ISSN 2181-8622

Manufacturing technology problems

Scientific and Technical Journal Namangan Institute of Engineering and Technology

INDEX COPERNICUS INTERNATIONAL

Google Scholar

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SLIB.UZ Scientific library of Uzbekistan

Volume 10
Issue 1
2025

SYSTEMATIC ANALYSIS OF THE PROCESS OF DEODORIZATION OF VEGETABLE OIL WITH THE PRESENCE OF MOBILE NOZZLES

NAZIRALIYEVA NIGORA

PhD student, Namangan Institute of Engineering Technology, Namangan, Uzbekistan
Phone.: (0899) 976-9492
**Corresponding author*

XAMDAMOV ANVAR

Docent, Namangan Institute of Engineering Technology, Namangan, Uzbekistan
Phone.: (0893) 946-0956, E-mail.: anvarkhamdamov@rambler.ru

Abstract: Plants from which oil is extracted include cotton, soybeans, sunflowers, peanuts, safflower, corn, olives, and sesame. Currently, the most common method for industrially extracting cottonseed oil is by pressing - extraction. In the production of cottonseed oil, about 20-22 kg of free fatty acids are released from one ton of black oil with an acid number of 4.2 mg KON. The main part of them is 95.2% during the chemical refining of "black oil", and the remaining 4.8% is separated during the deodorization process.

Keywords: deodorization, component, oxidation, vacuum, free fatty acids, rectification, detergents, nozzles, hierarchy, vapor and liquid phase.

Introduction. Since cottonseed oil is mainly consumed in Uzbekistan, it is of great importance to study the processes of obtaining cottonseed oil, its composition, and purification from harmful substances.

The composition of cottonseed oil is a complex multicomponent liquid, which consists of 70-75% liquid and 20-25% solid oils. Several processes are carried out in order to purify cottonseed oil so that it is suitable for consumption. In particular, deodorization is the last stage of the refining process. . In this, the cotton oil is cleaned from odor and taste substances and chloroorganic pesticides. With the help of this process, some of the remaining free fatty acids in the refined oil can be removed and the acidity index of the oil can be reduced. At the same time, oxidation products that worsen the stability of the oil to various factors and consumption characteristics are also removed. Deodorization and removal of fatty acids is carried out under a deep vacuum with the help of high-temperature steam.

