

Concentration of fusel oil in alcohol column

Oleksii Osypenko, Yurii Dolomakin, Viacheslav Osypenko

National University of Food Technologies, Kyiv, Ukraine

ABSTRACT

Keywords:

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Introduction. To improve the process of removal of fusel oils in food distillation of ethyl alcohol is advisable to identify the areas of concentration in the system ethanol-water-izoamilol that at rectification form condensates heterogeneous type, and identify some of their technological characteristics.

Materials and methods. Materials research - ethanol-water-izoamilol and fusel oils. Experimental studies of phase equilibrium liquid - liquid-vapor in the system ethanol-water-izoamilol studied the instrument circulation type. Model mixtures were prepared gravimetrically.

Results and discussion. Defined area of concentration of fusel oil in alcohol column based on a heterogeneous formation of steam condensate in the system ethanol-water-izoamilol. Zone heterogeneous solutions in an ethanol-water system, a node is limited izoamilol with an ethanol content of 8.5...11.4 % by mass, which forms a heterogeneous distillates at 20 °C. Technologically ethanol concentration greater than 10 wt%, izoamilol - 10 wt% enables to obtain a solution at a temperature of 91,1 °C heterogeneous distillate. At low 3...5 % by mass concentration of alcohol in solution izoamilol rectification ratio is limited to 1.

Appropriate to apply the results of research in improving the processes of rectification of ethanol distillation column design, contact devices, determine their number, the development of technology selection fraction of fusel oils.

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Corresponding author:

Yurii Dolomakin
E-mail:
dyy76@mail.ru

Introduction

The conditions of fusel oil removing in food rectification of ethanol is fairly well studied [1]. However, some technological features should be analyzed. The behavior of the rectification components in the of ethanol concentration related to both the construction of the column, contact devices, their quantity and technology of fusel oil fraction.

In alcohol-column the key components besides water and ethanol are alcohols fusel oils and their most significant representative – izoamilol. So we have selected mixture of these key components of ethanol-water-izoamilol for our research, moreover the behavior of ethanol and izoamilol alcohols in a wide concentration range, are closed to practice. In this research the concentrations area, attracts our attention, when liquid mixtures with atmospheric pressure are heterogeneous, i.e. have a line of separation. The purpose of this research: to reveal areas of concentration in the ethanol-water-izoamilol system that would formed heterogeneous condensates by rectification, and define some of their technological characteristics.

Materials and methods

Experimental researches of phase balance liquid-liquid-vapor in the system of ethanol-water-izoamilol have studied on the base of circulating on type.

The design of a device is simple. It was made of heat-resistant glass, is heated by electricity through the autotransformer 1, flasks to the investigated mixture 2, volume of about 70 ml. The device has steck for thermometer 3, for receptacle canal 4, fridge 7.

Stirring of liquid in the flask is reached by circulation, which is performed kettle 1. In circulation device, to reduce volume fluid retention, is soldered the capillary the tube 6 from acceptor to the flask. Volume delays of the steam phase is close to 0. The device is insulated by asbestoscord and fiberglass. To monitor the intensity of boiling

and the surface of section phases in isolation at the appropriate places was made "window". Modeling mixtures were prepared by the gravimetric method. The phase equilibrium was achieved in a isobaric conditions during the 1.5-2. A sample of vapor (volume = 1 ml) was taken into the pipette 5 by tap. The pipette was cooled by water. Methods of determining the quality of condensate is next.

A sample in the pipette was kept at +20 ° C during the 6-18 h to fully of section phase. Were fixed volumes of layers to within 0.01 ml. Then was determined the refractive index n_D^{20} for each layer on the refractometer. By dint of index of refraction (separate study) was determined the composition of alcoholic and aqueous layer on the line of solubility. The composition of the initial condensate steam was found on the composition and material ratio layers, using the lever rule.

