Structure-time analysis and development of dairy cows machine milking models in "Herringbone" milking parlors

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Abstract

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A real-time video monitoring of the milking process in three "Herringbone" milking parlors with capacities ranging from 2x6 to 2x10 was carried out. On the basis of the archived data the duration of all milking udder preparation operations (washing, drying and attaching of milking units) is timed. Based on the accumulated experimental information from the three monitored objects four recommended models were developed for the sequence of work in preparing animals for milking in „Herringbone" milking parlors. Models I and II have been found to be suitable for use in „Herringbone" milking parlors with a capacity of up to 2x6. Model III is applicable for parlors with a capacity up to 2x8 and model IV can be used in parlors with a capacity up to 2x10.

Keywords: milking parlors; machine milking; technological operations

Introduction

Machine milking in milking parlours is a technological process involving a series of sequential operations (entrance to the milking platforms, washing, drying, placement of milking units, removal of milking units, teat disinfection, exit of the milking platforms). The nature of these operations is in several aspects (Appleman & Micke, 1973; Burks, 1989; Spasov et al., 1990; Burks et al., 1998; Armstrong et al., 2001):

• fast and low-stress entrance and exit to and from the milking parlor;

• hygiene and disinfection of the teats in order to improve the quality and safety of the extracted milk, as well as the general prophylaxis of the udder;

• activation of the nerve-reflection and nerve-hormonal phase of the milk ejection (guruanimal.ru);

• comfortable and unstressed contact between the animal and the equipment when inserting and removing the milking units.

The effectiveness of milking is a function not only of the quality of milking equipment but also of the precision in the implementation of the aforementioned technological operations (Armstrong & Quick, 1986; Barry et al.; 1992 ; Wagner et al., 2001).

Achieving good results and increasing labor productivity in machine milking requires that the milker be:

– qualified;
– familiar with the physiology of dairy products;
– trained to work with milking equipment.

The total time for milking can be divided into two phases – preparing the animals for milking and actually milking. In the practice of modern intensive livestock breeding priority is given to those factors that lead to maximum increase of the hourly productivity of the installed equipment (Rasmussen et al., 1992; Thomas et al.; 1997; Wagner et al., 2001; Stewart et al., 2002). Such a concept may lead to an unjustified reduction in the duration of those technological operations which form the stage for preparing of animals for machine

milking. The supposed consequence of such an approach is incomplete milking of the cows and an increase in the risk of udder health problems (Marinova et al., 1989).

The meaning of the reasoning here puts the following question: "What determines the minimum permissible duration of pre-milking preparations and how long their duration is?" The duration of the latency period from the release of oxytocin to its contact with myoepithelial cells in the gland share of udder is from 30 to 90 s – mean 60 s (Fig. 1).
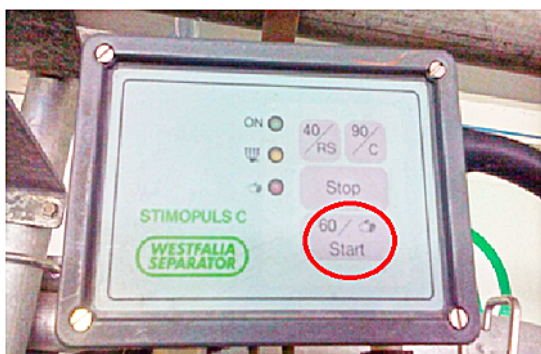

Fig. 1. Pulsator "Stimopuls C" Separator Westfalia

Based on the aforementioned physiological regularity it follows that the average duration of the preparatory operations (input, washing, drying / massage) must correspond to the duration of the latency period. The unwarranted reduction of preparatory operations calls into question the level of oxytocin in the blood and the complete milking of cows. Any extension of the preparatory operations over the latency period (oxytocin) reduces the hour productivity and creates prerequisites for "blocking" processes whose multiplied effect over time results in an increase in the total milking time of the animals (Kokorina, 1986).

The aim of the present study is to develop models for carrying out technological operations during machine milking of dairy cows in "Herringbone" milking parlors with capacities from 2x6 to 2x10.

Material and Methods

The subject of this study is "Herringbone" milking parlors with the animals positioned at an angle of 30° to the longitudinal axis of the technological channel. The study concerns technical and technological equipment with capacities from 2x6 to 2x10.

The subject is the duration of the separate milking process operations and the movement of the service staff in the technological corridor between the milking platforms. Ex-

perimental studies were conducted in three objects (dairy farms):

– *Farm A*: The milking parlor has a capacity of 2x10. Animals are served by two milkers each working on a platform with ten animals. The milker washed the udders of the ten cows (from No.1 to No.10). The milker returns to the first animal and begins to dry the udders in the same sequence (idle). The milker returns for the second time to the first cow (second idle) and places the milking units in order from the first to the tenth animal.

– *Farm B*: The milking parlor has a capacity of 2x10. Animals are served by two milkers each working on a platform with ten animals. The organization differs from that on farm A in that the milker washed the udder of the first animal, immediately dries it and places the milking units. The sequence of operations is repeated for all cows from No.1 to No.10.