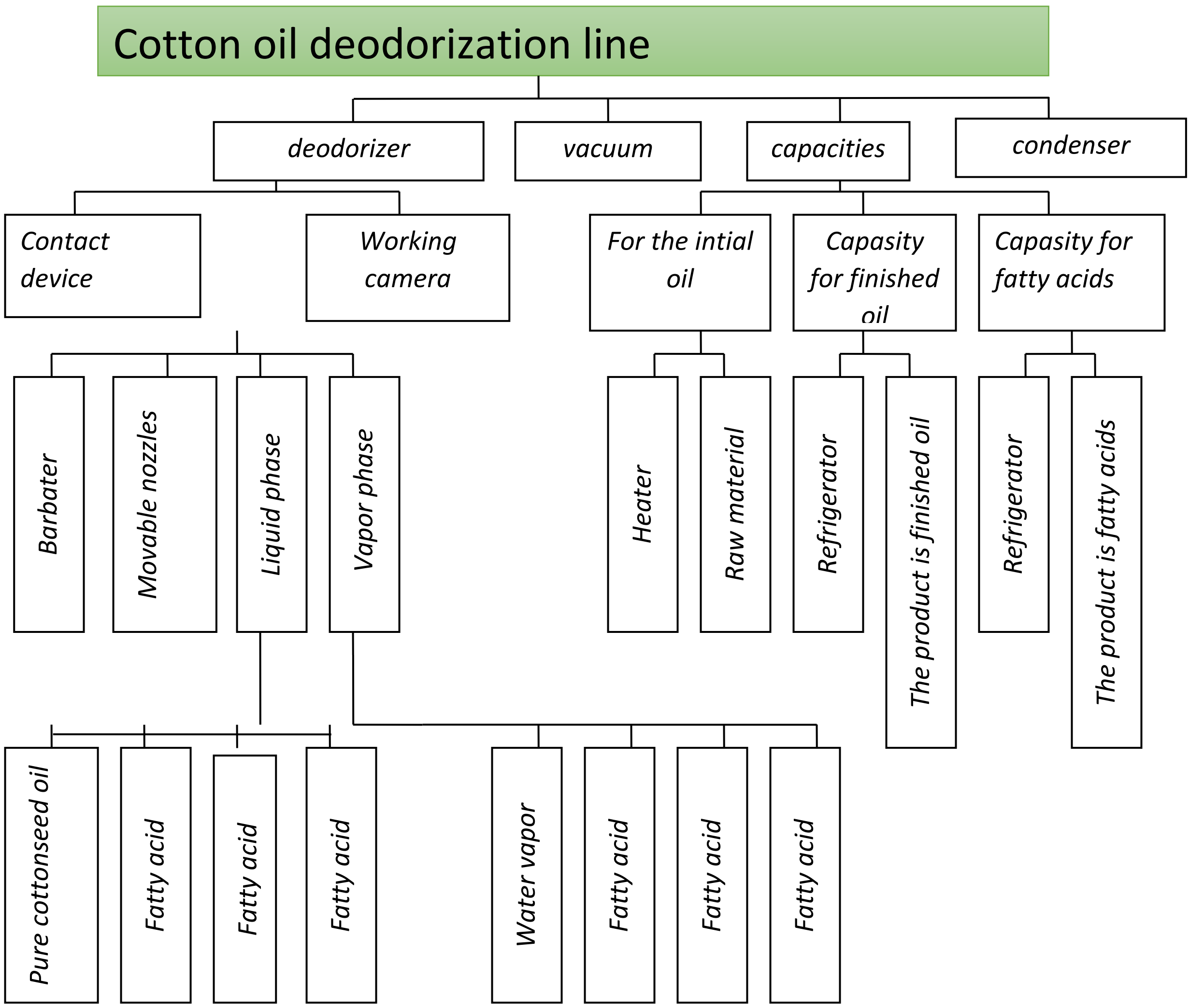
Deodorization and removal of fatty acids is carried out under a deep vacuum with the help of high-temperature steamIt follows that, using the rectification method, it is possible to separate and fractionate the free fatty acids contained in cottonseed oil.

The main part of them is 95.2% during the chemical refining of "black oil", and the remaining 4.8% is separated during the deodorization process. In the production of cottonseed oil, about 20-22 kg of free fatty acids are released from one ton of black oil with an acid number of 4.2 mg KON. The main part of them is 95.2% during the chemical refining of "black oil", and the remaining 4.8% is separated during the deodorization process. Free fatty acids are valuable raw materials in other branches of the chemical industry, so they are rectified and separated into separate fractions. In particular, individual natural fatty acids are required in the production of plasticizers, detergents, artificial rubber, impact-resistant polystyrene, and chemical fibers [7].

The properties of free fatty acids in cottonseed oil and some fatty acids and their physical properties are given in Table 1 below.

Table 1. Various fatty acids

Name	Formula	Molecular weight	Neutralization number	Density, *kg/м³*	Heat of vaporization, *kal/g*
Kaprin	$C_9H_{19}COOH$	172,26	325,69	853,1	70,4
Laurin	$C_{11}H_{23}COOH$	200,31	280,08	847,7	64,6
Miristin	$C_{13}H_{27}COOH$	228,36	245,68	844,5	60,3
Palmitin	$C_{15}H_{31}COOH$	256,42	218,80	841,4	56,5
Stearin	$C_{17}H_{35}COOH$	284,47	197,23	836,9	52,7



1-picture. Hierarchical structure of vegetable oil deodorization process with moving nozzles.

