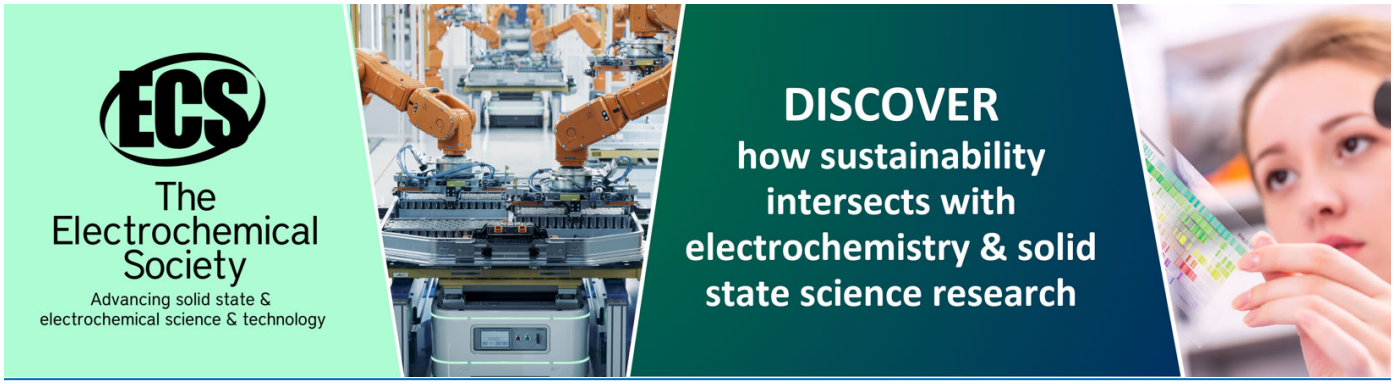
# Actual problems of the dairy industry automation in the Sakha Republic





# Actual problems of the dairy industry automation in the Sakha Republic

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**Abstract.** The development of the food and processing industry of the Russian Federation for the period up to 2020 provides for a systemic solution of the problems of development of the food and processing industry, resource and financial support of the industry, and improvement of the performance of agricultural production. The development strategy is designed taking into account the provisions of the Federal Law "On the Development of Agriculture". Implementation of the agrarian policy of the Republic of Sakha (Yakutia) is also carried out as part of the agrarian policy of the agro-industrial complex of Russia, under the priority national project "Development of the Agroindustrial Complex of the Russian Federation". The strategy is designed not only to provide the necessary conditions for the modernization of industry, the formation of a new technological mode, but also to solve financial, economic and social problems, contribute to the realization of the goals of socio-economic development of the Russian Federation until 2020. The relevance of the scientific article lies in the fact that at present the socio-economic situation in the country requires finding new approaches to improving food production conditions and living standards of the Sakha Republic (Yakutia), requires the introduction of innovative milk processing technologies to ensure safe, cheap, high-quality milk and dairy products for the population of the republic.

## 1. Introduction

In order to increase the technical and economic indicators of the milk production process, simplify its management, reduce the number of employees and service personnel, improve the quality of products, TP automation is increasingly beginning to be used. In today's world, automation occupies a fundamental position and its role in technical processes is difficult to overestimate. In this work an automated process control system (ACS TP) of dry milk production on the drying section is developed [1].

Without application of automation of technological processes, or on other words without implementation of ACS TP, not any branch of production can do. Design and development of APCS is carried out along with the implementation of SCADA systems in production, which makes such a system a universal, often distributed control system (DCS).

An important advantage of the APCS is to reduce the influence of the human factor in the controlled process, reducing the number of staff, saving consumables and raw materials, and of course the most important parameter in our time as the quality of the product, which ultimately affects the efficiency of production [2].

## 2. Materials and methods

Agricultural automation in its formation and development is based on the rich experience accumulated in industry. At the same time, the characteristic features of agricultural production determine a number of specific requirements for the methods and means of rural automation. Unlike industry, agriculture uses soil and living organisms along with machinery. Machine technology is intertwined and closely linked with biological processes. The main feature of agricultural production is the inseparable connection of machinery with biological objects, which are characterized by the continuity of physiological processes of production cycling [3].

Under these conditions, automation must work very reliably, since such a process cannot be interrupted, and it is practically impossible to catch up by intensifying the subsequent period. Production processes in agriculture are complex and varied and depend on specific zonal conditions of production. This leads to an even greater diversity of technological processes, some of which are in the stage of incomplete rearrangement to flow machine production, and also causes differences in the types, designs, characteristics and modes of operation of agricultural machines and plants, not always adapted to the use of simple automation devices on them.

