ASPECTS REGARDING THE OPERATION OF SOME PULSATORS FOR MILKING EQUIPMENTS

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Abstract

Mechanical milking can only be done using specific milking systems. The pulsators are components of the milking machines. These components make it possible to obtain a certain working frequency of the milking cup and also make it possible to obtain a certain ratio between the milk extraction phase and the massage phase during operation. The two mentioned parameters influence the milking time. Given the importance of pulsators for mechanical milking, this paper analyzes the operation of two types of pulsators: a BRK pneumatic pulsator and a prototype electromagnetic pulsator, design by author. Both types of pulsators are equipped with drawer type working elements. The electromagnetic pulsator was set for the operating mode in which the extraction time is longer than the massage time (3: 1 ratio). For both types of pulsators, the operating frequencies and the ratio between the extraction time and the massage time were determined on the basis of a number of vacuum-time diagrams. The value of the vacuum at the level of the milking cup was -42kPa. Following the tests, it was observed that both the pneumatic pulsator and the electromagnetic pulsator fall within the normal operating limits in terms of pulsation frequency. Regarding the work phases ratio at the prototype pulsator there is a bigger difference between its theoretical value and the real one than at the pneumatic pulsator. This difference can be corrected from the electronic control device of this pulsator.

Key words: milking equipment; milking cluster, pulsators

One of the important activities that take place in dairy farms is milk collection (milking). The way the cows are milked is important because it also influences the quality of the milk obtained, an aspect on which the European Union places a special emphasis. The hygienic quality of the milk obtained by mechanical milking is superior to that of the milk obtained after manual milking. This is also one of the reasons why only mechanical milking is used in modern farms.

Mechanical milking installations mimic calf sucking. This causes that during their operation, at the level of the milking teat cup to appear and to alternate two phases that realize a work cycle. A phase of milk extraction from the udder and a massage phase when the milk is no longer extracted.

In order to obtain the two phases of operation, the milking teat cup is built in such a way that two concentric chambers are formed inside it. A central chamber (inside the milking liner) and an outer chamber (between the milking liner and the body of the milking teat cup). In the central chamber a continuous vacuum is formed, and in the outer chamber an intermittent vacuum (alternates the vacuum with atmospheric pressure). Intermittent vacuum is produced by the pulsator.

The purpose of the pulsator is to control the number of operating cycles (obtaining a working frequency) and to allow a certain ratio to be obtained between the extraction phase and the massage phase during operation. The two mentioned parameters influence the milking time. Milking time is a factor that determines the amount of milk harvested (Maciuc V. *et al*, 2015).

The working frequency given by the pulsator must be set at a value of 50 ... 60 cycles per minute (FAO ANIMAL PRODUCTION ANDHEALTH PAPER 78). Most types of pulsators are working with frequencies with values of about 60 cycles per minute (Besier J. *et al*, 2016).

The ratio between the extraction phase and the massage phase, made by the pulsators are between 50/50 and 70/30.

The recommended vacuum value at the level of the milking cup (value at which the pulsator also works) is 32...42 kPa (ISO 5707-2006).

MATERIAL AND METHOD

The paper presents the results of a study in which two types of pulsators used in the construction of mechanical milking installations

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were tested. The operation of a BRK pneumatic pulsator and an electromagnetic pulsator, which was designed by the author, was analyzed. The BRK pneumatic pulsator (*figure 1*) falls into the category of pulsators used for mobile milking systems, and the electromagnetic pulsator (*figure 2*) in the category of those used for milking parlors and milking robots.

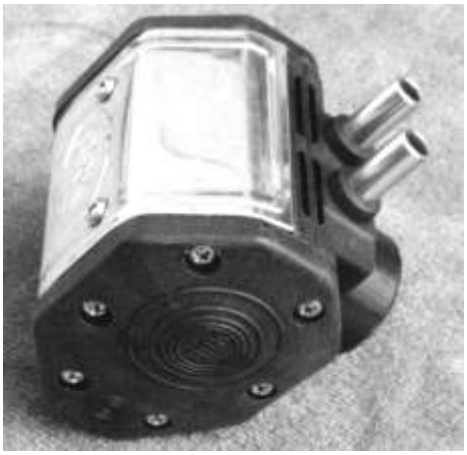

Figure 1 **The pneumatic pulsator BRK**

In this study, the operating parameters of the pulsators analyzed was recorded in laboratory conditions. For this purpose, a stand of our own design was used, which also includes a milking plant where the milk is collected in the milk bucket.

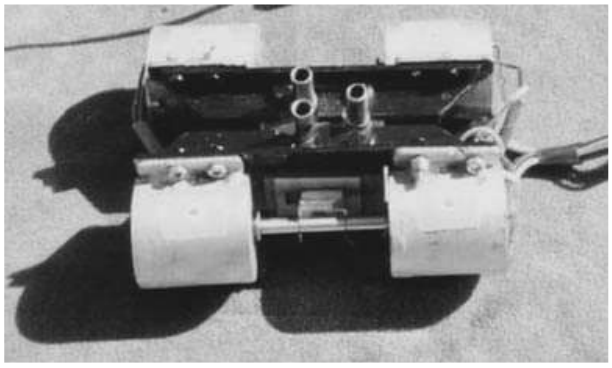

Figure 2 **The electromagnetic pulsator**

The milking cluster used milking teat cups with rubber milking liner. with a diameter in the upper area of 25 mm and a small volume collector of 25 ml. The hose that connects the vacuum distributor to the pulsator is 2 meters long.

Water was used instead of milk during the tests, as the densities of the two liquids are close in value (999.7 kg / m3 for water at 11^{o}C; 1030 kg / m3 for milk).

