Organization of efficient and environmentally friendly milk processing production

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Abstract. The article discusses the prospects for the technical equipment of milk processing industries in accordance with the implementation of the best available technologies (BAT). Examples of technologies and equipment corresponding to BAT for milk processing are shown, which implement membrane methods for processing whey, making cottage cheese and cheeses, which reduce energy costs and improve product quality compared to classical methods. Both domestic and imported units of equipment for milk processing are presented, the technologies and equipment developed are described in tabular form, conclusions are drawn about the need to increase own production of various membrane units.

1. Introduction
Currently, the Russian legislation has introduced a legal mechanism of regulation based on the use of the best available technologies (BAT) and a differentiated approach to regulation of impact, depending on the assignment of sources of exposure to a certain category. Enterprises of the food and processing industry were assigned to category IV with a minimum negative impact on the environment, but this does not underestimate the importance of introducing technologies and equipment that reduce the harmful impact on natural objects and increase the competitiveness of products [1].

Today, mainly imported equipment is distinguished by high-tech characteristics in the food and processing industry, for example, in the dairy industry, its share is about 70.0%. Almost half of the workforce, especially in small dairy processing enterprises, is outdated. Losses of raw materials in the process of processing reach 30%, the level of waste generation, discharge of untreated industrial effluents into open water bodies and emissions of industrial pollution into the atmosphere is quite high [2-4]. All this necessitates an early change in the existing situation.

2. Materials and methods
The research materials were information on the state and prospects of development of highly efficient environmentally friendly technologies and equipment for milk processing by membrane methods; machine-building enterprises, scientific and educational organizations, one of the activities of which is the development of technologies and equipment for the introduction of membrane methods for milk processing. In carrying out theoretical studies, the method of system analysis was used.
3. Results
One of the ways to increase the efficiency and reduce the negative impact on the nature of milk processing industries can be environmental regulation in accordance with the industry reference book "Production of drinks, milk and dairy products", which is a document on standardization, developed as a result of analysis of technologies, technical and managerial decisions in the production of dairy products, with BAT for milk processing, including those involving the use of resource-saving membrane technologies [2-4].

The authors analyzed the current state of development of membrane technologies for processing raw milk based on open information sources. The selection took into account the indicators specified in the reference book, including: for ultrafiltration, nanofiltration, electrodialysis plants, the productivity is 5-25 m³/h. Systematized information on environmentally oriented membrane equipment that ensures the transition to BAT principles is given in table 1.

**Table 1.** Examples of environmentally friendly and energy efficient membrane equipment for milk processing.

| Technological process | Characteristic |
|-----------------------|---------------|
| Waste-free milk processing technology "Bio-Ton" FGBOU VO North Caucasus Federal University | Based on biomembrane after the introduction of polysaccharide (spontaneous reverse osmosis) fractionation of the original milk into four components: cream, skim milk, natural casein concentrate (casein-calcium-phosphate complex in micellar form and whey-polysaccharide fraction. It allows you to reduce the costs associated with waste disposal and environmental protection in accordance with BAT, rationally use raw materials, get variations of normalized mixtures, changing the nutritional, biological value and activity of the final product [5]. |
| Technologies for producing lactose, complex federal project SKFU-MKS "lactose +" FGBOU VO North Caucasus Federal University | Includes membrane conditioning of all types of lactose-containing raw materials with original logistics for extracting "pure" lactose (100 patents), with full digitalization and automation. Complies with BAT requirements. It is implemented on the equipment of the innovative enterprise ShchekinoAzot JSC. Provides efficient production of low-lactose milk [6]. |
| Technology for obtaining dry cheese whey Federal State Budgetary Educational Institution of Higher Education North Caucasus Federal University in cooperation with Drying Machinery Process LLC Whey processing technology FSBEI HE Vologda GAU | The defatted, separated pasteurized cheese whey is concentrated in a nanofiltration plant, effectively removing up to 70% of water from the raw material. To increase the efficiency of the process and ensure wastelessness, it is proposed to carry out nanofiltration in conjunction with reverse osmosis. Includes the use of reverse osmosis plants at large dairy farms to remove some of the water from raw milk. Conforms to the requirements of BAT, it is sold using imported equipment. Allows you to additionally receive industrial water from milk whey in the amount of 50% of the amount of raw materials. Nanofiltration allows to reduce the total energy consumption for thickening, and crystallization of lactose - to reduce energy consumption during drying [7]. Implemented on imported equipment. The introduction will reduce: the volume of raw materials and the resulting whey, transport, resource costs (energy, water). Will increase the efficiency of the production of canned milk, cheese, cottage cheese [8]. |
| The technology of obtaining lactose-free milk by multistage diafiltration FGBOU VO Ural GAU | The parameters for the application of membrane technologies have been developed. With a permeable membrane permeability equal to 40 • 10·3 m³/(m²•h), the optimal serum Domestic membranes produced by NPO Keramikfilter, Moscow, and foreign membranes, produced by TAMI Deutschland GmbH (Germany). It will make it possible to obtain milk with a |
| Technological process | Characteristic |
|------------------------|---------------|
| Technology and equipment for processing milk whey | velocity above the membrane was 1.5-2 m/s, the optimal pressure was 0.3 MPa. It is based on the use of ultrafiltration and nanofiltration methods for the processing of whey both at large dairy enterprises and at small enterprises. minimum lactose content, identical in composition to natural and inexpensive to manufacture [9]. Implemented at the pilot plant of OOO NPO Keramikfilter (Moscow), manufactured jointly with OOO Molnashstroy (Yekaterinburg). We used KUFE - 19 (0.02) membranes from NPO Keramikfilter LLC and DOW NF245 membranes (USA) [10]. |
| Concentration technology for milk cheese whey | Based on the application of the ultrafiltration method The use of the principle of rotation allows to significantly intensify the process of UV concentration, to increase the duration of uninterrupted operation of the installation to 270 min and to obtain a protein concentrate of cheese whey with the required mass fraction of protein. |
| Soft cheese production technology | It is based on the use of milk concentration by ultrafiltration, determination of the optimal ratio of dry substances and protein in the concentrate, study of the influence of technological methods on the organoleptic characteristics of the finished product. |
| Technology for concentrating milk whey | Based on the use of membrane processes for the concentration of whey. It was found that with an increase in the output specific flux of the solvent, the retention coefficient decreases, and for whey from goat milk, preliminary separation is required due to its high fat content. |
| Cottage cheese production technology | Based on the use of ultrafiltration membranes for milk concentration. Provided the specified quantitative composition of macronutrients proteins: fats, as 1:1. |

4. Discussion
Summarizing the information presented in the table, it should be concluded that the developed technologies for milk processing using membrane methods are most often provided with the use of imported equipment, or imported components, which confirms the need to increase domestic production. There are also obvious prospects for the use of membrane processes that contribute to resource conservation and increase the efficiency of production of cheese, cottage cheese, whey processing, ensuring the use of all milk components, with their help, environmentally friendly principles of complex processing of raw milk are implemented in accordance with BAT.
5. Conclusion
The state agrarian policy provides for the innovative development of the agro-industrial complex, which ensures high efficiency. The transition to advanced technologies in agricultural production will provide an opportunity to significantly increase its productivity and raise the quality of products. For the systematic and effective development of dairy processing industries and obtaining competitive domestic products, it is necessary to produce and introduce new domestic equipment for membrane technological processes that ensure the implementation of BAT.

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