As can be seen from the table, the density of all fatty acids is less than the density of water (r=1000 kg/m3). Density and heat capacity vary with pressure and temperature, i.e. Where ϱ is the density, kg/m3; s is the heat capacity of the liquid, kJ/kg0C; is the enthalpy of the vapor, kJ/kg0C. According to Professor A.E. Lutskoy [6], the density of a substance with n number of carbon atoms in its molecule is found by the following formula:
$d_n = \frac{b_n}{b_n+1} d_{lim}$(1) where is equal to 0.877 for fatty acids; b is a constant, 4486 for fatty acids.

At the first stage of the hierarchy there is a device for carrying out the deodorization process. Improvement of the process organization is achieved by improving the design parameters of the device, as well as by changing the technological parameters of the process control.

In order to thoroughly study the IMA processes of the second stage of the hierarchy, the body of the periodic oil deodorizer, the working chamber, the oil inlet and outlet pipe, and the superheated water vapor inlet and outlet pipe are separated. In order to accelerate heat and substance exchange in the deodorization column, the process is carried out with the participation of moving nozzles.

The process that takes place in the lower system is carried out in equipment consisting of a vacuum pump, containers for raw materials and finished products, and a condenser for cooling the secondary vapors produced.

The next step in the hierarchy is the bubble layer in the device, which consists of a bubbler and movable nozzles. The height of the bubble layer created by steam depends on the steam consumption, pressure and oil consumption. The optimal values of the above parameters are calculated or determined indirectly based on experimental results.

The supply of liquid and vapor phases to the deodorizing column in the opposite direction of movement allows for the formation of many sub-layers. Each sub-layer consists of mobile nozzles, liquid and vapor phases. Due to the intensive mixing of wooden nozzles under the influence of sharp water vapor supplied from the bottom of the device, the process time is significantly reduced.

At this stage, the mass exchange process in the apparatus begins with the introduction of oil into it on the one hand, the introduction of water vapor from the bottom of the device in an open manner on the other hand, and the intensive movement of nozzles moving in the oil layer, causing the volatile components in the oil to escape with water vapor. The concentration and intensity of substances in the steam depends on the hydrodynamics of the nozzles. As a result of the movement of the nozzles, the steam bubbles rising from the oil layer burst, many small bubbles are formed, and their total number increases. The difference between the velocities of the vapor and liquid phases improves the hydrodynamic structure of the flow by accelerating the movement of the liquid in the device. It is known from the basic equation of heat transfer processes that the larger the contact surface between the vapor and liquid phases, the faster the process occurs. As a result, the main part of the light volatile components in the oil is driven from the liquid phase to the vapor phase.

As it decreases, their concentration in the vapor phase increases. At the fourth stage of the hierarchy, phenomena occurring in the liquid and vapor phases are considered. An analysis of the hydrodynamics of phase flows, the common and useful contact surface of phases, the presence of a non-participating zone in the device is carried out. At the fifth stage of the hierarchy, changes in the physico-chemical properties of the components - oil, water, free fatty acids and vapors of these components are determined. IA processes allow for the decomposition of the system under study, the analysis of their interactions and connections with each other and with the external environment, and the disclosure of the hierarchical structure of the system. In this case, each hierarchical structure corresponding to IMA processes has a subsystem that forms process organization and improvement methods. There are principles of synthesis that are used to develop the scientific basis for creating new technological processes and improving existing ones. The research work used the principle of decomposition - the method of dividing technological processes into functional blocks.

Due to the complexity of the mechanism of the improved oil deodorization process and the fact that it is carried out in equipment of a fundamentally new design, we will first sequentially decompose this system into several simpler functional subsystems. In the future, we will separate each of these subsystems to the level of separate devices and elements and form their corresponding mathematical models. Heat and mass exchange processes take place in the periodic oil deodorization apparatus. In this case, oil enters the apparatus from above, after which wooden nozzles are thrown into the oil, and heating water steam is supplied from the bottom of the apparatus in an open manner. In the future, water vapor rising from the oil layer will carry away the volatile components it contains. The intensity of these phenomena depends on the hydrodynamic regime formed by the nozzles. The turbulent motion of the nozzles creates new bubbles in the liquid layer, which then burst, creating contact between the liquid and the gas. As a result, the release of light boiling components from the deodorizing oil is accelerated.

