

Analysis and Operation Experience of Robotic Milking System

P.I. Migulev, S.I. Schukin, D.A. Abylkasymov

Abstract: This article describes laboratory tests of elements of robotic milking system (teat cup liner, collector of milking system). Performances of serial ADU-1 milking system were compared with those of experimental milking system with independent vacuum at artificial udder test rig, the obtained results and oscillograms make it possible to state higher capacity of the experimental milking system, decreased milk drainage, and safer milking.

Index Terms: collector, milking system, robotic milking system, teat cup liner, vacuum gauge pressure.

I. INTRODUCTION

In recent year dairy farms in Russia are continuously modernized on the basis of advanced equipment and milk cattle with high production potentials [1].

Modern milk production enterprises are located in most Russian regions and CIS countries. Nowadays application of robotic milking systems becomes more and more popular, such milking systems successfully operate in Lipetsk, Vologda, Kaluga, Ryazan, Yaroslavl oblasts and some other regions [1, 2].

In the nearest future robotic milking systems will be used more intensively. However, at present such devices are mainly supplied from abroad.

II. PROPOSED METHODOLOGY

A. General description

In 2016–2017 the Chair of mechanization and electrification of cattle production, Tver State Agricultural Academy, carried out laboratory experiments and study of elements of robotic milking systems: experimental teat cup liner and collector at artificial udder test rig [4]-[6].

B. Block diagram

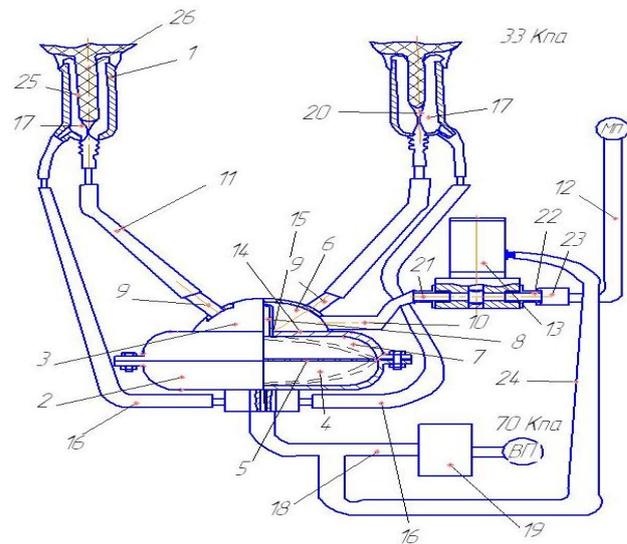


Fig. 1. General view of robotic milking system connected to milking pipeline: 1 - teat cups; 2 - collector; 3 - milk collecting chamber; 4 - chambers of varying vacuum; 5 - separating membrane; 6, 7 - top and bottom chambers; 8 - pipe connector; 9, 10 - inlet and outlet pipe connectors; 11 - connecting hoses; 12 - disposal milk hose; 13 - shut-off valve; 14 - foundation of top chamber; 15 - cross section of foundations; 16 - connecting hoses; 17 - interstitial chamber; 18 - main vacuum hose; 19 - pulsator; 20 - teat cup chambers; 21, 22 - couplings; 23 - inlet pipe connector; 24 - vacuum hose; 25 - teat cup liner; 26 - cow teat

Experimental robotic milking system is distinct from serial milking system by collector design [6]:

- 1). Number of collector chambers (3 chambers);
- 2). Total capacity of the collector (500 cm³);
- 3). Membrane between the chambers;
- 4). Modified teat cup liner.

It should be mentioned that the experimental element of robotic milking system operates according to the principle of fuel pump, subsequent portion of milk pushes previous portion, thus, no foam is generated, bulk milk accounting (milk counters) is improved.

Membrane motions upon operation of collector are illustrated in Figs. 2 and 3 [6].

Revised Manuscript Received on 30 May 2019.

* Correspondence Author

P.I. Migulev, Tver State Agricultural Academy, Tver, Russia.

S.I. Schukin, Tver State Agricultural Academy, Tver, Russia.

D.A. Abylkasymov, Tver State Agricultural Academy, Tver, Russia.

© The Authors. Published by Blue Eyes Intelligence Engineering and Sciences Publication (BEIESP). This is an open access article under the CC-BY-NC-ND license <http://creativecommons.org/licenses/by-nc-nd/4.0/>



Fig. 2. Collector of experimental milking system (lower position of membrane)



Fig. 3. Collector of experimental milking system (upper position of membrane)

C. Flowchart

Comparative tests were carried out for ADU-1 serial milking system and the element of robotic milking system. Russian cattle farms (more than 90%) are equipped exactly with ADU-1, which explains such selection of prototype.

The tests were repeated thrice using a fragment of ADM-200 milking system in vacuum modes (40 kPa, 45 kPa, 54 kPa) of vacuum line and milk pipeline (16 kPa–25 kPa) [3], [6].

