intensive process and the condition of market economy in Bulgaria is appropriate to use mobile and stationary devices periodically.

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УДК

DETERMINATION OF THE ACTUAL NUMBER OF TRAYS FOR COHOBATION COLUMN 1. AT MANUFACTURING OF CONIFEROUS DISTILLATION WATER

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The required actual number of trays for a cohobating column, manufacturing distillation waters from coniferous plants, is defined according to the McCabe-Thiele graphical method. Calculations for determining of the plate number were done on the base of three concentrations of feed distillation waters – minimal, average and maximum. The height of the column is also determined.

Key words: cohobating column, number of trays, coniferous.

INTRODUCTION: In the world there are more than 17 500 known plant species, and about 300 of them have industrial importance for obtaining of different essential oil products. One of the main processes for producing of essential oil products is distillation. In the process of essential raw materials distillation the primary distillate is obtained. It is then cooled and separated in decanters into two fractions – primary oil and primary distillation waters. These waters still contain certain quantity emulsified, mechanically trapped and dissolved essential oil. After additional processing of the primary distillation waters this oil is extracted as a secondary oil and the rest waters, called secondary distillation waters usually are discarded [2, 17].

The apparatus, in which the process re-distillation is performed, is called cohobator and really is the stripping section of distillation column [2, 10, 18].

In Bulgaria for performance of re-distillation process, a continuously operating cohobator of Irinchev and Delev is used. This cohobator is a column with filling of ceramic Rashing rings, placed on the extended part of reboiler with volume of 1000 m^3. The distillation waters, previously heated in a heat exchanger, are sprayed over the filling through the spraying devices. The waters flow down through the filling and then are collected in the reboiler. There they are heated indirectly with steam to the boiling state. This provide a vapor flow against the dripping waters, which take the essential oil to the top of the column. The rest skimmed waters (bottom residue) are discharged through an overflow in a small vessel for bottom residue [5, 6].

The above described cohobator has a capacity of 2400-3000 dm^3/h distillation waters and 250-300 dm^3/h secondary distillate (10 – 15 %) [5].

In Russia the most used cohobator is a “UNK” cohobator [2, 10, 17] with 17 cap trays. It has a capacity of 4500 $dm^3/$ h and extracts the essential oil with 5 % secondary distillate.

It is recommended to perform the cohobating process according to an individual regime for the different essential raw materials [3, 11], but the cohobating process of all essential raw materials is actually performed according to the established optimal technological regime for processing of rose distillation waters [11], because it’s characteristic features are more fully examined (although there is not enough theoretical generalization) [5, 6].

For proper sizing of a cohobating column height it is necessary to be defined the actual number of the column plates [1, 8, 9].

In literature there are data for determination of the actual number of plates for cohobating column, processed lavender distillation waters. The calculations are performed for three concentrations of the feed waters at the same composition of bottom residue [20].

There are also data about a computer program for determination of the contact stages number of distillation column, used for binary solutions separating [12], but there is no data about the number of trays for cohobating columns, processing other distillation waters.

Purpose of this article is to be defined the actual plate number and height of the cohobating column, processing distillation waters of coniferous raw material (pine and fir) on the base of the constructed corresponding phase diagrams [19].

MATERIALS AND METHODS: Calculation for determination of the theoretical trays number have been done for a column, described in [20] with technical parameters, presented in Table 1:

Table 1 – Parameters of cohobating column

Parameters	Value
Mass flow rate of feed waters – m_F kg/h	68,4
Mass flow rate of distillate – m_D, kg/h	9
Mass flow of bottom residue – m_W, kg/h	59,4

The data from [4] are used for determination of the molar concentration of:

1. Pine. The molecular weights of the basic components of pine essential oil are:

— for α-pinene – 136.24

— for myrcene – 136.23

2. Fir. The molecular weight of the basic components of fir oil are:

— for α-pinene – 136.24

— for lemonen – 136.24

The essential oil concentration in the feed distillation waters is according to the [2, 3].

Calculations for theoretical plate number have been done for three concentrations of feed distillation waters (minimal, average and maximum) and for a constant bottom residue concentration. The concentration of the distillate is calculated. The obtained results are presented in table 2.

Table 2 – Molar concentration of feed distillation waters, distillate and bottom residue for pine and fir

Parameters	Unit	Minimal concentration	Average concentration	Maximal concentration
pine and fir				
x_F	% mol.	0,0035	0,0039	0,0043
x_D	% mol.	0,027	0,03	0,033
x_W	% mol.	0,0001	0,0001	0,0001
B	% mol.	0,0004	0,00043	0,00047

On the base of constructed phase equilibrium diagrams [19] for the corresponding binary systems "essential oil – water" and derived equations, describing this equilibrium the process lines of the cohobating column are built. The graphical method of McCabe and Thiele [1, 7, 9, 15] is used for determination of required theoretical plates number. After that the stepped line between the equilibrium and process lines is built.
The actual plate number is calculated usually according to the equation [8, 13, 14]:

$$n_Д = \frac{n_T}{\eta} \tag{1}$$

where: n_T – number of theoretical plates;
η – plate efficiency coefficient;
$n_Д$ – actual plate number.

The plate efficiency coefficient value could be defined only experimentally with sufficient accuracy. Usually this coefficient has values between 0,2 and 0,8 [8, 13, 14]. In our case we have accepted that $\eta = 0,6$.

The equation, presented in [16] is used for cohobating column height determination. According to it the column height is a sum of the re-boiler height (H_1), the distance between upper plate and the column top (H_3), and the value of the expression ($n_Д$ -1).h, where h is the distance between the two plates.

RESULTS AND DISCUSSION: The theoretical plate number of cohobating column, processing coniferous distillation waters has been defined according to the graphical method of McCabe and Thiele. The actual plate number is defined then with the plate efficiency coefficient. Calculations have been done for three variants with different feed waters concentration (minimal, average and maximum) and at a constant bottom residue concentration. The obtained results are presented in table 3.

Table 3 – Determined theoretical and actual number of trays

Parameters	Unit	Minimal concentration	Average concentration	Maximal concentration
Pine				
n_T	number	28	30	30
η		0,6	0,6	0,6
$n_Д$	number	47	50	50
Fir				
n_T	number	21	28	28
η		0,6	0,6	0,6
$n_Д$	number	35	47	47

The analysis of obtained data show that the number of theoretical plates is equal for the average and maximal feed water concentration and only for the minimal feed concentration is lower than the two other cases.

The height of cohobating column is calculated on the base of the number of actual column plates for every one of the given feed waters concentrations. The obtained results are presented in table 4:

Table 4 – Determined height of cohobating column

Parameters	Unit	Minimal concentration	Average concentration	Maximal concentration
$H_1 = (2,5 \div 3)h$	m	0,125		
$H_3 = (2 \div 2,5)h$	m	0,1		
White pine				
$n_Д$	number	47	50	50
$(n_Д-1)h$	m	2,3	2,45	2,45
$H_{общо}$	m	2,525	2,675	2,675
Fir				
$n_Д$	number	35	47	47
$(n_Д-1)h$	m	1,7	2,3	2,3
$H_{общо}$	m	1,925	2,525	2,525

The results, presented in table 4 shows that the height of the cohobating column, processing fir waters is 1,925 m for the minimal feed water concentration and 2, 525 m for the maximal feed water concentration.

Analogically the height of column, processing pine waters is 2,525 m and 2,675 m for the minimal and maximal feed waters concentration. The difference between the column height for the two studied raw materials (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