The input parameters of this object are the mass of the oil, the concentration of volatile substances in its content, the consumption and temperature of the entering water vapor, and the working pressure inside the apparatus. The output parameters of the facility include changes in oil mass, concentrations of volatile and practically non-volatile substances, and consumption, temperature, and concentration of volatile substances in the steam mixture released from the device. The second stage shows the processes in the system consisting of the oil inlet pipe, steam supply pipe, casing, working chamber, oil discharge pipe, volatile components and water vapor mixture discharge pipe. The input parameters for the second stage are the accumulated oil mass and water vapor consumption. The output parameters can include steam pressure and consumption. The working chamber where the deodorization process takes place is the third stage of the system. The input parameters of the system are the mass, temperature, and concentration of the oil entering the chamber, as well as the water vapor consumption, temperature, and concentration of the volatile components in the oil. Oil mass, temperature and volatile component concentration are considered as output parameters.

The most important for the study are the IA processes that occur between vegetable oil and water vapor in the working chamber. For this purpose, mathematical expressions of events occurring in the liquid and vapor phase are first written, and a mathematical model of the process is developed. After that, a computer model of the research is formed based on the mathematical model. In the process of multi-stage mathematical modeling, it is taken into account that the working chamber consists of moving nozzles, oil and vapor phases, and that the volatile components transfer from the oil phase to the vapor phase due to the chaotic movement of the moving nozzles as a result of the imbalance between the oil phase and the vapor phase.

We assume that the oil phase consists of several sublayers. During the process, the vapor phase passes through each sublayer. The input parameters of the liquid phase include oil mass and temperature, and the output parameters include oil mass, temperature, and concentration of the volatile component. The change in the concentration in the liquid phase is also affected by consumption, temperature and the concentration of volatile components. The lower stage device consists of a set of lower layers, similar to the oil layer. Liquid and vapor phases can be analyzed in the downstream device state. Then, in each downstream device, the liquid phase contains triglycerides, acids, ketones, and other volatile components, while the vapor phase contains water vapor and volatile components. In doing so, a computer model is created using equations that describe the physical and chemical properties of each sublayer during the deodorization process. In this way, a multi-level systematic analysis of the oil deodorizing apparatus was created based on the systematic analysis. Based on a systematic analysis, the possibility of speeding up the process by finding the hierarchical steps of the periodic oil deodorization apparatus is studied.

References:

1. N.R.Yusupbekov, H.S.Nurmuhamedov, S.G. Zokirov. Kimyoviy texnologiya asosiy jarayon va qurilmalari. - T.: "Fan va texnologiya", 2015. - 848 bet.

2. Заминян А. А., Рамм В. М. Абсорберы с псевдоожиженной насадкой. - М.: Химия, 1980. - 184 с., ил.

3. Лаптев А.Г., Фарахов М.И., Минеев Н.Г. Основы расчета и модернизация тепломассообменных установок в нефтехимии. Монография. – Казань: Казан. гос. энерг. ун-т, 2010. – 574 с.

4. Л.Я. Живайкин, В.Б. Сажин, М.Б. Сажина, М.А. Апарушкина, М.А. Кипнис,В.А. Курпас. Насадочные колонны с подвижной (псевдоожиженной) насадкой Успехи в химии и химической технологии. Том XXIV.2010. №5 (110) ст. 120-122.

5. Хамдамов Анвар Махмудович, Игамбердиева Дилфуза Алимовна. "Математическое моделирование равновесного состояния экстракционного бензина и жирных кислот" Science Time, no. 4 (40), 2017, pp. 209-213.

6. Султанов С. Х., Хамдамов А. М., Артиков А. А. Эффективное использование плавающих деревянных насадок при интенсификации процессов массообмена //Universum: технические науки. – 2022. – №. 4-7 (97). – С. 46-48.

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