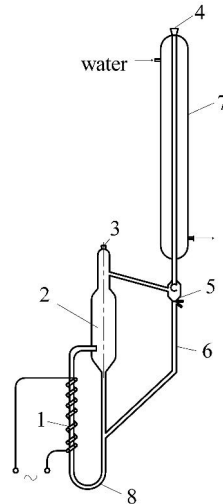


Fig. 1 Circulation device:

**1 – heater; 2 – flask; 3 - place for thermometer; 4 - place for the receptacle canal;
5 - three-way valve; 6 - capillary canal; 7 – fridge; 8 - sampling valve**

Results and discussion

In this work were used data of solubility in the system of ethanol-water-izoamilol at +20 ° C and at boiling temperature. Ethanol is easily dissolved in water and in izoamilol, the water at +20 ° C in izoamilol is dissolved only 2.83 wt%, at boiling point - to 3.07 wt% [2]. Izoamilol is dissolved in water at +20 ° C at 9.75 wt% at boiling point - 13.93% by weight. In the triple system observed two binary azeotrope: ethanol-water that consists of 95.57 wt% ethanol with boiling point 78,15 ° C and izoamilol-water - 50.4% by weight, with boiling point - 95,2 ° pp.

The line that is connecting the azeotrope components on concentration triangle (fig. 2) is intransitive line, that contains distillate components m_1m_2 [1]. The area of a triangle is limited by the solubility line at a certain temperature - the zone of heterogeneous solutions, which increases with decreasing of temperature, at that in the system ethanol-water-isobutanol zone heterogeneous solutions lower at the same temperature.

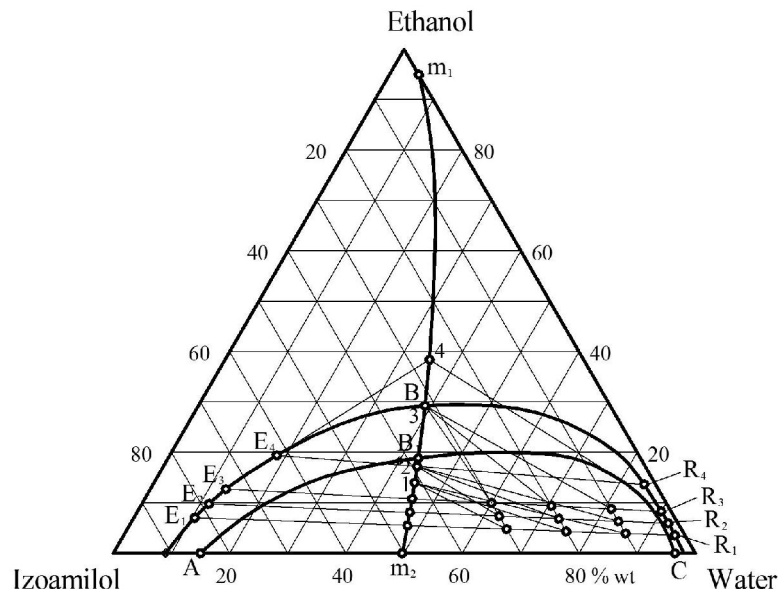


Fig. 2 Рівноважні склади рідин і пари в системі етанол-вода-ізоамілол:

m₁m₂ – лінія неперехідності;
 R₁E₁, R₂E₂, R₃E₃, R₄E₄ – ноди гетерогенної області;
 E₁BR₁ – лінія розчинності при +20 °C;
 AB₁C – лінія розчинності при температурі кипіння

Within the solubility curve components of the liquids placed on nodia - solubility curve. Components of a node within the curve of solubility are equilibrium with the same distillate at the temperature of boiling, because it is known that the composition of the distillate does not depend on the layers boiling heterogeneous mixture.

With increasing ethanol of content, its concentration in the liquid in the steam increases and components of the balance distillates are moving along of intransitive line to homogeneous components.

Distillates marginal mixtures do not separate into layers of hydrogen and alcohol when its cooling to 20C, have a boiling temperature 91,1C and ,according to the experiment data, containing not more than 11,41% of ethanol. Balance steam conforms to point B on the Solubility line at boiling temperature 20C. So, the zone of solutions, of which distillation provide heterogeneous distillates, are limited of node E₃R₃, content of ethanol – 8,5-11,41%.

During distillation mash, that containing little ethanol and higher alcohols, higher alcohols have greater volatility, than ethanol, and fusel oil is completely removed and the loss of his from barda – unlikely.

The lower plates of the column have little alcohol also and they vigorously transformed into steam phase.

It can be predicted that after one or two plates steam will match to points on the impassable line when the content in the liquid izoamilona 3 %wt. Chance maximum concentration izoamilol in steam not exceeding 50% by weight. The maximum concentration izoamilol if ethanol in the liquid up to 10 wt% (real terms) does not exceed 10% by weight.