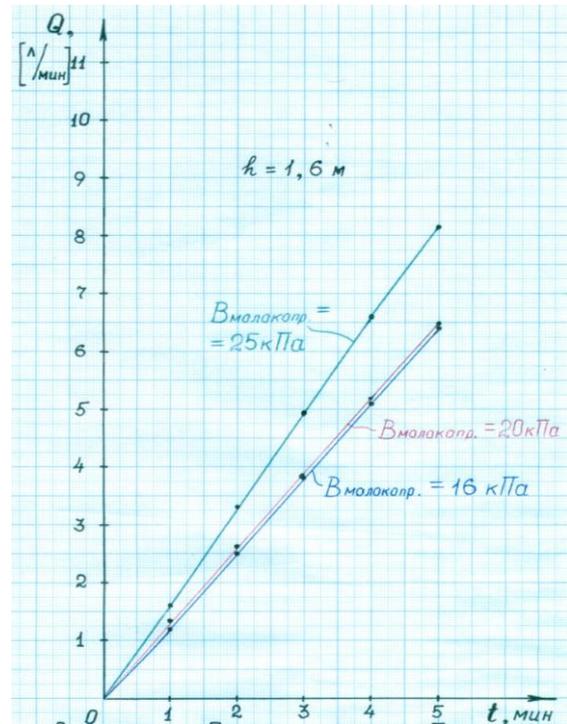
The test duration of experimental milking system with independent vacuum in each mode was 5 min. The tested collector has total capacity of 500 cm³.

The lifting height of milk from collector to mil vacuum cock was 1.6 m. Time was detected using mechanical stopwatch. Milk flow rate was determined each minute.

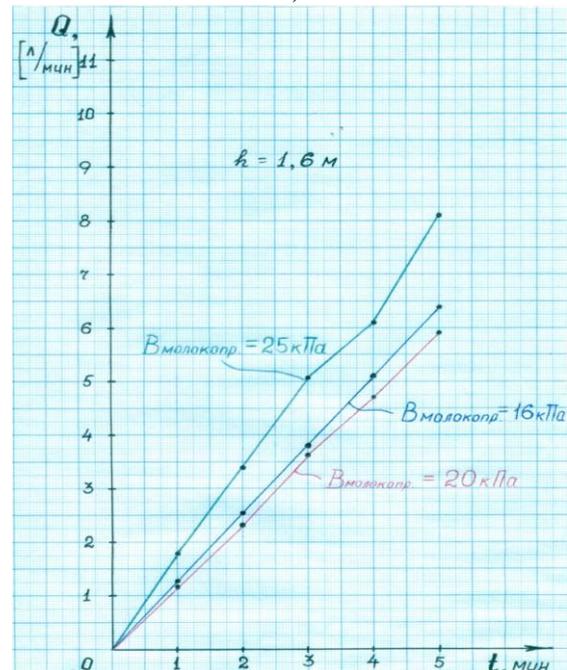
Amount of obtained liquid at each operation mode of experimental milking system was measured using milk bucket and electronic balance.

III. RESULTS AND DISCUSSION

Intensity of milk ejection by ADU-1 serial milking system and the element of robotic milking system in various vacuum modes as a function of time was determined (Fig. 4) [6].



a)



b)

Fig. 4. Capacity of ADU-1 serial milking system (a) and element of robotic milking system (b).

Analysis of milk ejection intensity using the element of robotic milking system demonstrates that with the increase in vacuum in teat cup chamber from 16 to 25 kPa and increase in vacuum in vacuum line from 40 to 54 kPa there occurs increase in intensity of milk ejection with simultaneous decrease in pulsation frequency.

Test results of serial and experimental milking systems are summarized in Table I.



IV. CONCLUSION

Experimental results of comparison of ADU-1 milking system with elements of robotic milking system have demonstrated that the throughput of ADU-1 is lower than that of robotic milking system in all operation modes of vacuum system.

2. Analysis of oscillograms shows that the elements of robotic milking system provide decreased number of impacts on teat body, hence, milk drainage to udder decreases by 10% with respective increase in milk ejection intensity.

3. The elements of robotic milking system with new design of collector and modified teat cup liner have demonstrated optimum performances in all operation modes of vacuum system which, probably, promotes safer automatic milking.

REFERENCES

1. Legoshin, G., et al. "Sravnenie effektivnosti tekhnologii proizvodstva moloka na fermakh s doeniem v stoilakh, v doil'nykh zalakh i na ustanovkakh dobrovol'nogo doeniya (robotakh)" ["Comparison of efficiency of milk production at farms with cowshed milking, milking barns, and voluntary milking systems"] *Molochnoe i myasnoe skotovodstvo*, vol. 4, 2013. pp. 1-5.
2. Khazanov, E.E., Gordeev, V.V., and Khazanov, V.E. "Modernizatsiya molochnykh ferm" ["Modernization of dairy farms"]. St Petersburg: GNU SZNIIMESKh Rossel'khozakademii, 2008.
3. Shchukin, S.I. "Substantiation of parameters of pairwise actuators of milking machin". PhD. Thesis. Moscow, 2006.
4. V. V. Kirsanov et al. "Milking machine". RF Utility Patent 109956 (U1) (RU). Date of publication: November 10, 2011.
5. V. V. Kirsanov et al. "Milking machine". RF Utility Patent 118839 (U1) (RU). Date of publication: April 18, 2012.
6. S. I. Shchukin and T. N. Shchukina. "Osnovanie parametrov doil'nogo apparata s nezavisimym vakuumnym rezhimom" ["Substantiation of parameters of milking machine with independent vacuum mode"]. Tver: Triada, 2017.