– *Farm C*: – The milking parlor has a capacity of 2x6. It is served by two milkers whose sequence of work is identical to that of Farm A.

The technical equipment of the milking parlors in the three dairy farms (with its corresponding options) is the same and allows for full comparability of the production operations.

The methodology of the conducted experiments is based on video monitoring (in real time) with full archiving of the captured information. For this purpose a system of 4 cameras, a four channel DVR with a hard disk, a router and a peripheral to connect to the Internet are used.

The following operations related to the preparation of the animals to the machine milking were observed:

– entry of the cows in the milking parlor;
– verification of mastitis: in the three monitored farms are carried out non-systematically, only on individual animals which the milker chooses subjectively;
– washing, drying and udder massage;
– placement of the milking units;
– actual milking;
– exit of the animals from the milking parlor.

Results and Discussion

The structure of the time for preparing an animal in the milking parlors of the farms A and C is illustrated in Fig. 2.

It can be seen from the graphs that the duration of the preparation of the first few animals (for the two monitored farms) ranges from 108 to 114 s/cow while the latter is 118-127 s/cow. It is noteworthy that the duration of pre-milking operations exceeds the maximum value for the oxytocin latency period (about 90 seconds) which increases the risk of "blocked" processes and reduces the overall performance of
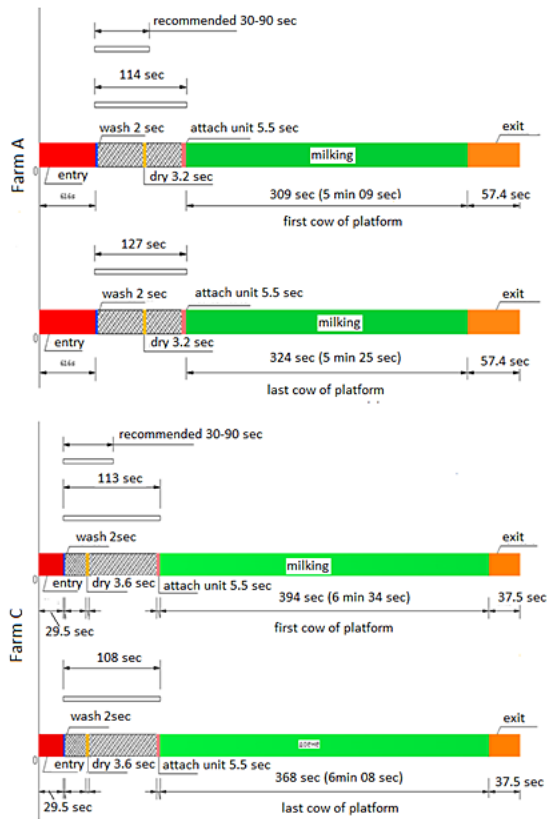
**Fig. 2. Duration of preparation operations
for one animal of Farm A and C**

milking equipment. This necessitates a change in the common organization of work of the two milkers in the observed milking parlors according to a model where the pre-milking preparatory manipulation does not exceed 90 s/cow.

The diagram of Fig. 3 illustrate the structure of the pre-milking preparation times for the cows at Farm B.

**Fig. 3. Duration of preparation operations
for one animal of Farm B**

The existing organization of the production process determines the duration of preparation of the udders (before milking) about 20-25 s/cow which is considerably less than the minimum reference values recommended by the westfalia separator and set in the "Stimopuls C" Fig. 3. The probable consequences of such reduction in timing of udder preparation are expected to have a negative impact on the course of the nerve-hormone phase of milk ejection and to reduce the concentration of oxytocin in the blood. The finding made it necessary to rethink and introduce new method of operation in which the duration of the preparatory operations (chronometrized until the placement of the milking units) is about 60 s/cow.

On the basis of the experimental information gathered from the three farms four recommended models were developed for sequencing work in the preparation of animals for milking in "Herringbone" milking parlors. The boundary conditions for the patterns are as follows:

– the duration of all operations for udder preparation for milking (washing, drying and placement of milking unit) – 45 to 90 s (physiologically determined);

– washing time – 2 s (mean of experimental timing);

– drying time – 4 s (mean of experimental timing);

– placement time of the milking units – 4 s (mean of experimental timing);

– time of movement of the milker between two adjacent animals – 3 s (mean of experimental timing);

– movement time (idle) – from 1 to 6 animals – 4 s; from 1 to 8 animals – 6 s; from 1 ÷ 10 animals – 10 s (mean of experimental timing).

