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Direction of rational use of water at livestock facilities

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Abstract. The article notes the world water shortage problem. Against this background, Russia's agricultural production is considered, in particular the livestock sector as the main consumer of water resources. The structure of the main technological processes at livestock facilities is given and possible technological damage is indicated in case of the lack of technological processes for servicing animals and poultry with water. The direction of rational use of water based on the introduction of new technical and technological solutions of water supply systems and means is substantiated. Constructive solutions of systems and facilities that help to reduce water consumption are presented, and as well a possible positive effect.

1. Introduction
There is currently a shortage of water resources in many countries [1,2]. Therefore, there is a need to find technical and technological and organizational solutions for the rational use of water in all spheres of human life. At the same time, it should be noted that in relation to Russia, agriculture is the largest water consumer. In comparison with industry, agriculture consumes 4-5 times more water. [3, 4] Providing water is particularly important for livestock facilities. This is largely due to the fact that the lack of water directly affects the productivity of biological objects (animals, birds), and in some cases leads to their diseases and death [5]. The lack of water in the performance of separate technological processes for servicing animals (removal of excrements) has a negative impact on the ecology in the zone of location of the cattle-breeding facility. Therefore, under conditions of water resources shortage, rationalization of water consumption at livestock facilities within the framework of zoological and technical requirements is one of the key problems of modern livestock production.

Inside the livestock premises, that is a separate livestock facility, the water discharge is mainly distributed according to the technological processes of animal drinking, milking (large and small cattle), sanitary treatment of the skin of animals and the process of sanitary disposal of technological equipment. At the same time, the quality of the performance of technological processes for servicing animals and water consumption largely depends on the operated technical and technological solutions of the water supply system for technological processes, and some of its structural elements [5].

2. Results and discussion
The water supply system should take into account the physiological characteristics of the served animals, the actual water flow including its temperature in accordance with the zoological and
technical requirements, and exclude or reduce the non-productive water flow. In order to fulfill these requirements, a multi-purpose water supply system for technological processes was developed Figure 1.

Figure 1 – Scheme of a multi-purpose water supply system for technological processes of servicing animals: 1 – vacuum pipe of milk line; 2 – vacuum chamber; 3 – an inlet pipeline; 4 – valve-float device; 5 – storage capacity; 6 – return piping; 7 – the main piping for supply of wash water; 8 – working piping for supplying the wash water; 9 – washing device; 10 – pneumatic exciter; 11 – pulsator; 12 – piping for the wash water supply; 13 – the main piping for drinking water supply; 14 – distribution piping of drinking water; 15 – auto drinkers; 16 – return piping of drinking water; 17 – locking devices; 18 – electric heater; 19 – working piping for the wash water removal; 20 – main piping for contaminated water removal; 21 – vacuum tank for the collection of contaminated water.

This system provides the preparation of water for use (heating up to the set temperature), its feeding into the zoning (means of automatic drinking, devices for washing the udder of the cow), the collection of nonproductive water (contaminated), followed by its filtration and treatment for reuse. Considering the system in relation to the served species, it should be noted that it can be transformed and used by separate units (subsystems). When using the group means of automatic drinking of flowing type in the automatic drinking subsystem, the non-productive water flow increases. [5-14] It can be up to 3 m³ per day from one group drinker.

Increased non-productive water flow is associated with manual periodic regulation of the water flow inside the drinker. With the adopted method of regulation one can not control the 24-hour monitoring of the water flow, which is directly dependent on the outside temperature of the surrounding air. Therefore, in order to rationalize the water discharge, we suggest their upgrading with the automatically regulated water passage in the winter period of their operation Figure 2, 3.
The main element of the device is a thermo-power sensor with a solid filler, one of its main statistical ones is the increment of the stroke of the rod, depending on the water temperature change in the water bowl. Studies have established that the operating temperatures of the sensor are in the range of 1-15 °C, and the developing effort reaches 16 kg.

