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INNOVATIVE APPROACH TO DETERMINE THE TEAT CUP LINER TENSION

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Abstract. In order to implement the technological restructuring of the milk production process at large scale it is necessary to ensure a constant and efficient operation of the milking and dairy equipment. This article highlights some of the technological challenges that are common in the operation of milking systems. It describes the main parameters of teat cup liners, which are both important for measurements and affect significantly the milking process. It has been found that the development of new reasonable and effective technological solutions regarding dairy cattle exploitation along with improving the parameters and operating regimes of the means of implementation in production processes provide the background for identifying the maximum productive capacity of animals as well as for improving the efficiency of the staff. The method and the device for determining the teat cup liner tension in the milking machines based on the use of a dial indicator to control the liner tension have been developed. The implementation of presented developments into production will ensure the prompt receipt of reliable information regarding the liners' tension which will enable timely detection of negative factors, and namely the lower tension.

Key words: Dairy cattle farming; Milking; Teat liner; Tension; Device.

INTRODUCTION

Livestock farming is one of the largest and leading sectors of agricultural production. In this regard, the solutions to food safety and security problems depend greatly on its effective development, namely the development of dairy farming which is one of the strategic sectors of animal husbandry in Ukraine. It determines country's food security, the nutritional quality of food for population and has a high export potential (Petruša, E.Z., Nagornyj, S.A. 2013, Palij, A.P., Palij, A.P., Naumenko, O.A. 2015).

It is possible to improve the efficiency of domestic dairy farming gradually through the integrated implementation of the latest innovative technological and organizational solutions. Only the complex mechanization of production processes and operations, the coordination of mechanization issues with the technological achievements and the organization of production by means of creating production lines can guarantee an increase of production efficiency. The mechanization of individual processes doesn't mean a reduction of the total number of employees but, on the contrary, requires skilled professionals for the maintenance of machinery and equipment, which consequently increases the number of employees (Škurko, T.P. 2003, Palij, A.P. 2014c).

The contemporary practice of domestic dairy farming shows that unexpected temporary shut-downs in the dairy farming violate the whole structure of a certain regime of production line, and this, in its turn, significantly affects the physiological functions of animals leading to a decrease of their performance and consequently increased costs of the obtained products. Therefore, the mechanization of modern dairy complexes should be oriented both towards the restoration of the old equipment and its modernization achieving the transition to a new technological level. Thus, the development of tools and methods that will prevent unexpected interruptions and adjust the equipment as close as possible to the physiological needs of the milking animals represents an urgent and prospective task both of practical and scientific interest (Boroznin, V.A., Plotnikov, V.P. 2003, Palij, A.P. 2014d).

One of the main problems in the technology of milk production is the use of adaptive machines, which give the opportunity to obtain quickly and accurately high quality milk while saving its primary properties. Nowadays the introduction of modern milking technologies and equipment into the structure of quality food production gains a huge importance (Solov'ev, S.A., Kartašov, L.P. 2001, Palij, A.P. 2014b).

Determining the priorities regarding the improvement of technologies implemented in the dairy farming is impossible without carrying out a thorough analysis and monitoring the necessity of implementing innovative techniques and technologies.

MATERIAL AND METHODS

The purpose of the study was achieved using analytical, theoretical and zootechnical research methods, as well as based on standard measuring equipment.

The development of methods as well as the manufacturing and adjustment of device for determining the tension length of the teat cup liners were carried out within the scientific laboratory of the Department of Technical Systems and Technology in Animal Breeding named after B.P. Shabelnik of the Education and Research Institute of Technical Service (ERI TS) of Kharkiv Petro Vasylenko National Technical University of Agriculture.

The scientific and economic researches were carried out in the state-owned enterprise experimental farm "Kutuzovka" of the Institute of Animal Science of the National Academy of Agrarian Sciences of Ukraine, Kharkiv district, Kharkiv region, on the milking installation for milking in stall of herringbone types (2x8) (MEH - Milking Equipment of Herringbone type) produced by the Open Joint Stock Company „Bratslav”.

RESULTS AND DISCUSSIONS

In order to implement the technological restructuring of the milk production process at a large scale it is necessary to ensure a constant and efficient operation of the milking and dairy equipment. To ensure the mechanization of main and auxiliary operations in the milking of cows it is planned to manufacture high-performance and efficient machinery and equipment thus obtaining a complete technological unit. But along with the development of high-performance equipment and saturation of dairy livestock industry, the issue of improving its reliability is even more acute as it is one of the main reserves for increasing machine productivity eliminating technical and technological failures, fact which will increase milk yield and milk quality. A more efficient use of the milking and dairy equipment, rational use of all its systems and components, timely detection and prevention of failures and malfunctions largely depend on the timely and quality diagnostics and maintenance (Palij, A.P. 2014a).

