Environment Protection Engineering

Vol. 11 1985 No. 3–4

N. Y. VOROBYOVA*, I. N. MYASNIKOV*,
L. V. GANDURINA*, YU. V. KEDROV*

METHODS OF THE VARNISH INDUSTRY WASTEWATER TREATMENT

The main sources of wastewater in varnish industry was characterized and the kinds of the pollutants present in these wastewaters are given. It has been shown that their treatment should be done by the following physicochemical methods: sedimentation, flotation, filtration, chemical precipitation and oxidation, adsorption on activated carbon, evaporation and extraction.

The varnish industry wastewater originates in production of varnish resin, varnish, enamel, and semi-processed goods, as well as in washing the equipment, packing, floors and premises. Varnish industry wastewater contains a great amount of dissolved and emulsifiable organic substances and coarse dispersed matter: pigments, alkali, phthalic and maleate anhydrids and their acids, xylene, toluene, white-spirit, phenol, glycol, fatty acids and resins. This wastewater is also characterized by varying quantitative composition of pollutants, which are determined by the range of the products and the technology of

Table 1

Chemical composition of varnish industry wastewaters
Skład chemiczny ścieków pochodzących z przemysłu lakierniczego

Characteristics	I group of wastewaters		II group of wastewaters	
	Range of changes	Averaged data	Range of changes	Averaged data
pH	7.4–12	9.6	5.4–8.6	6.7
Coarse dispersed matter, mg/dm^3	40–6400	1500	11–300	120
Chloroform extractable, mg/dm^3	56–810	200	24–400	150
Petroleum products, mg/dm^3	10–75	40	4–100	30
COD, mg/dm^3	400–14000	1500	350–5000	4000

* VNII VODGEO, Moscow, USSR.

the production. Table 1 gives the characteristics of the two main groups of the varnish plant wastewater. The first group includes effluents polluted by the coarse dispersed matter. The second group contains organic dissoluble and colloidal substances. The total pollution of the wastewater is the sum of pollutant contained in the effluents of separate technological processes, in particular those of varnish-boiling, synthetic resin, varnish-oil, package washing shop and the siccative department. That is why in order to solve the problem of the treatment of the varnish plant effluents, a highly effective local method of the wastewater treatment must be found and perfect technological lines of the varnish plant sewage treatment be worked out.

The most effective treatment of the varnish plant wastewater is achieved by physico-chemical methods, since they satisfy the following main demands:

high efficiency of the process,
compactness of the structure,
simplicity of the treatment plant construction and its operation,
automatic controllability of the process,
technical and economical efficiency of the methods.

The wastewater treatment incluides the following methods:

sedimentation,
flotation,
filtering,
chemical precipitation,
chemical oxydation,
adsorption by activated coal,
evaporation,
extraction by dissolvents.

Thus, the treatment of polyester resin industry wastewater includes the sedimentation from the mechanical admixtures and catalytic oxydation at 200–250°C C(L) (SAKHARNOV, 1971) in which the copper–chromium contact is used as a catalyst. The purified water is used in the recirculation water supply system. In the adsorption method, in which activated coal, peat, and activated anthracite are used as sorbents, suspended and emulsifiable substances were extracted (SAKHARNOV, 1971). In the sedimentation, flotation, and seepage processes, the coarse dispersed matter is separated and, preliminarily treated by coagulants and flocculants, is further purified. For instance, 50–70% of the coarse dispersed matter can be extracted by sedimentation (fig. 1).

The separation of the coarse dispersed matter is intensified by using multilayer settlers due to which the clarification process and its efficiency are intensified. Since the aggregative-stable colloid pollutants cannot be removed by mechanical sedimentation, coagulation and flotation processes are applied.

The wastewater treatment by pressure flotation with the use of sulphate aluminium as coagulant makes it possible to reduce the coarse dispersed matter from 586–920 mg/dm^3 to 101–1096mg/dm^3 and the substances extracted by sulphuric ether from 140–1408 mg/dm^3 to 32–255 mg/dm^3. During further treatment of the varnish plant wastewater on the flotation-sandy filter, the content of the ether-extracted substances reduces to 3–20 mg/dm³. Since the quality of such water meets the demands of the recirculation water supply system, the use of fresh water could be approximately two times reduced (NADYSEV, STUPAKOVA, 1974).