To reduce water consumption and improve comfort of the technological process of servicing the cow, the subsystem for sanitary disposal (washing) the udders of animals should be equipped with containers for washing water and high pressure air, a system of pulsating feed of the wash water, lines for transporting water and air to the washing device [5,15,16]. To increase the effectiveness of the action of wash water on bacterial contamination, the skin of the udder, we consider it suitable to heat water and divide it by acidity into acidic and alkaline. Studies have established that the microflora of the skin of the udder is mainly represented by microorganisms, which refer to group 17 (gram-positive cocci) of the genus Micrococcus and Staphylococcus according to Berji’s the classification. It was also found that the spore microflora is suppressed both with acidic and alkaline solution. The most effective ones are acidified solutions (pH 6.0 and below, as well as alkaline solutions with a pH of 8.0 or more. They reduce bacterial contamination by 11 or more times. However, the use of alkaline solutions contributes to the appearance of an adverse side effect (drying of the skin of the udder, followed by the appearance of cracks on its surface). It is advisable to perform the treatment of the udder with a water-air mixture twice (before putting on the teat cups and after removing them).
Figure 3 – Construction (a) and installation of a control device for the water flow in the drainage zone (b):
a – the construction of the device; 1 – body; 2 – cover; 3 – bracket; 4 – thermo sensor; 5 – valve; 6 – membrane; 7 – spring; 8 – damping device; b – scheme of the device installation; 1 – drain piping; 2 – drain hose for water; 3 – drain plug; 4 – water trough; 5 – bypass pipe; 6 – the cover of the bowl; 7 – drainage branch pipe; 8 – the protective cover of drinking bowl; 9 – the body of drinking bowls; 10 – thermo-power device

Analysis of the proposed structural improvements of the subsystem (Figure 4) and technological requirements for the udder washing process shows that the subsystem under consideration can be unified with the automatic drinking subsystem (a single transporting material is water; a compatible temperature regime for water preparation is up to 30...45°C) and a ventilation system for livestock
facilities (the required component of the mixture is air). In this case, the design of the storage tank should be three-section (the section for placing water for needs of automatic drinking, the section for placing the activated water with pH 6.0, the section for placing the activated water with pH 8.0), while the body is double-walled with a cavity for accumulation of air of increased pressure.

Figure 4 – The scheme of the subsystem of washing the udder of cows: 1 – fresh water delivery line; 2 – vacuum line of the milking plant; 3 – pulsator; 4 – pneumatic exciter; 5 – air cavity of the water tank; 6 – cavity for drinking water; 7 – valve-float device; 8, 9 – cavities for activated water in pH; 10 – airline ventilation system; 11 – heat power unit; 12 – compressed air delivery line; 13 – the suspension; 14 – piping for wash water supply; 15 – piping for compressed air supply; 16 – washing device; 17 – piping for the suction of polluted water; 18 – capacity for the collection of contaminated water; 19 – piping for polluted water discharge; $P_a$ – air of increased pressure; $P_{as}$ – atmospheric air; $P_{vac}$ – a vacuum

3. Conclusions

As a result of the analysis of the importance of water resources in various spheres of human activity and the dynamics of changes in the natural water balance, the following conclusions should be drawn:

1. The rational use of water is one of the ways to maintain the water balance within a particular economic entity;
2. Animal husbandry is one of the main consumers of water when performing technological processes for servicing animals;
3. The main water flow in the maintenance of animals goes to the processes of automatic drinking and milking;
4. Development and introduction into production of a multifunctional system of water supply for technological processes of servicing animals and resource-saving constructive solutions of the basic elements of the system makes it possible to ensure rational use of water;
5. The offered technical and technological solutions of systems and means of water supply for technological processes of servicing animals allow to reduce non-productive water discharge for a
drain of 3 m$^3$/day up to 0.8...1.0 m$^3$/day, the production water consumption for a single treatment of the udder of one cow from 2 litters to 1.5 water. At the same time, a positive concomitant effect is possible: improving the quality of milked milk; decrease in the incidence of the udder of the cow; decrease in the risk of morbidity of attendants.

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