PRELIMINARY STUDIES REGARDING THE FLOW-METER FOR A WORKING REGIME SELECTOR OF AN ELECTRO-MAGNETIC PULSATOR

C-tin Chirilă[1*], P. Cârlescu[1], R. Roşca[1]

[1]*University of Agricultural Sciences and Veterinary Medicine Iasi, Romania*

Abstract

The study was developed starting from experimental tests regarding the milk flow through a calibrated orifice flow meter. The flow meter is aimed to automatically select the working regime of an electro-magnetic pulsator, according to the milk flow at the exit of the claw of the milking machine. The flow meter senses values of the milk flow under or over 0.2 kg/min; the flow meter working principle is based on the height of the milk level in the flow meter when milk flows out of the device through a calibrated. A level sensor equipped with electrodes is used in order to sense the milk level. The aim of theoretical simulation was to establish optimum position of the entry manifold with regard to the position of the calibrated orifice. Information regarding the free level of milk in the electrodes area was also obtained as a result of the modeling. This is important, because the waves who are formatted in liquid disturb selector working. In this case is necessary to introduce retardation from electrical control signal.

Key words: milking; milking equipment

INTRODUCTION

The intensive dairy farming requires the application of modern technology with a high level of mechanization, automation and computerization even. Modern milking equipment manages through flow of milk collected from animals to control the pulsation frequency, vacuum intensity and withdrawing operation of milking machine. In this case can be achieved differentiated vacuum level at the beginning and at the end of the milking. Also, the stimulation and milking each cow, is carried out according to the flow of milk.

Determination of the quantity of milk flowing through the machine milking at a time is done performed by the means of a flowmeter. The signal of flowmeter can be converted into an electrical signal that can be processed easily to change the operating mode of milking equipment.

The present paper presents some aspects about the construction of a milk flow meter, which is part of a device for selecting the operating mode of an electromagnetic pulsator.

MATERIAL AND METHOD

The presented studies refer to a flowmeter which has a calibrated orifice, the constructive data are shown in figure 1 [1]. The dimensions are in millimeters.

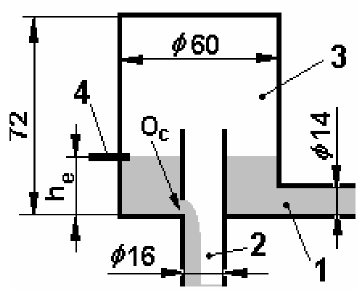

Fig. 1 The analyzed flowmeter drawing
1 – inlet; 2 – outlet; 3 – flowmeter body;
4 - electrode; he electrode placement height;
Oc – calibrated orifice

It is equipped with two electrodes, placed at a height corresponding for a milk flow of 0.2 kg / min (200ml/min), through collector.

The flowmeter is located after the claw (figure 2) and sends an electrical signal to an

*Corresponding author: chirilac@uaiasi.ro
The manuscript was received: 22.03.2013
Accepted for publication: 08.09.2013

electronic device for selecting the operating mode of an electromagnetic pulsator.

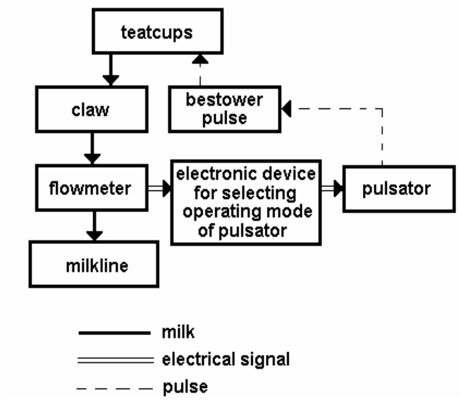

Fig. 2 Analyzed flowmeter location scheme

If the level milk in the claw does not flood the electrodes, the pulsator will work with a pulsation ratio of 1:1. If the electrodes are immersed in to milk, the pulsator will work with a pulsation ratio of 3:1.

