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RESULTS AND FURTHER DEVELOPMENT OF AN AUTOMATIC MILKING SYSTEM

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ABSTRACT

A prototype of the feeding-milking robot was developed in the Hungarian Institute of Agricultural Engineering in 1988-89. Before starting with the operation tests the cleaning system had to be elaborated. The cleaning system has two parts.
Those are the complete cleaning of the system, producing a practically sterile state, as well as flushing through the milking device between milking of two cows. Separate electronic sensor development was necessary for both system which can connect to the control system of the robot.
To clean the system pneumatic air input was applied.
As an effect of the local adjustment of the electronic control system optimal flow conditions can be formed what is more favourable comparing to the earlier solutions of cleaning due to the mechanical effect.
In the flushing through overpressure air is applied. The air and the cleaning liquid input duration can be adjusted to the local conditions. The electronic control unit can be connected to the electric circuits of robot.

INTRODUCTION

In the National Institute of Agricultural Engineering, Hungary, a prototype

milking robot was developed utilizing partly foreign research results. In the prototype the locating and feeding mechanisms were developed. The robot is a positioning type i.e. it search for the centre of the udder and the basis is a defined region of cow. Teat searching are corrected on the basis of preloaded coordinates, regarding the later changes and the udder quarters of milking posts. Before plant tests cleaning of the equipment and several feedback sensors for the system control and monitoring had to be solved. In this study our research and results aiming cleaning system automation is presented.

OBJECTS

Two problem group is raised by the cleaning of milking apparatus to robots.
1. The cleaning of the whole milking system regularly to avoid seeds increase.
2. Flushing through the milking apparatus between cows following each other in order to minimalize spread of possible infection.
Concerning both cleaning system the development and experiment works were carried out. In the cleaning of the system it is a principal task to perform as quick as possible and with so small amount of material, energy and water as the contaminating material should be the possible least amount for the waste handling. In the course of cleaning practically four main parameters should be satisfied. They are the followings:
1.) duration,
2.) mass of chemicals (concentration),
3.) temperature,
4.) mechanical effect of cleaning liquid on surface i.e. flow intensity (figure 1).
In the system cleaning three factors could be minimalized or optimized in a possible level. Our aim in the system cleaning was to achieve
- low water consumption,

- between water and air entering,
- delay in closing air flow to closing water (figure 5).

The program is started by the automatic removal of milking device from the udder. In the traditional milking stands the start can be made mechanically or with mechanically operated electric switch, e.g. the driving gates operating lever. The adjusting possibilities are necessary because the local installations are different as the lines can have different cross sections and lengths as well as the contamination of udders and the infectedness of the in the stock can also be different. In the case of optimal setting the water consumption is reduced with an extent of 300-350% comparing to the similar aim known solutions. It further great advantage that the less quantity contamined liquid can be handled more economically.

CONCLUSION

The machine milkers and cow keeping farmers has a heavy job to milk the cows. They make milking 6-8 hours a day and spend 1-2 hours with cleaning and disinfecting the equipments. Robotizing the milking is mainly advantageous and economic for those reasons. It is proved by the researcher that there is real possibility to automatize each operation.

To make the robots effective and reliable helper in the milking several problem should be solved:

- reliability
- reasonable cost
- breeding aspects.

Figure 1. Cleaning requirements
Figure 2. Characterizing giant bubbles
Figure 3. Overview of the cleaning system
Figure 4. Cross section area ratios

Q_M - necessary quantity of cleaning solution (litre),
Q_V - the whole volume of the lines, hoses, devices,
Q_T - water content (litre) in washing bin below the suction pipe ends (+ 3 cm),
Q_L - water content (litre) in the milk separator upto the automatic start level.

The value of Q_V:

$$Q_V = Q_{V1} + Q_{V2} + Q_{V3} + Q_{V4}$$

Q_{V1} - washig line volume (litre)
Q_{V2} - milk line volume (litre)
Q_{V3} - volume of hoses, whashing connectors, teats, collectors altogether (litre),
Q_{V4} - line volume between milk separator and washing bin (litre)

At last the quantity of washing liquid can be determined in advance, however the developed impulse generator should be adjusted in the given site according to the local circumstances and pipeline arrangement. It depends on wether the robot operates not only in one but two devices system inserted with one milk separator.

With 0.6 kPa vacuum 1.8-2.2 m/s velocity average liquid flow is obtainable in the milk line. To achieve an acceptable quality cleaning (number of seeds below 10/cm^3 in the flushing water) the most favourable value occured if the impulse generator was adjusted to identical air input and water flow and break time. 10-20 seconds are advantageous air input time, thus the period time is 20 to 40 seconds so the pacing is practicable to be set to 1.5-3 per minute. If the milk separator is located straight next to the milking post, even adjusting 4-5 cycle/min can be necessary (figure 3).

