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The Features of Technologies for Obtaining Cocoa Butter Substitutes from Vegetable Oil

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Abstract:

The article analyzed several ways to obtain cocoa butter substitutes (CBS) from vegetable oil.

Keywords: cocoa butter, cocoa butter substitute, hydrogenation, transesterification, cotton palmitin, salomas, triacyl glyceride.

Introduction

The oil industry is one of the important sectors of the food industry. Its enterprises provide the population and the national economy of the Republic of Uzbekistan with oil, margarine products, mayonnaise, soaps, glycerols and others.

Currently, the global production of hydrogenated oil and fats totals about 8 million tons/year, of which the United States accounts for about 3.5 million tons, the CIS countries - about 1.2 million tons. The use of hydrogenated fats in developed countries is expanding sharply. This is due to the wide variety of raw materials and the improvement of catalytic hydrogenation technology. It should be canceled that the large assortment of salomas produced in the USA and Western Europe is determined by the desire to more fully meet the needs for the production of salad oils, preservation oils, margarines, culinary, confectionery and bakery products, as well as the soap, cosmetic and chemical industries [1].

Considering the need to process a very diverse range of raw materials and produce a large assortment of salomas on their basis, hydrogenation is mainly carried out by a periodic method. In the oil and fat industry of the Republic of Uzbekistan, the main direction of technological progress is the creation of a new, improvement and intensification of existing technologies for processing oils and fats, which ensure a significant increase in the productivity of technological equipment. Of particular importance in this direction is the production of hydrogenated fats of various purposes, the need for which is constantly growing.

In this regard, theoretical and experimental studies are relevant for industry which aimed at intensifying the process of hydrogenation of vegetable oils and finding new sources of hydrogenated fats, which include cotton palmitin.

Currently, the hydrogenation of fats is carried out in autoclaves using a powdered, suspended nickel-copper catalyst. The obtained salomas contains a catalyst which is separated by filtration. Stationary catalysts at hydrogenation plants of the Republic of Uzbekistan are not

yet used. Catalysts used in the hydrogenation of fats should: a) ensure the production of salomas of the desired quality, i.e. have selectivity of action; b) be made of affordable and inexpensive materials; c) the manufacturing process should not be particularly complicated; d) do not require complex equipment, easily separate from salomas, easily regenerate.

The main raw material for hydrogenation is soybean, cotton rapeseed and some other vegetable oils. The peculiarity of the triacylglyceride composition of these oils allows slightly reducing the requirements for the selectivity of hydrogenation of disaturated acids. Cotton oil is the main raw material of the fat processing industry in Central Asia. However, its reserves are insufficient to fully ensure the capacity of the hydrogenation plants in the region and therefore it becomes a task to replace part of this oil with other oils.

A significant part of vegetable oils in refined form is directly used as a food product, as well as as a liquid oil component of various foods margarines, cooking fats, mayonnaise, etc.

Commodity fats of plant and animal origin consist of glitseridny and neglitseridny (not fat) parts. The first of them is mix of the triglycerides differing on structure, the building and degree of not limitation. One of the most serious modern problems of refining fats for the food purposes consists in need of the maximum preservation of his food advantage and physiological value. Carefully refined oil is exposed to a hydrogenation. Depending on quality of initial raw materials and the mode of its catalytic modification receive fats for margarine, confectionery products, for production of toilet and laundry soap, etc.

Chemical and physical properties of natural vegetable oils and animal fats depend on their fatty acid composition and distribution of fatty acids in mix of triglycerides.

The correction of the hydrogenation process in order to obtain fats with the specified properties consists in the selection of feedstock for hydrogenation, catalyst, process conditions (hydrogen pressure temperature, hydrogenation duration, catalyst amount, ratio between feed rates and hydrogen).

By combining controlled process parameters, hydrogenated fats with different properties are produced on an industrial scale. To produce food fats with moderate melting point and uniform consistency, liquid vegetable oils containing glycerides of linoleic and polyunsaturated fatty acids are hydrogenated.

There are many studies in the literature [2] devoted to the study of the process of catalytic hydrogenation of vegetable oils and fats. All of them are aimed at improving the catalytic process, i.e. at selecting a more efficient catalyst, determining the optimal parameters of the process, the conditions for its implementation. The complexity, and in some cases contradictory, of catalytic phenomena seems to be the main reason that there is still no universal theory of heterogeneous catalysis, which allows, in particular, to fully explain the mechanism of fat hydrogenation.

Fat hydrogenation is a complex catalytic process, where the effectiveness of the catalysts is determined not only by their nature, but also by the conditions of the process.

The rate of hydrogenation of fats depends mainly on the composition of their fatty acids, the activity, nature and amount of the catalyst, the intensity of hydrogen bubbling and the uniformity of its distribution in the fat, and the heating temperature of the fat. The hydrogenation rate increases to a known limit as the amount of catalyst introduced increases [3]. However, at a temperature of 180 ° C or higher, an increase in the amount of catalyst in excess of 0.3-0.4% by weight of fat does not significantly increase the reaction rate. This appears to be due to the low solubility of hydrogen and the low rate of its diffusion in fat. The optimum amount of catalyst also depends on the dispersion of its particles and other factors [4]. Therefore, in different cases it can be different.

