provides the proposed design of the reactor catalyst, to increase the time of contact of the inner volume is divided section wise partitions in the lower part is barotrauma device on the outer casing is placed a submersible units with thin-layer modules.

According to the results of the research data on the time required for the stay of wastewater in the reactor neutralizer for the transfer of hard-oxidized organic compounds in easily oxidizable forms.

When conducting laboratory analyses of industrial wastewater, it was found that the two streams of effluents coming from the printing shop and the spinning shop are better averaged and mixed, the washing waters contained in them contain a large amount of acids and alkalis, which are neutralized when mixed. The experiments have shown that the average and mixed runoff is better and more efficiently cleaned in the reactor neutralizer, separating and cleaning the runoff on separate lines is a more expensive technology.

According to the results of the experiments of the proposed equipment, the following results were obtained:

1. The cleaning efficiency index for the chemical oxygen consumption of the proposed device was 74%;
2. The efficiency index of purification by biological oxygen consumption of the proposed device was 74%;
3. The efficiency index for synthetic surfactants of the proposed device was 80%;
4. The efficiency index for the color of the proposed device was 88%;
5. The efficiency index for suspended solids of the proposed device was 73%.

**References**

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