The electrical signal from the electrodes can be processed in order to modify the vacuum intensity.

Determination of the height placement of the electrodes was performed using a flow measuring stand, own design [1], shown in figure 3.

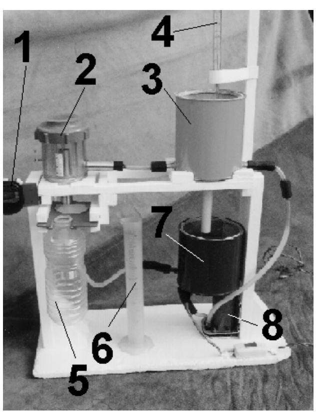

Fig. 3 Stand for measuring flow through the calibrated orifice flowmeter
1 – chronometer; 2 -flowmeter; 3 – tank overflow; 4 – thermometer; 5 – tank lease; 6 –beaker; 7 – tank; 8 pump

A matthematical model was used in order to analyze the flow of liquid through the flow meter in the electrodes zone. It introduces a simplification of the real process flow, considering steady liquid flows, unlike the real case when unsteady flow occurs.

Using flowmeter constructive dimension was studied by simulation stream lines and the turbulent flow that would affect the height of milk and position placing the calibrated orifice.

CFD simulation (Computational Fluid Dynamic) stream lines was carried out in three stages [2]. In the first step of preprocessing was performed mesh inner volume flowmeter with a total of 231,690 tetrahedral volumes. Boundary conditions were required for entry flow speed knowing that the inflow and outlet pipe fluid flow. Pressure at the liquid surface was considered constant.

This simple model allows the calculation of flow turbulence for the fluid volume considered. The two equations of the model are added to the equation of continuity [2]. The calculations needed to determine the converging solutions for the designed system were conducted with the TYAN graphics station. The number of iterations was 1350, and the whole computation time was 6 minutes.

The last step in the CFD simulation was postprocessing, when data was obtained of current stream lines, velocity and Reynolds turbulence field inside the flowmeter.

RESULTS AND DISCUSSIONS

Using the experimental data [1], nomogram was designed in ordre to establish the optimal for electrode placement height, as a function of the value of the calibrated orifice diameter and recorded flows through it (figure 4).

The diagram shows that, for the same milk flow of 200 ml/min, the electrodes could be placed at three different heights, depending upon the diameter of the calibrated orifice.

Taking into account that the mounting height of the electrodes should be at least 10 mm, only two variants for the diameter of the calibrated orifice could be considered (3 mm and respectively 3.5 mm). For an orifice with a diameter of 3 mm (the chosen variant) the mounting height of the electrodes was 22.5 mm.

Tests made with water and milk, when a calibrated orifice with a diameter of 3 mm was used, showed that flows obtained for the same value of the flow fluid level do notsignificantly different (Table 1).

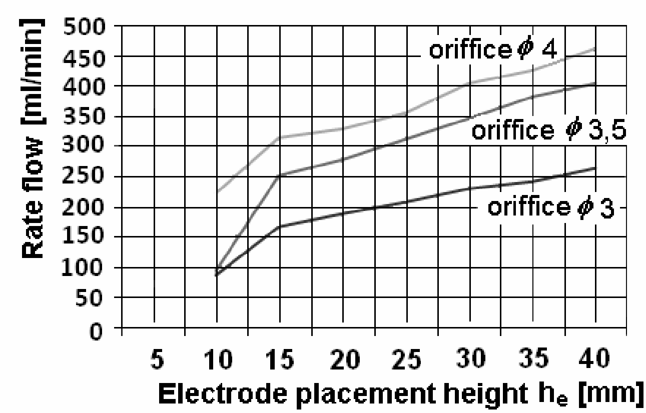

Fig. 4 Nomogram for choosing height placement of the electrodes

Table 1 Liquid flow in ml / min, depending on liquid level of flowmeter

Liquid	Liquid level of flowmeter [mm]				
	22	25	30	35	40
Water	201	210,9	233,9	251,1	270,6
Milk	199,3	213,1	233,8	255,1	272,8