The detailed research on the varnish plant wastewater treatment by means of coagulation, settlement, and flotation, conducted by VNII VODGEO, has shown that the efficiency of the treatment depends on the type and dose of the reagent, the place of its introduction, the mixing-up conditions, the flocculation conditions and on the concentration of pollutants.

The best results were obtained when using the alumnium sulphate (70–150 mg/dm³) with polyacrylamide (1–2 mg/dm³) as coagulant. The result obtained allowed us to choose

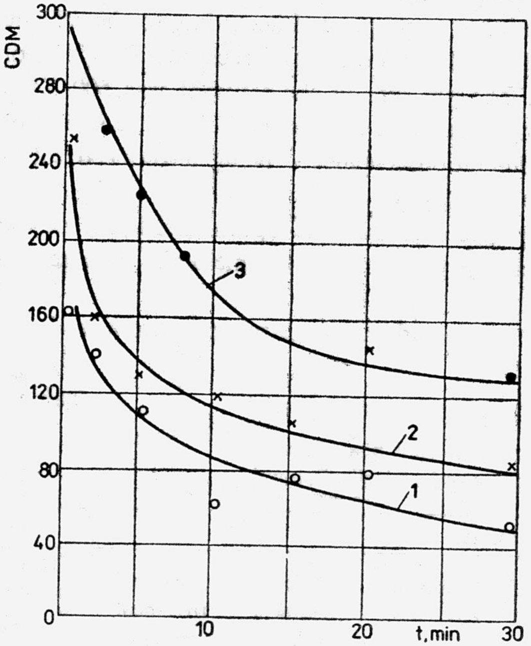

Fig. 1. Kinetics of coarse dispersed matter removal from varnish industry wastewaters

Initial amounts of coarse dispersed matter: 160 mg/dm³, *2* — 250 mg/dm³, *3* — 300 mg/dm³, CDM — coarse dispersed matter

Rys. 1. Kinetyka usuwania gruboziarnistej zawiesiny ze ścieków pochodzących z przemysłu lakierniczego

Początkowa zawartość gruboziarnistej zawiesiny: 160 mg/dm³, *2* — 250 mg/dm³, *3* — 300 mg/dm³, CDM — gruboziarnista zawiesina

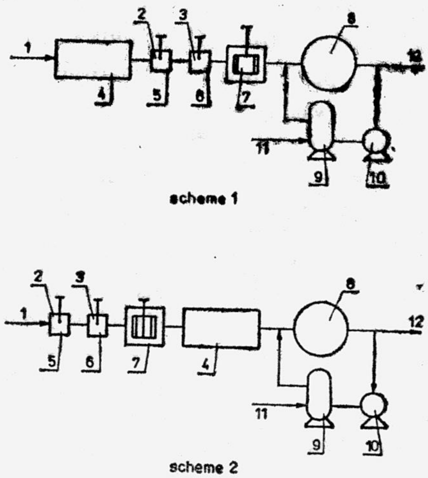

Fig. 2. Basic scheme of varnish industry wastewater treatment

1 — influent, *2–3* — addition of reagents, *4* — settling tank, *5–6* — mixing chambers, *7* — flocculation chamber, *8* — flotation chamber, *9* — saturator, *10* — pump, *11* — air from compressor, *12* — effluent discharge

Rys. 2. Schemat podstawowy oczyszczania ścieków pochodzących z przemysłu lakierniczego

1 — dopływ, *2–3* — dodanie reagentów, *4* — osadnik, *5–6* — komory mieszania, *7* — komora flokulacji, *8* — komora flotacji, *9* — saturator, *10* — pompa, *11* — powietrze z kompresora, *12* — odprowadzenie wycieku the optimum schemes of the plant wastewater treatment. Wastewater containing a great quantity of coarse dispersed matter (fig. 2) should be subject to preliminary sedimentation followed by the treatment with reagents and the separation of the flocculated flakes by means of pressed flotation.

The highest purification degree of the wastewater of the II group was obtained by the coagulation, using sulphate aluminium together with the polyacrylamid, sedimentation and, finally, by applying pressure flotation (fig. 2). Purification of the wastewater of the I group reduced the coarsely dispersed matter to 84–90% and COD to 50–80%, the corresponding values for the II group being 98% and 50–64%, respectively.