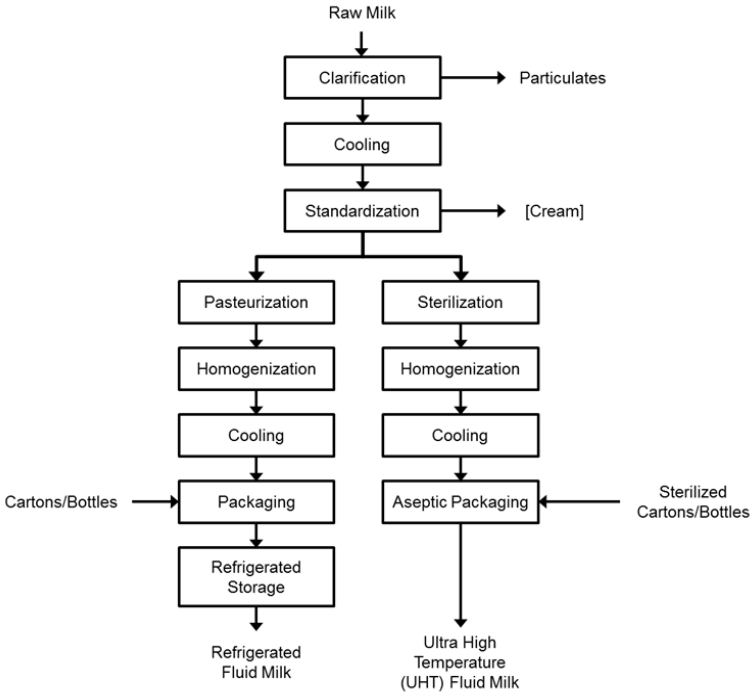


**Figure 1.** Stages of automated Milk Production.

## 3. Findings

Let us analyze the activity of the enterprise "Yakutsk Milk Combine", the largest enterprise in the region for processing milk and producing dairy products. The production capacity of the enterprise is designed to process about 700 tons of milk per day and produce almost 100 types of products (milk, cottage cheese, cheese, sour-milk products).

Lately the experience of interaction with large federal trading networks has been gained. The plant's plans are not limited to this - it is starting to work in the Customs Union, and there are plans to develop the Kazakhstan market [4].

Such a large enterprise of regional importance needs stable work of all sections of each production cycle. A significant part of technological processes is automated, but with the increase of production it is often necessary to modernize one or another area. The ultimate goal of automation in a dairy plant is to adjust the production cycle to a certain mode of operation, which is reduced to minimal involvement of employees:

- observation of the process,
- adjustment of monitoring devices,
- mechanisms and equipment,
- preventive maintenance;
- troubleshooting.

Automation in the dairy industry is a lengthy and costly process that is implemented by studying the specifics of production. This includes, first of all, selection of a set of necessary technical means; development of design documentation; creation of programs containing algorithms for control of technological equipment and algorithms for collection and processing of information; installation of the system and carrying out preliminary tests. As a rule, all these works at "BMK" are performed by its specialists without outsourcing, namely, by the staff of the department of instrumentation and automation [5].

Only for the last year the dairy plant implemented several systems, including the system of regulating water supply to the gas boiler and the modernization of the automatic batch packaging of dairy products in PET bottles. In addition, the accounting system for finished products and empty containers was implemented at the plant.

The milk processing plant has been operating for more than a year without any failures the automated unit at the milk and milk products bottling line, to be more precise - the automatic machine for bulk packaging which collects PET bottles into a group of 6 pieces and packages them in shrink wrap.

The packer originally had a relay control circuit. However, after an emergency stop it had to be taken apart for more than a day - the system turned out to be practically unrepairable. It should be noted that a day's downtime of the line is a lot of money, so after the accident it was decided to modernize the machine.

Part of the old circuit, which implemented the relay logic of the packaging process control, was dismantled, and the control circuit for the conveyor, knife heating and control of the packaging film unwinding was left unchanged.

Control of complex lines is most often developed on controllers with high speed and possibilities of various combinations of inputs/outputs, but in this case it was possible to implement the system using programmable relays.

The system uses two basic devices: programmable relay PR110-24.12D.8P and switching unit BKM1.

