(pine and fir) at the same feed waters concentrations is due to the different column plate number and to the binary system “essential oil – water”.

CONCLUSION. The actual number of plates and height of the cohobating column, processing the distillation waters from coniferous raw material (pine and fir), are determined on the base of constructed phase equilibrium diagrams for the two studied binary systems. Since the height of column is highest for the maximal feed water concentration, then the height of column have to be equal to this maximal column height.

The results confirms the correctness of the results, obtained in [20] for column height at processing of lavender distillation waters.

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УДК

CHARACTERISTIZATION AND COMPOSITION OF WASTE WATER FROM INSTALLATION FOR AIR PURIFICATION

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Wastewater from installation for air purification by cooling installed on spray dryer for Birch and Herniaria extracts was investigated. Wastewater characterization was carried out by total dry solids, suspended and soluble solids, pH and chemical oxygen demand. Obtained results showed great pollution of wastewater in both

cases. Gas chromatography was used for wastewater composition determination from birch extract drying. Results showed main presentation of organic compounds such as glycerol 13,45 %, glucose isomers 6,70 %, fructose isomers 5,00 %, 4-hydroxyphenylbutanol 1,88 %, 1,3-dihydroxybutane 1,74 % and etc. Degree of wastewater pollution and required degree of water purification were calculated on the base of present limits for second category water-bodies in Bulgaria.

Исследовалась отходная вода от установки для очистки воздуха через охлаждение, установленная к распрыскательной сушке для растительных экстрактов от березы и от грыжника. Сделана характеристика воды по общему сухому веществу, растворенным и нерастворенным веществам, pH и химической потребности кислорода. Результаты показывают значительное загрязнение отходной воды и в двух случаях. Проведено газхроматографское исследование состава отходной воды от сушения экстракта березы. Вычислены степень загрязнения и необходимая степень для очистки воды, на базе действующих норм в Болгарии, для второй категории водоприемников.

Key words: wastewater, characterization, composition, flow rate, food industry

Introduction

Environmental issues are a critical factor for today industry competitiveness. Water is an essential factor to our existence as well as to our economy. Industry is a major user of this precious resource and has a responsibility to conserve water by using it efficiently. Water has traditionally been a key processing medium in food processing plants. It is used in various steps throughout the food production process such as cooling, washing, heating, cooking, sanitizing, transport and clean up. Water which is not directly put into the products is usually discharged at wastewater.

Processing industry including food processing plays prominent part in Bulgarian economy. Increasing production rates lead to strengthening of harmful environmental impact. Ecological problems of food industry are related to generation of specific and various wastewaters, big quantity of organic wastes, great raw materials, water and energy resources consumption, using of various packing materials and generation of packaging wastes. According to national statistical data the share of mining and processing industries towards the total gross domestic product for 2011 in Bulgaria is 21,2 % and the share of food industry is 2,6 %. The share of generated wastewaters from food processing towards total industrial wastewaters is 10,73 % and towards total discharged wastewaters for the country is 3,99 % [6].

Water legislation is one of the full regulated parts of the environmental legislation in European Union. Different waters are divided to surface, drinking, ground and wastewaters. One of the main goals of the EU legislation is to prevent harmful influence of industrial wastewaters to human life and environment [7, 8, 9].

Distinguishing marks of food industry are the wide variation and specific composition of the pollutants released from different production processes. This is as result from various assortment structure based on the big number of raw materials from plant and animal origin that are used for food production. One of the general environmental impacts of food industry is generation and discharge of different in composition and great variability both of quantity and quality wastewaters [10, 12, 14].

The main and compulsory parameters for controlling of pollution degree of food wastewaters are pH, total solids, suspended and dissolved solids, chemical oxygen demand (COD), five-days biological oxygen demand (BOD_5), total nitrogen, total phosphorus and increasing of water intake temperature [7].

It is determined that the most important factors affect on the choice of water treatment methods and equipments are wastewater's characterization, composition and flow rate [13].

The sources of contaminants in wastewater vary greatly among food industry branches and are result of a combination of external and internal factors. However, information about the characterization and chemical composition of many food processing wastewaters, especially in effluents from spray drying of plant extracts is not available in scientific literature.

This study is deal with characterization of effluents from installation for air purification by cooling, installed on spray drier for plant extracts.

Materials and methods

Object of this study was effluents from pilot installation for air purification installed on spray drier for Birch and Herniaria extracts in the University of Food Technologies-Plovdiv, Bulgaria. Installation is shown on fig. 1 [5].

Wastewater samples were collected during March-May 2012 according BDS ISO 5667-10:2002 [4]. The pH-value was measured by pH-meter Milwakee SM102 at 20 ^{o}C. Total solids (TS), suspended (SS) and dissolved (DS) solids were determined according BDS 17-1.4.04-80 [1]. The chemical oxygen demand (COD) values were determined according DIN ISO 15705 [15]. Permanganate oxidation was determined according BDS 17.1.4.16-79 [3]. Wastewater odor and color were assessed according BDS 17.1.4.01-77 [2].