Liners are the only item in the milking machine which is in direct contact with the animal's udder. Compared to other parts of the milking machine, it operates in harsh conditions. During the milking process, a teat cup liner is expanded and compressed up to 60–70 times per minute and for 5–6 minutes (the average time for most milking cows) it squeezes a teat 300–420 times.

Liners are made of rubber or silicone. They consist of the following main parts: a head located in the upper part; a hose (the middle part); a teat tube (the bottom part) (Kurak, A. 2010).

The main data which are essential for measurements and have a significant influence on the milking process are as follows: the diameter of the head inlet, the diameter of the rod of a liner, the outer diameter of a liner sucker deformation, the wall thickness of the rod and the effective length of the whole liner.

The wall thickness determines physical properties of a liner hose (the degree of softness / hardness). The edge of the head inlet is also essential. It should also vary in softness / stiffness, depending on the shape of the teat to which it is applied.

The milking process is carried out so that to keep an udder healthy and to milk the animal quickly, completely and painlessly. For more than a hundred years, since the establishment of the above described milking machine, it has not almost changed.

The use in the milking machine of liners with different physical and mechanical properties and degree of tension leads to the fact that the teat cups are not equally affecting the cow's teat, and this is one of the main reasons that animals fall ill with mastitis. Moreover, the loss of milk when milking cows with milking liners, which do not correspond the zoo-technical requirements or to those of poor quality, can range from 7 to 21 % (Baranovskij, M.V., Kažeko, O.A. 1991, Boroznin, V.A., Boroznin, A.V. 2005).

After carrying out the patent search it's possible to conclude that current methods, devices and tools designed to study performance properties of the teat cup liners, namely their tension, have a number of disadvantages: difficulties during the operation, unreliable design, the need for time-consuming measurements. In addition, not all of them provide a rapid collection of reliable data.

In order to eliminate the above mentioned drawbacks we have designed a method and apparatus for determining the tension of teat cup liners (Palij, A.P. 2014e, Palij, A.P. 2015f).

The device for determining the tension of teat cup liners consists of a counting device (dial indica-



Figure 1. Device for the detection of the tension in teat cups liners.

tor) with a limit range of measurement up to 25 mm, a housing, a fixation screw, a stop, a movable bushing, a pivot arm and a fixed insert.

The implementation of the method and operation of the instrument is as follows: ready-to-use device (a dial indicator readings are in the initial position) is inserted into the liner and placed in an upright position, with the stop limiting the depth of device insertion (Fig. 1).

The pivot arm and a fixed insert are in contact with the inner surface of the liner, thus determining its tension. The teat cup liner tension is indicated on a scale of the dial indicator.

After removing the device from the liner, the transmitter takes the original position.

Scientific and economic studies using advanced devices and techniques proved that during regular and long lasting exploitation of the liner of a milking machine, from 0 to 4 months, the reduction of tension decreases from 56–60 H to 43–45 H, the maximum speed of milk yield is reduced from 2.0–2.1 l/min. to 1.3–1.4 l/min., and the average rate of milk yield is reduced from 1.7–1.8 l/min. to 0.9–1.0 l/min.

Thus, the proposed method and apparatus provide a high accuracy in detecting the tension of teat cup liners and give the opportunity to obtain reliable information about their state. The developed device is reliable, convenient and easy to use and it does not require significant financial costs to conduct measurements.

The testing of the method and apparatus determining the tension in teat cup liners in actual production conditions confirmed their efficiency and effectiveness.

CONCLUSIONS

1. It is possible to ensure the effectiveness of milk yield only under the condition of determining the influence degree of milking machines on the animal's body.

2. One of the main ways to increase the speed of cow milking, to improve animals' productivity, as well as the productivity of the milking operator and milking machine, to increase the quality of milk and to reduce the incidence of animals is to use a high-quality liner providing efficient operation due to its reliable fault detection during the milking process.

3. The use of the proposed method and device for determining the tension in teat cup liners in a production environment will ensure prompt receipt of reliable information about the condition of liners, which will allow to identify timely the negative factors occurring in the course of their operation.

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