When power is applied, the indication turns on and the bottles enter the conveyor. Switching on of the sensors and actuators can be traced by the indications on PR110. The cycle starts either when the products are accumulated or when the CYCLE button is pressed. As soon as the limiting bar is lowered, a relay is actuated and the pusher is fed forward. As soon as the pusher reaches the front position of the bottles, it retracts and the knife seals the shrink-film and cuts it off the roll.

If a foreign object is detected in the working area of the knife, the position sensors activate and block the movement, and the knife returns to its original position. To release the interlocks, either the power must be reset or a full cycle must be skipped [6].

As a result, stable operation of the machine has been achieved. Functional possibilities were expanded - before there were difficulties with packing small products, now it is possible to pack containers from 0.25 to 2 liters. Finding and troubleshooting has been greatly facilitated, resulting in less emergency downtime.

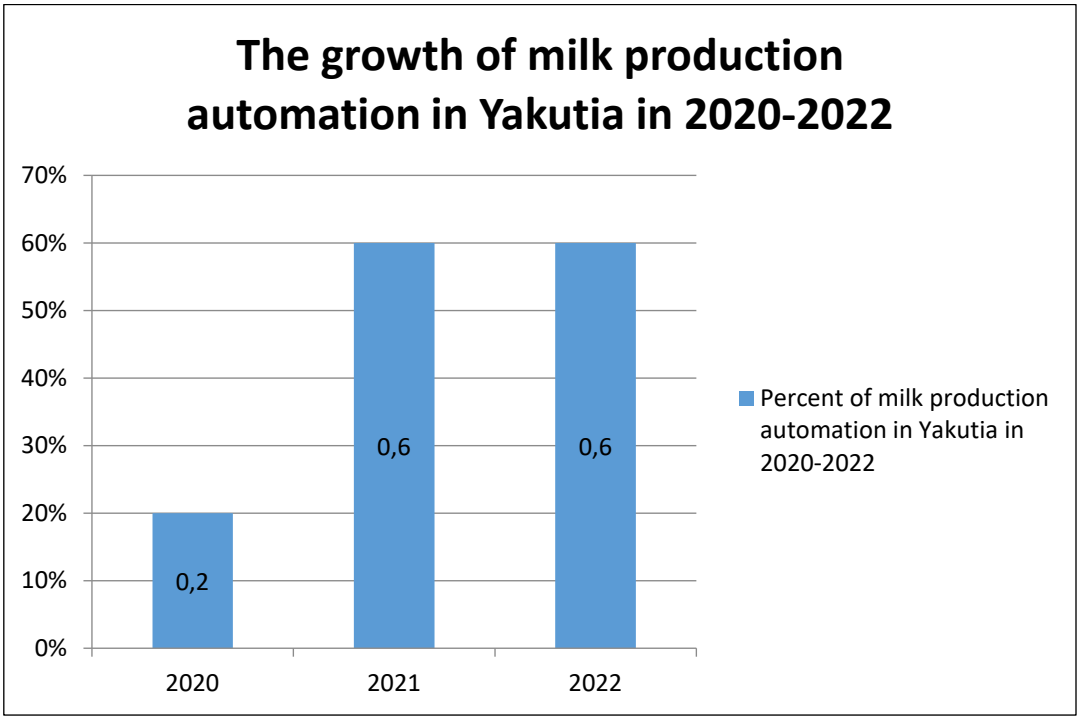


**Figure 2.** The growth of milk production automation in Yakutia in 2020-2022.

The plant implemented a system for regulating water supply to the gas boiler. The system is designed for uninterrupted supply of initial feed water from two independent sources. The first source is the main water supply, the second is condensate water, which is formed during the production of the main product.
The system provides:

- stability of water supply;
- possibility of operation with one water source;
- control of temperature of water supplied to the filtration system;
- quality control of condensate water and shutdown of its supply in case of unacceptable changes in its chemical composition;
- disconnection of condensate water supply to the intermediate tank in case of exceeding the set level [7].

Selection of automation equipment. In the company is a representative of the instrument-making company TECHOM-AUTOMATIKA, with which the plant has signed a favorable contract for the supply of automation. Products OVEN was chosen not only because of the wide range of instruments offered. The main reason - an acceptable ratio of price and quality.
Water supply system consists of devices:

- PR114 programmable relay;
- Universal logical controller SAU-U-D;
- level indicator of liquid and bulk solids;
- frequency converter, digital single-channel meter;
- pressure transducers;
- single-channel meter with a sensor.