Model I – (one milkman serves one platform): The milker washed the udderss of all animals, returned to the first (idle), dried them, returned again (second idle) and placed the units from the first to the last cow of the platform. The second milker moves and operates similarly to the described scheme serving the animals on the opposite platform.
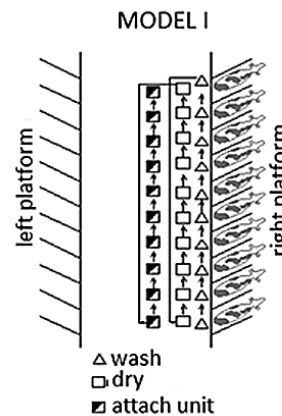

**Fig. 4. Movement
and sequence of
work of the milker
in Model I**

Model II: The milking parlor is conditionally divided into two parts in the longitudinal direction. Each milker serves simultaneously the animals on both platforms of the corresponding "half" of Fig. 5.
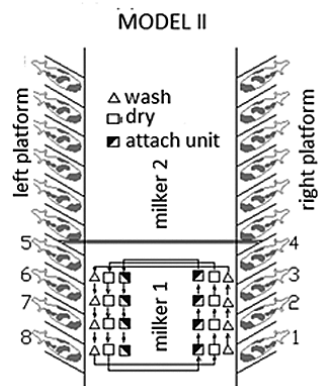

Fig. 5. Movement and sequence of work of the milker in Model II

Fig. 6. Movement and sequence of work of the milker in Model III

The milker washed sequentially the udders of animals from 1 to 4 on the "left" platform. The milker is transported and similarly serves the animals from 5 to 8 on the "right" platform. Turning back to the "left", drying the udders from No.1 to No.4, goes to the "right" and in the same order manipulates the animals from No.5 to No.8. He is transferred for the third time to animals from the "left" platform and in the established sequence puts the units of cow from 1 to 4, turns to the "right" platform and serves the animals from No. 5 to No. 8.

Model III (one milker serves one platform): The milker washed sequentially all the animals from the platform (from first to tenth). The milker returns to the first cow (idle), dries the udder and immediately puts the milking units then moves to the second, third and so on animals (Fig. 6). The second milker moves and operates similarly to the described scheme serving the cows on the opposite platform.

Model IV: The milking parlors is divided into two parts in a longitudinal direction. Each milker serves the animals on the two platforms at the corresponding half of Fig. 7.

The milker washed the animals from No1 to No4 from the "left" platform. He is transferred and similarly manipulates the cows from No5 to No8 on the "right" platform. The milker turns to the "left" platform, dries the udders and immediately
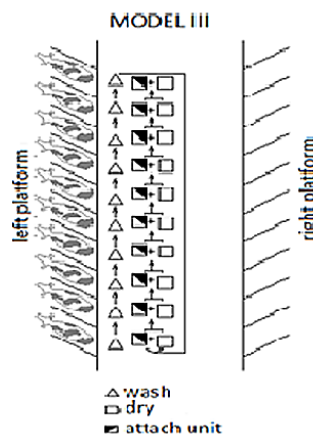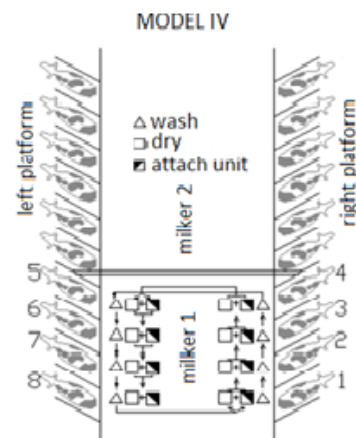

Fig. 7. Movement and sequence of work of the milker in Model IV

puts the milking units consecutively on cows from No1 to No4. He moves to the "right" and works the same way.

The hypothetical results from the use of the presented four models are attributed to "Herringbone" milking parlors with a capacity of 2x6, 2x8 and 2x10. Data from the analysis are summarized in Table 1.

The presented information shows that Models I and II are only applicable to "Herringbone" milking parlors with a capacity of up to 2x6 (the duration of the preparatory operations is less than 90 s/cow). The same models are unacceptable for capacities above 2x6 as the total.

Table 1. Duration of pre-milking preparation operations using the four recommended models.

COW №	MODEL I			MODEL II			MODEL III			MODEL IV		
	2x6	2x8	2x10	2x6	2x8	2x10	2x6	2x8	2x10	2x6	2x8	2x10
1	70	100	171	72	96	130	39	44	50	35	40	50
6	78			90			81			58		
8		149			145			92			69	
10			234			200			111			90

Model III is recommended for work in milking parlours with 2x6 and 2x8 capacity. This is unacceptable for 2x10 milking parlors due to the huge difference in the duration of the preparatory operations between the first and the last animal on the respective milking platform. The relative difference value is about 130% and the absolute duration of the last cow's preparation exceeds 110 seconds.

Conclusions

The organization for work of the milker in "Herringbone" milking parlors significantly influences the time of preparation of the cows before actual milking. Presented models for working with conditional indication I and II are suitable for use in "Herringbone" milking parlors with a capacity of 2x6. The model for working with conditional indication III is applicable to machine milking in "Herringbone" milking parlors with capacities up to 2x8. The model for working with conditional indication is applicable to machine milking in "Herringbone" milking parlors with a capacity of up to 2x10.

Recommendation

The work of milker and the manipulation of animals in the milking parlors should guarantee the duration of the preparation (up to put the milking units) before the actual milking in the interval 40-90 s/cow which is "an optimum" between the productivity of the technical equipment and the overall productive and healthy status of the animals.

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