The author of study[2] concludes that with an increase in the hydrogenation temperature from 60 ° C to 100 ° C, its speed increases on palladium, platinum catalysts and Rhenium nickel by an average of two times, and selectivity also increases, to the least extent this is observed in the process carried out with a nickel ceramic catalyst, to a large extent when working with Rhenium nickel, platinum and palladium.

V.I. Shlyakhov, D.V. Sokolsky [5], studying the effect of temperature on the rate of hydrogenation of cotton oil on skeletal catalysts, found that at temperatures of 120-180 ° C the temperature reaction coefficient has a value equal to 1.30-1.35, while at temperatures of 60-120 ° C and 180-200 ° C its value approaches unity.

D.V. Sokolsky, N.A. Nechaev et al. [4] studied the kinetic patterns of cotton oil hydrogenation on a skeletal nickel catalyst. The process was carried out at a hydrogen pressure of 0.05-0.8 Mn/m2. The hydrogenation rate increases with increasing pressure to 0.6 Mn/m2 and increasing hydrogen transmission rate to 10 ml/min. low activation energy is observed in the temperature range of 120-220 ° C.

If the hydrogenation of fats takes place in the diffusion region, then the reaction rate increases to a certain limit with increasing temperature and does not increase further[5]. In the kinetic region, the change in the reaction rate with an increase in temperature proceeds according to the Arrhenius equation.

Hydrogen pressure has a significant impact on the quantitative and qualitative performance of the hydrogenate. In the case of high feed rates, the saturation rate is proportional to the hydrogen pressure, and at small rates - to the square root of the hydrogen pressure[6].

Many conflicting opinions have been expressed on the effect of mixing intensity on hydrogenate quality indicators. Similar conclusions [5] can be drawn about the effect of the amount of catalyst on the rate of hydrogenation of vegetable oils. However, when the oil is hydrogenated on stationary catalysts in column vessels, this parameter remains practically constant. It is advisable to carry out the process of hydrogenation of oils and fats in as short a period of time as possible, as mentioned in Work [6].

Work [6] studied the influence of the amount of hydrogen supplied on the process of hydrogenation of cotton oil on stationary alloy catalysts S-3 and D-4 in a column-type apparatus. It has been shown that it is most rational to carry out the process of hydrogenation

of vegetable oils in a column-type plant at a bubbling hydrogen supply rate of 100-120 h-1, which ensures high activity and stability of stationary catalysts, optimal physicochemical properties of the obtained salomas.

Salomas for the production of cosmetic stearin grade 5-2 according to OST 18-373-81 is obtained in a battery of five columns in a direct flow mode under a pressure of 0.6-1.0 MPa. However, the use of various types of fatty raw materials and the insufficient degree of their purification affects the stability of the quality of the hydrogenate and stearic acid obtained by distillation of fatty acids. Therefore, the existing plant was modernized, which consisted in replacing the column battery with a typical autoclave for hydrogenation of fats with a capacity of 12 m3. In a modernized plant in the presence of a nickel-copper catalyst, hydrogenation of cotton, palm oils and mixtures thereof, low iodine salomas of the desired quality was obtained, i.e. with an iodine number of 10.0-13.8% iodine and a titer of 56.0-57.0 oC [10].

Investigated the main ways to intensify the technology of cotton oil hydrogenation on nickel-copper catalysts in order to obtain hydrogenates with the specified properties[5].

It is proposed to circulate the reaction mass with the help of a sprayer installed on the upper part of the autoclave and a pump with a capacity of 20 t/h. It was shown that the improvement of the autoclave made it possible to increase the production of food salomas by 10-15%. Hydrogenation of cotton oil is intensified by promoting nickel-copper aluminum catalyst with germanium, rhenium, tin, rhodium and other metals. For promoter metals, descending rows of activity and selectivity are composed.

For the hydrogenation of fats and oils, a large amount of catalytically acting metals is proposed - both noble and ignoble. The former have high catalytic activity, but are very expensive to use in factory practice. Of the non-noble metals, mainly dispersed nickel or mixed nickel-copper catalysts are used for this purpose. The use of nickel-aluminum alloy catalysts is also practiced. The use of nickel-aluminum alloy catalysts promoted by various additives is also practiced. The search for new, more effective catalysts and methods of hydrogenation of oils and fats is an urgent scientific and technical task.

As can be seen, the influence of the process parameters considered on the quantitative and qualitative indicators of the process of hydrogenation of oils and fats can be assessed in different ways. First of all, this is due to the nature of the catalyst used and the form of its use with the combination and interaction of the composite parameters of the process, the hardware design of the technology, etc.

Summarizing the disclosed methods and techniques for hydrogenation of oils and fats, we can say that the known versions of the technology differ mainly in the nature and form of the catalyst used, the scheme for organizing material flows, as well as the processes for preparing raw materials and processing finished products.

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