The system equipment is located in the boiler room and steam shop. In the boiler room the following is carried out:

- water conductivity indication to assess water quality;
- condensate water level control
- conveyance of condensate water from the boiler plant to the boiler room (PCV).

In the boiler room, the following is provided:

- water supply to the boiler feed system from the intermediate tank of the steam-power plant (IFP);
- control of pressure by a sensor cut into the supply line and included in the feedback circuit;
- control and regulation of water level in the intermediate tank in the steam plant ;
- monitoring of water temperature, supplied to the boiler [8].

Control of condensate water quality is based on measurement of liquid conductivity. When impurities in the form of detergent solutions (acid, alkali) or milk processing products get into the water, water conductivity increases, which is recorded by the system. In the pipe, through which the condensate water flows from the intermediate tank located in the boiler room, there are conductometric sensors, the signal from which is sent to the inputs. The peculiarity of the controller is the possibility to adjust the operation of inputs depending on the conductivity of liquid. The inputs are adjusted programmatically using additional adjustment resistors. The system is configured to shut down when the set conductivity threshold is exceeded.

Condensate water flows by gravity from the process plant. Control of water level in the intermediate tank in the boiler shop is carried out with the help of alarm device SAU-M7E. Conductometric sensors installed in the tank control the upper and lower levels. When the upper level is reached, the output relay closes, which is connected in series with the condensate water pump in the intermediate tank of the steam plant. The output is switched off when the lower level is reached. The set hysteresis excludes frequent switching on of the pump [9].

Water supply to the boiler drum is carried out by means of a pump, the capacity of which is regulated by a frequency converter. The signal for switching on comes from the output. If the water level in the tank drops below 0,4 m, the output opens the start-up circuit. The light and sound alarms are activated in the boiler operator's room, and the personnel performs the necessary actions for switching over to the emergency water supply or stopping the boiler.

The intermediate tank is filled from two sources: main water supply and condensate water from the boiler room. The water level is maintained by a relay and monitored by a transducer that indirectly indicates the level in the tank. A single channel display shows the current water level in meters or setpoint in the same units.

The boiler consumes water from an intermediate vessel. If there is no liquid in the boiler, there is a signal allowing the condensate and opening of the main water valve. The mains water supply to the intermediate vessel is regulated by means of a control ball valve with electric actuator. When the set point is reached, the main water valve begins to close and the condensate water continues to flow in. At a level of 1.6 m, the condensate water supply is interrupted.

The level in the tank is maintained at the setpoint level by the controller. When the level is above the set point (0.4 m), a switch-on authorization signal is given. If the system is ready for operation, the operator starts it manually. In this way, an uninterrupted water supply to the boiler drum is ensured [10].

The meter monitors the temperature of water supplied to the boiler according to the sensor readings and switches off the condensate water relay when the setpoint value (60 0 C) is exceeded.

The system ensures uninterrupted water supply to the boiler. In addition, the system allows to use not only the main water, but also the condensate coming from the workshops, which in turn significantly saves consumption of artesian water. Also, the quality of incoming condensate water is monitored,

which prevents disruption of boiler equipment and premature deterioration of expensive filtering material.

Automation of milk processing areas at "BMK" made it possible to reduce personnel involvement in complex production processes and exclude their influence on the accuracy of compliance with instructions, leaving the employees to organize the management of technological equipment.

## 4. Discussion

The development of the food and processing industry of the Russian Federation for the period up to 2020 provides for a systemic solution of the problems of development of the food and processing industry, resource and financial support of the industry, and improvement of the performance of agricultural production. The development strategy is designed taking into account the provisions of the Federal Law "On the Development of Agriculture". Implementation of the agrarian policy of the Republic of Sakha (Yakutia) is also carried out as part of the agrarian policy of the agro-industrial complex of Russia, under the priority national project "Development of the Agroindustrial Complex of the Russian Federation".

## 5. Conclusion

To strengthen the vector of innovative development in the processing industry it is necessary to activate a new mechanism using a technological platform, to combine the efforts of business, government and science. The information base of the study is the data of the Federal State Statistics Service, publications in the periodical press, legislative acts of the Russian Federation and the Republic of Sakha (Yakutia), regulating the rural economy, instructions of the Central Trade Union of the Russian Federation, the websites of the Ministry of Agriculture of the Republic of Sakha (Yakutia), Sakhastat.

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