Table 1

Node	Composition of the liquid						Boiling temperature, °C	Composition of the steam						K
	Ethanol		Water		Izoamilol			Ethanol		Water		Izoamilol		
	wt %	mol %	wt %	mol %	wt %	mol %		wt %	mol %	wt %	mol %	wt %	mol %	
R ₁ E ₁	Heterogeneous liquid						93,8	Heterogeneous condensate of steam						
	3,9	1,6	91,1	97,3	5,0	1,1		14,0	9,4	44,6	76,2	41,4	14,4	
	4,0	1,7	86,0	96,0	10,0	2,3		14,0	9,4	44,6	76,2	41,4	14,4	
	4,2	2,0	75,8	93,0	20,0	5,0		14,0	9,4	44,6	76,2	41,4	14,4	
	4,5	2,4	65,5	89,2	30,0	8,4		14,0	9,4	44,6	76,2	41,4	14,4	
4,7	2,8	55,3	84,7	40,0	12,5	14,0	9,4	44,6	76,2	41,4	14,4			
R ₂ E ₂	Heterogeneous liquid						93,0	Heterogeneous condensate of steam						
	5,5	2,3	89,5	96,6	5,0	1,1		19,0	12,7	43,2	74,0	37,8	13,3	
	5,7	2,5	84,3	95,2	10,0	2,3		19,0	12,7	43,2	74,0	37,8	13,3	
	6,0	2,9	74,0	92,0	20,0	5,1		19,0	12,7	43,2	74,0	37,8	13,3	
	6,3	3,4	63,7	88,1	30,0	8,5		19,0	12,7	43,2	74,0	37,8	13,3	
6,6	4,0	54,3	83,5	40,0	12,5	19,0	12,7	43,2	74,0	37,8	13,3			
R ₃ E ₃	Heterogeneous liquid						91,1	Heterogeneous condensate of steam						
	8,5	3,7	86,5	95,2	5,0	1,1		28,2	19,2	40,0	69,5	31,8	11,3	
	8,8	3,9	81,2	93,7	10,0	2,4		28,2	19,2	40,0	69,5	31,8	11,3	
	9,5	4,8	70,5	90,0	20,0	5,2		28,2	19,2	40,0	69,5	31,8	11,3	
	10,0	5,6	60,0	85,7	30,0	8,8		28,2	19,2	40,0	69,5	31,8	11,3	
10,5	6,7	40,5	80,1	40,0	13,2	28,2	19,2	40,0	69,5	31,8	11,3			

							1							0
R ₄ E	Heterogeneous liquid						Heterogeneous condensate of steam							
	15,5	7,3	74,5	90,2	10,0	2,5	88,8	39,5	27,6	35,2	63,1	25,3	9,3	0,90
	16,2	8,6	63,8	85,9	20,0	5,5	88,8	39,5	27,6	35,2	63,1	25,3	9,3	0,47
	17,0	10,1	53,0	80,6	30,0	9,3	88,8	39,5	27,6	35,2	63,1	25,3	9,3	0,38
	17,4	11,1	47,6	77,3	35,0	11,6	88,8	39,5	27,6	35,2	63,1	25,3	9,3	0,32

K - Volatility of izeamilol comparatively ethanol (coefficient of rectification)

On the base on data from Table 1 and Figure 1 zone selection fusel oil in alcohol column should be chosen with plates where in the fluid ethanol is less than 10% by weight, and izeamilol at its regular selection, not more than 10% by weight. This condensate of steam are heterogeneous, therein ethanol was less than 28% by weight. Boiling temperature of solution at atmospheric pressure is 91,1 °C, but with the working pressure at the bottom of column 2 m w.c:

$$t_{boil} + 2,5 \cdot Pp = 91,1 + 2,5 \cdot 2,0 = 96,1 \text{ } ^\circ\text{C}$$

According to the research it is clear fusel oil appearance in rectified alcohol, when the quantity are accumulated in the column, when insufficient selection, when there is insufficient filing it epyurats and associated with this reduced selection of rectified alcohol. In these cases, rectification shifted to the intransitive line or coincides with it.

Conclusions

Was found the zone of heterogeneous in the system of ethanol-water-izeamilol, that is limited by node, containing ethanol 8,5-11,4% wt, that forms heterogeneous distillates at temperature 20 °C

Technologically, from solution which consists of 10% of athanol and the same number of izeamilol can be obtained the heterogeneous distillate at the temperature of 91,1 °C

We confirmed that at lower 3-5%wt concentrations of alcohols in solution coefficient of rectificatoin izeamilol is limited by 1.

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