For determination of wastewater composition was used gas chromatograph 7890A with MS-detector 5875C, column HP-5MS (30 m x 250 μm x 0,25 μm), at following time-temperature regime: 100 °C for 1 min, 15 °C/min to 180 °C for 1 min, 5 °C/min to 300 °C for 10 min. Carrier gas helium, split 15:1, gas flow rate 1.00 cm^3/min. Temperature of MS-source 230 °C and MS-Quad 150 °C. These analyses were carried out in «Agrobioinstitute», Sofia.

For determination of pollution degree of industrial wastewater in engineering practice is introduced design parameter called "population equivalent" (PE). It is the number expressing the ration of the sum of the pollution load produced during one day by industrial facilities and services to the individual pollution load in household sewage produced by one person in the same time. For practical calculations it is assumed that one unit equals to 60 g BOD_5 and 65 g of suspended solids per one person per day. The PE based on the suspended solids in investigated effluents was calculated by the following formula [11]:

$$PE = \frac{SS.q}{65}, \quad (1)$$

where: SS – suspended solids of wastewater, g/dm^3;

q – daily wastewater flow, dm^3/d;

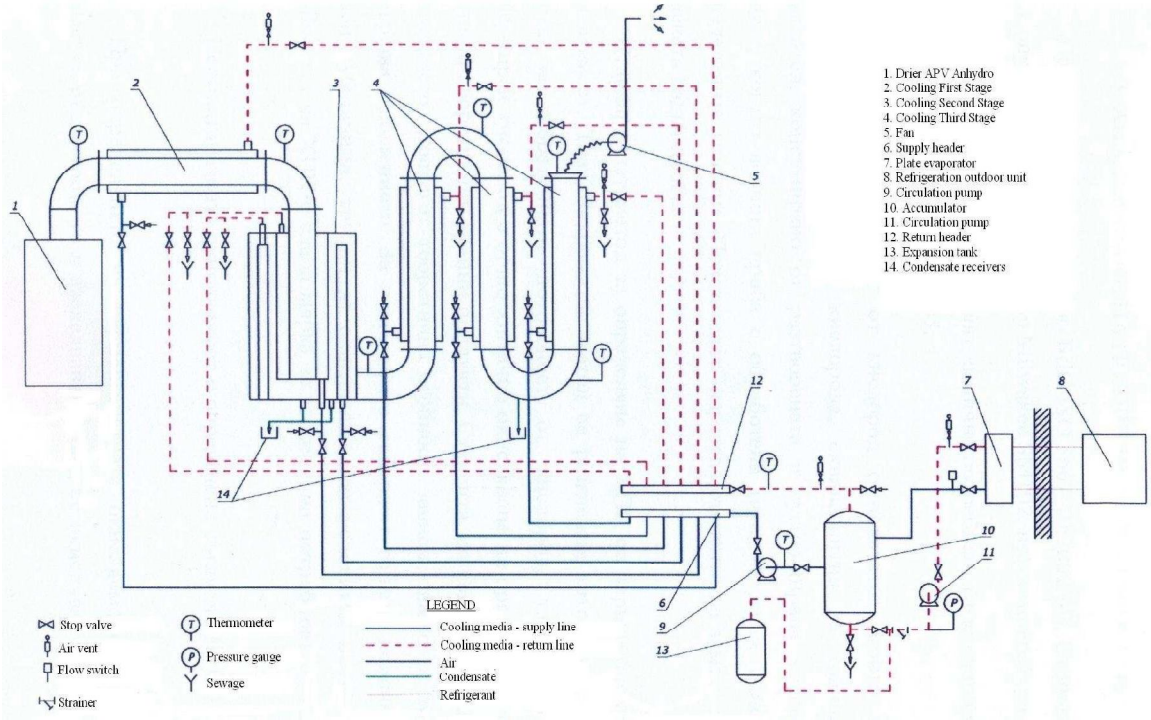

Fig. 1 – Pilot installation for air purification

Necessary wastewater degree of purification (η) was calculated by the formula [11]:

$$\eta = \frac{C_0 - C_{el}}{C_0}.100,\%, \quad (2)$$

where: C_0 – concentration of the pollutant in investigated wastewater, mg/dm^3;

C_{el} – established level of the pollutant for second category of receiving waterbody, mg/dm^3 [9].

All determinations were reproduced three times.

Results and discussion

In table 1 are presented the results for effluent parameters from studied installation for air purification during drying of two plant extracts. The obtained data show deviation from the established levels for all studied parameters. It was established that the main part of total solids is organic mater respectively 78,1 % for effluent from drying of birch extract and 83,2 % for herniaria extract. Most of the pollutants are soluble respectively 95,6 % for birch and 98,2 % for herniaria. Determined total solids are around 2,3 times more in the effluent from drying of herniaria extract. The COD-values show specific pollution of both effluents.