The optimum parameters of the physico-mechanical wastewater treatment were determined in the semi-industrial set-up of the capacity of 5 m^3/h. This set-up includes the reagent economy, multistage thin-layer settler and radial flotation chamber. the barbotage saturant and the compressor. The flotation set-up operated according to the scheme of the single-pass flow (all the water passed to the saturant) and recirculation (25% of the purified water passed to the saturant). The pressure in the saturant was 500 KPa. In the case of the single-pass scheme, the reagents were introduced before the settler or before the saturant, in the case of the recirculation scheme – being introduced solely before the settler (GANDURINA, MYASNIKOV. KEDROV, 1977).

The performed investigations made it possible to find the optimum scheme of the package-washing-shop wastewater treatment by physicochemical methods. The results are given in tab. 2 and fig. 3.

It can be seen that the maximum effect is reached when the reagents are introduced

Table 2

Results of wastewater treatment in pilot plant installation
Wyniki oczyszczania ścieków w instalacji pilotowej

Operating conditions	Coarse dispersed matter			COD		
	Before treatment mg/dm^3	After treatment mg/dm^3	Treatment efficiency %	Before treatment mg/dm^3	After treatment mg/dm^3	Treatment efficiency %
1) Direct-flow scheme a) addition of reagents before saturator	114–5080	12–200	68–98	250–1330	240–440	65–67
b) addition of reagents before settling tank	120–32.30	15–150	70–99	612–2150	342–1000	30–75
2) Scheme with recirculation and addition of reagents before settling tank	1150–6000	20–100	93–99	1400	110	92

to the settling tank and the flotation chamber works according to the recirculation scheme. Such a scheme provides the best conditions for mixing the reagents with wastewater, for flocculation and for the adsorption of pollutants.

The single-pass scheme of the flotation wastewater treatment is less effective when the reagents are given before the saturant due to destruction of the coagulated pollutants occurring in the pump or saturant.

From the tests performed it follows that the humidity of foam amounts to 88% and that of the sediment from the settling tank to 80%.

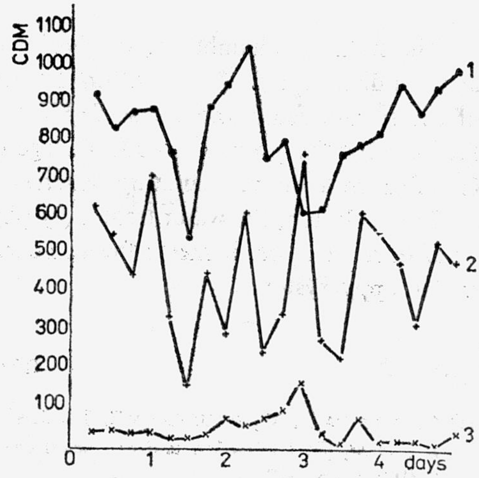

Fig. 3. Decrease of the coarse dispersed matter in the effluent from the pilot plant installation

1 — influent, *2* — after settling tank, *3* — after flotator, CDM — coarse dispersed matter

Rys. 3. Zmniejszenie zawartości gruboziarnistej zawiesiny w odcieku z instalacji pilotowej

1 — dopływ, *2* — po wyjściu z osadnika, *3* — po wyjściu z flotatora, CDM — gruboziarnista zawiesina

Based on the research carried out by the VNII VODGEO, a combined structure has suggested for the physicochemical treatment of the wastewater (fig. 4) in which mechanical destruction of the coarse dispersed matter, its mixing-up with the reagents and floccu-

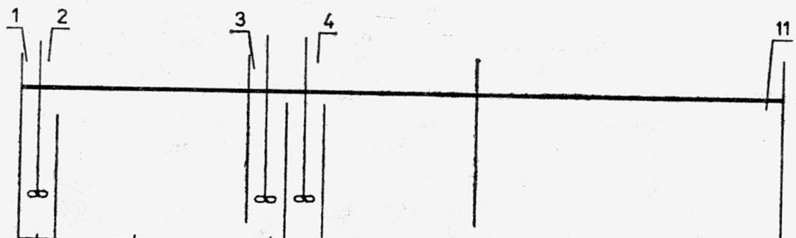

Fig. 4. Scheme of the combined installation for physicochemical treatment of varnish industry wastewater