Based on the constructive dimensions of the flowmeter by choosing a mathematical model and CFD simulation can easily see the stream lines of the liquid [2]. The path stream lines by changes in the level of liquid in the flowmeter shows top fluid (figure 5). By changing the position of the inlet flow of liquid from hole position (3mm diameter) can be seen a change in stream lines path at the top of the liquid. Thus, if the input and output flow are at an angle of 180°o fluid turbulence has a large top level (figure 5 a). It was noted that at the level electrodes, the liquid make waves, what it will lead to a high frequency of change the order of selection of the operating mode of the pulsator. This makes it necessary to introduce a device for filtering the electrodes signal in order to enable the functioning electromagnetic pulsator in the two regimes. If the commands are succeeding too fast, then the pulsator will no longer respond promptly to the control signal

By increasing the angle and location 270°o tangential inlet stream lines dampens turbulence results (figure 5 b). In this case the flow of liquid is still in the electrodes. It is noted that there are differences between the liquid levels located above inlet and calibrated orifice located above the liquid level. This causes the liquid level in the electrodes area to be no longer horizontal but tilted at an angle.

If the angle increased up to 360°o the turbulence in the top layer of the liquid is reduced further enabling accurate placement of electrodes (Figure 5 c).This solution is more advantageous than the previous ones, because the liquid flowing in the electrodes area is still, and the liquid surface is almost horizontal. This makes the solution to be recommended for the flowmeter design.

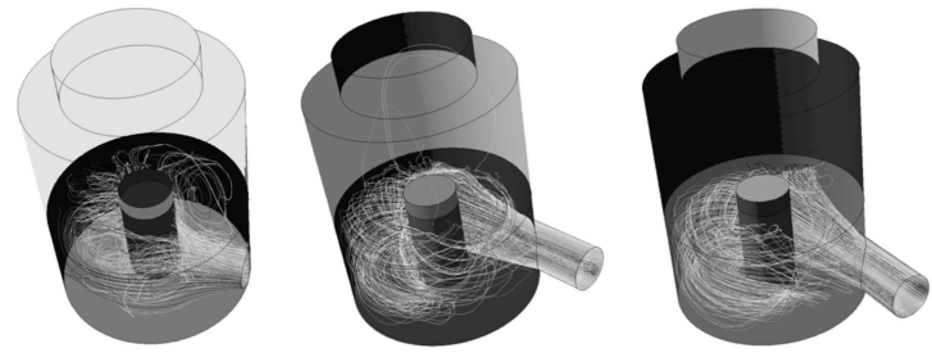

Fig. 5 CFD simulation of flow in the flowmeter
a – Input arranged on the radius of flowmeter and calibrated orifice arranged at 180 ° to it;
b - Input tangentially arranged on the flowmeter and calibrated orifice arranged at 270 ° to it;
c – Input tangentially arranged on the flowmeter and calibrated orifice arranged at 360 ° to it;

CONCLUSIONS

From the above it follows that:

- Using water as test fluid in the flowmeter preliminary study did not seem to introduce major errors if it is used instead of milk.
- Making nomogram for choosing height placement of the electrodes allows quick solving of possibilities for placing electrodes on the meter body.
- CFD simulation allows previous testing execution flow meter and electrode positioning with high accuracy.
- Positioning tangential inlet flow leads to reduced turbulence in the liquid surface.
- Advantages of modeling and simulation design leads to ease and reduce the time to obtain a flowmeter operating parameters.

REFERENCES

[1] Chirilă C.; Balan O., 2005 : The design a flow meter, part of equipment for selection of the working regime for an electromagnetic pulsator -, Lucrări Științifice – seria Agronomie vol. 48, Editura “Ion Ionescu de la Brad” Iaşi. (ISSN – 1454-7414).

[2] Cârlescu P. M., 2005: Modelling and numerical simulation of industrial physical processes. Editura Performantica (ISBN -973-730-137-4).