It was determined from sensory evaluation of the samples that both wastewaters have very strong specific odor with threshold odor number 800 for the birch extract and 1000 for herniaria respectively and intensive col-

oration with the dilution index 195 and 201 respectively. Determined values for odor and color for both effluents considerably exceed established levels.

Table 1 – Characteristic of effluents from installation for purification of outlet air from spray drier for plant extracts

Parameter	Plant extract		Established levels*, mg/dm^3
	Birch	Herniaria	
pH	4,8	4,5	6,0-8,5
Total solids, mg/dm^3	1510 ± 7,1	3417,5 ± 3,5	-
Total fixed solids, mg/dm^3	330 ± 28,3	575,4 ± 1,9	-
Total volatile solids, mg/dm^3	1180 ± 35,4	2842,2 ± 1,9	-
Suspended solids, mg/dm^3	66,0 ± 3,6	67,5 ± 17,7	50
Dissolved solids, mg/dm^3	1444,0 ± 3,6	3350 ± 14,1	1000
Permanganate oxidation, mg/dm^3	2082 ± 4,2	1519,5 ± 4,9	30
COD (dichromate oxidation), mg/dm^3	42485 ± 21,2	16490 ± 14,1	70
Effluent temperature, ^{o}C	29 ± 1,0	29 ± 1,0	-
Odor, grades	> 5	> 5	3
Color, degrees	> 50	> 50	20

* The established levels are in accordance with second category receiving water-body [9].

In table 2 are presented results for effluents daily flow rate, degree of pollution expressed by population equivalents and necessary degree of purification. The population equivalent values are very low because of low concentration of suspended solids in both effluents and low daily flow rate. Having in mind established high COD-values (tabl.1) and theoretical relations between COD and BOD_5 parameters it can be concluded that population equivalent based on wastewater organic loads will be higher than presented for both effluents.

Table 2 – Daily flow rate, population equivalent and necessary degree of purification of effluents from installation for purification of outlet air from spray drier for plant extracts

Parameter	Plant extract	
	Birch	Herniaria
Effluent daily flow rate, dm^3/d	59,4	55,8
Population equivalent, persons	0,06	0,06
Necessary degree of effluent purification by suspended solids, %	24,2	25,9
Necessary degree of effluent purification by dissolved solids, %	30,7	70,1
Necessary degree of effluent purification by COD, %	99,8	99,6

In table 3 is presented composition of effluent from studied installation during drying of birch extract. The obtained data are in accordance with statement that the main part of pollutants in the effluent consists organic substances such as glycerol 13,45 %, glucose isomers 6,70 %, fructose isomers 5,00 %, 4-xydroxyphenylbutanol 1,88 %, 1,3-dixydroxybutane 1,74 % and etc. Some of these pollutants are responsible for specific odor and color of the effluent.

Table 3 – Composition of effluent from installation for purification of outlet air from spray drier for birch extract

Substance	RT
2-Hexanoic acid	3,88
3-Hydroxypropanoic acid	3,98
3-Hydroxybutiric acid	4,24
3-Methoxypropenoic acid	4,40
1,3-Dihydroxybutane	5,33
Glycerol	5,44
1,2,3-Trihydroxybutane	5,63
Succinic acid	5,79
Glyceric acid	6,00

Table continued

Fumaric acid	6,21
3,4-Dixydroxydihydrofuranone	6,43
Malonic acid	6,54
Malic acid	7,45
Trans-Farnesol	7,66
4-Methoxybenzoic acid	7,72
L-Threonic acid	8,04
4-Hydroxyphenylbutanol	8,21
Xylose	8,47
2-Ethylphenol	8,66
P-Hydroxybenzoic acid	8,81
2,6,10-Trimethyltetradecane	9,71
Ribonic acid	10,98
Levulose	11,16
Fructose-I isomer	11,33
Fructose-II isomer	11,45
Fructose-III isomer	11,55
Glucose-I isomer	12,63
Glucose-II isomer	14,04
2-Methyloctadecane	15,90
Stearic acid	17,60

Conclusion

The investigated effluents generated from studied installation during cooling of outlet air from pilot spray drier for plant extracts of birch and herniaria were significant polluted as it is shown from data for COD and dissolved solids. The wastewater had pH-value less than the established level, in both cases. The characterization and composition analysis presents specific pollution of both effluents.

It was established that organic matter predominates in both wastewaters therefore it can be suggested pH correction, physical chemical treatment to remove the odor and color and to decrease COD-values and subsequent biological treatment in municipal wastewater treatment plant for final purification before discharging of the water in receiving water-body.

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