During the tests, the test stand simulates the flow of milk through the milking teat cups with the help of water taken from a tank.

Both pulsators have drawer-type working members.

The BRK pneumatic pulsator has the ratio between the extraction time and the massage time expressed in percentages, of 60/40. This report cannot be changed. The proposed electromagnetic pulsator allows to change the ratio between the extraction time and the massage time to certain desired values even during operation. The proposed electromagnetic pulsator has been designed to work with two values for the ratio between the extraction time and the massage time, namely 50/50 and 75/25.

The parameters that was analyzed during the tests are: vacuum intensity, working frequency, and the ratio of milk extraction time to massage time.

The value of the vacuum intensity was determined by means of an analog type vacuum gauge.

The test stand allows the value of the vacuum in the installation to be changed. This is possible due to the use of a vacuum regulator. In this way it was possible to register the operating parameters of the analyzed pulsators. for certain vacuum values established in the tests.

The working frequency and the ratio between the extraction time and the massage time were established with the help of operating diagrams of the two pulsators. These diagrams show the variation of the vacuum values from the space formed between the milking liner of the milking teat cup and its body depending on the time. The measurement of the vacuum value in the mentioned space was made in the area of supply connection for the intermittent vacuum of the milking teat cup.

RESULTS AND DISCUSSIONS

For the two pulsators analyzed, the operating frequency and the ratio between the extraction time and the massage time were determined, for a value of the vacuum at the level of the milking teat cup of -42kPa. This value was chosen for vacuum because it is recommended by ISO 5707-2006.

For the BRK pneumatic pulsator the studied operating parameters are presented in *table 1*.

For the electromagnetic prototype pulsator the studied operating parameters are presented in *table 2*.

In the *tables 1 and 2* show that the average working frequency for the BRK pneumatic pulsator is 56.29 pulsations/minute, and for the prototype electromagnetic pulsator it is 60.24 pulsations/minute. It is observed that both pulsators fall within the accepted value range of 50...60 pulsations/min. The prototype electromagnetic pulsator has a working frequency equal to that of most types of pulsators. During the tests for the BRK pneumatic pulsator there was a variation of the value of the working frequency (between the maximum and the minimum value) of 2.9 pulsations/min, and for the prototype electromagnetic pulsator of 0,3 pulsations/min. It is observed that all the values of the working

frequency for both pulsators fall within the accepted range of values.

The theoretical value of the ratio between the extraction phase and the massage phase for the BRK pneumatic pulsator is 1.5 (60/40). During the tests, an average value of this ratio of 1.41 was obtained. The difference between the theoretical value and that during the tests was 0.09. The variation of the value of this ratio (between the maximum and the minimum value) is of 0.30.

The theoretical value of the ratio between the extraction phase and the massage phase for the prototype electromagnetic pulsator is 3 (75/25). During the tests, an average value of this ratio was obtained, of 2.26 (69/31, approximate value 70/30). The difference between the theoretical value and that during the tests was 0.74.

The variation of the value of this ratio (between the maximum and the minimum value) is of 0.35.

It is observed that both pulsators have the values of the ratio between the extraction phase and the massage phase in the accepted interval (50/50...70/30). It is also observed that the differences between the maximum and minimum value of this ratio for the two pulsators are small (0.3 for the BRK pulsator and 0.35 for the electromagnetic pulsator).

At the prototype electromagnetic pulsator the correction of this ratio can be done by modifying the control signal by the pulse generator for the control of the pulsator electromagnets.

Table 1

Operating frequencies and working phases ratios obtained during tests for the BRK pneumatic pulsator

Chart	The determination number	Working frequency [pulsations / min]	Work phases ratio
1	I	57.0	1.42
	II	56.1	1.37
	III	57.0	1.33
	IV	55.2	1.40
	V	56.1	1.46
2	I	55.9	1.48
	II	57.8	1.30
	III	55.9	1.38
	IV	55.9	1.48
	V	55.9	1.38
3	I	58.1	1.40
	II	57.1	1.34
	III	58.1	1.40
	IV	55.3	1.42
	V	54.5	1.37
4	I	57.2	1.48
	II	56.3	1.42
	III	56.3	1.42
	IV	55.4	1.37
	V	55.4	1.46
5	I	57.1	1.50
	II	56.2	1.44
	III	57.1	1.60
	IV	55.2	1.38
	V	55.2	1.38
AVERAGE		**56.29**	**1.41**

Table 2

Working frequencies and working phases ratios obtained during tests for the electromagnetic prototype pulsator

Chart	The determination number	Working frequency [pulsations / min]	Work phases ratio
1	I	60.2	2.15
	II	60.2	2.15
	III	60.2	2.15
	IV	60.2	2.15
	V	60.2	2.15
2	I	60.4	2.22
	II	60.4	2.22
	III	60.4	2.22
	IV	60.4	2.22
	V	60.4	2.22
3	I	60.4	2.22
	II	60.4	2.22
	III	60.4	2.22
	IV	60.4	2.22
	V	60.4	2.22
4	I	60.1	2.35
	II	60.1	2.35
	III	60.1	2.35
	IV	60.1	2.35
	V	60.1	2.35
5	I	60.1	2.29
	II	60.1	2.50
	III	60.1	2.29
	IV	60.1	2.29
	V	60.1	2.50
AVERAGE		**60.24**	**2.26**

CONCLUSIONS

The electromagnetic pulsator tested, although a prototype, has a stable operation like the BRK pneumatic pulsator which is produced in large series.

The working frequency of the prototype electromagnetic pulsator is more stable because it is electromagnetically controlled, not being affected by the fluctuations of the vacuum value in the milking installation.

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