1 — influent, *2–4* — addition of reagents, *5, 7, 8* — mixing chambers, *6* — settling zone, *9* — flocculation chamber, *10* — flotation zone, *11* — effluent discharge

Rys. 4. Schemat instalacji łączonej do fizykochemicznego oczyszczania ścieków pochodzących z przemysłu lakierniczego

1 — dopływ, *2–4* — dodanie reagentów, *5, 7, 8,* — komory mieszania, *6* — strefa osadzania, *9* — komora flokulacyjna *10* — strefa flotacji, *11* — odprowadzenie wycieku lation and flotation purification take place. These processes occur in the appropriate zones, i.e. settlement, mixing before and after settlement, flocculation and the flotation separation of the coagulated pollutant.

To intensify the sedimentation, the water was clarified in the thin layer. The clarification process is carried out in the shelf nozzle of the single-pass type. The structure of the nozzle provides an even distribution of the flow without using a special arrangement. The mixing-up chambers and the flocculation chambers are equipped with the mechanical mixers, which provide the optimum conditions for the process and reduce the hydraulic losses.

The flotation chamber of the horizontal type is eqipped with the arrangements for an even distribution of flow within the structure and the arrangements for the destruction of the surface foam and the settled sediment. The combined structure is equipped with facilities for the production and dosage of the reagents, and for supplying the flotation chamber with the recirculating water.

In conclusion, the water treated by physicochemical methods is of the required quality and, in most cases, it meets the standards for the wastewater reuse in the recirculation water uppy systems.

REFERENCES

[1] GANDURINA L. V., MYASNIKOV I. N., KEDROV YU., *Installation for the varnish industry wastewater treatment*, [In:] *Chemical and petroleum engineering industry abstracts*, TSINTI "Chimnephtemash" 3 (1977), pp. 6–7.

[2] NADYSEV V. S., STUPAKOVA L. PH., *Wastewaters from the varnish industrial amalgamation Lakokraska and methods for their treatment*, Varnish materials and their use, 6 (1974), pp. 71–73.

[3] SAKHARNOV A. V., *Wastewater treatment and gas sweeting in the varnish industry*, Chimiya Publishing House, Moscow, 1973.

METODY OCZYSZCZANIA ŚCIEKÓW PRZEMYSŁU LAKIERNICZEGO

Scharakteryzowano główne źródła ścieków w przemyśle lakierniczym i podano rodzaje występujących w nich zanieczyszczeń. Wykazano, że ścieki te wymagają zastosowania fizyczno-chemicznych metod oczyszczania, takich jak: sedymentacja, flotacja i filtracja, chemiczne strącanie i utlenianie, adsorpcja na węglu aktywnym, odparowanie i ekstrakcja.

Przeprowadzono badania w skali półtechnicznej oczyszczania ścieków pochodzących z mycia opakowań i opracowano optymalny schemat unieszkodliwiania tych ścieków.

DIE REINIGUNG VON LACKABWÄSSERN

Charakterisiert werden eingehend die Entstehungsquellen der Abwässer der Lackindustrie und die darin enthaltenen Schmutzstoffe. Zwecks Reinigung, benötigen diese Abwässer physikalisch-chemische Verfahren wie z.B.: die Sedimentation, Flotation, Filtration, chemische Fällung und Oxydation, Adsorption mittels Aktivkohle, Verdampfung und Extraktion.

Die Abwässer aus einer Waschanlage von Lackfarben-Behältern wurden in einer halbtechnischen Reinigunganlage behandelt und anhand dieser Versuche, wird eine optimale Verfahrenskette vorgeschlagen.

МЕТОДЫ ОЧИСТКИ СТОЧНЫХ ВОД ЛАКОКРАСОЧНОЙ ПРОМЫШЛЕННОСТИ

Охарактеризованы главные источники сточных вод в лакокрасочной промышленностии и приведены виды встречающихся в них загрязнений. Доказано, что эти сточные воды требуют применения физикохимических методов очистки, таких как: седиментация, флотация и фильтрация, химическое осаждение и окисление, адсорбция на активированном угле, упаривание и экстракция. Произведены испытания в полупромышленном масштабе очистки сточных вод, происходящих от мытья тары, и разработана оптимальная схема обезвреживания этих сточных вод.