2. At the rinsing the milking device the greatest question is the 25 times difference in the flow cross section (the ratio of the collector and the long milk line sections) (figure 4). At the expanding cross sections the decrease of the flow velocity of washing liquid is rather considerable. The milking devices

applied with robot has 1300-1500 cm^2 inner surface. The rinsing volume is 500-950 cm^3. The common cross section area of the long milk line is 2 cm^2. The 4 pieces short milk hoses, the teats and collector have 2.5, 18 and 57 cm^2 cross section, respectively. Corresponding to those forementioned increasing the mechanical effect with vacuum is limited. It is almost the only possibility to enhance the pressure difference by using overpressure. This makes necessary using compressors without oiling. Corresponding to that a Y joint air and water inlets was applied to the long milk line of the milking device. Through this joint after the milking device disconnection water and air mix was pumped in. Therefore the cleaning liquid flows in the opposite direction to the milk. Of course that time the long milk line should be closed after the inlet part. The cleaning starts with water introduction followed by the air in several seconds. Water valve is closed first and the air the last. Such a way the remaining water is swept out by the air blow from the milking device.
It was considered acceptable if there were fewer than 10000 seeds per millilitre in the control rinse liquid at the control bacteriology test.
The technical specifications are as follows:
- the rinse water temperature is between 30 and 40 centigrade (there were no significant change, but it is practicable to come near 40 °C physiology reasons).
- liquid pressure was 0.4-0.6 MPa
- compressed air pressure was 0.5-0.7 MPa
- in the measurements the air and liquid ratio in the mixture was changed between 2 and 10.

The rinse time was 5-10 seconds.
In order to set the charge time and value precisely an electronic governor was developed. Later it was extended to more channel and get into application with traditional milking equipment types. The governor give possibility to change durations, like
- whole period,

- optimum concentration,
- optimum temperature,
- optimum duration,
- the necessary and the possible highest flow velocity.

They had to be reevaluated for the flushing through the milking device:

- maximum 5 minutes flushing through time,
- less than 1 litre cleaning water,
- a 40 centigrade temperature limit,
- no chemical in the flushing liquid,
- according to the necessity the maximal mechanic effect.

RESULTS

1. The system cleaning

We started with a vacuum level increase as high as possible for getting the cleaning water circulated in the course of washing. 60 kPa vacuum can be reached but a higher value is not practicable, since the vacuum pumps made for milking are too much loaded by the high vacuum. Further possibility is given by reducing the specific mass of flowing liquid to cause the cleaning water to flow faster effected by the vacuum difference, as the lower specific mass cleaning water are forced higher intensity motion by the same force. The possibility is applied through periodic input of air into the flow circle simultaneously with the cleaning water. The pace and period of should be so that so called giant bubbles be formed which occupy the whole pipeline cross section thus they act mechanically at the top of the pipes (figure 2). The necessary washing water quantity was calculated as follows. The parts, washing lines need a quantity (Q_M) to be filled up and to keep the continuous flow:

$$Q_M = Q_V + Q_T + Q_L$$

where:

Figure 5. Impulse signals

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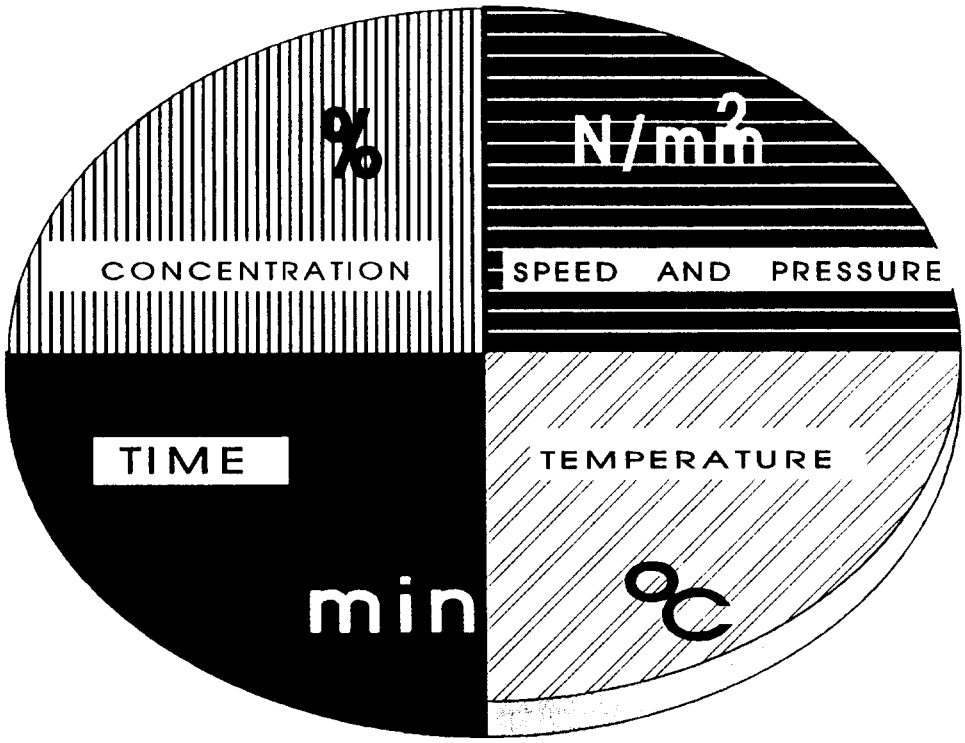
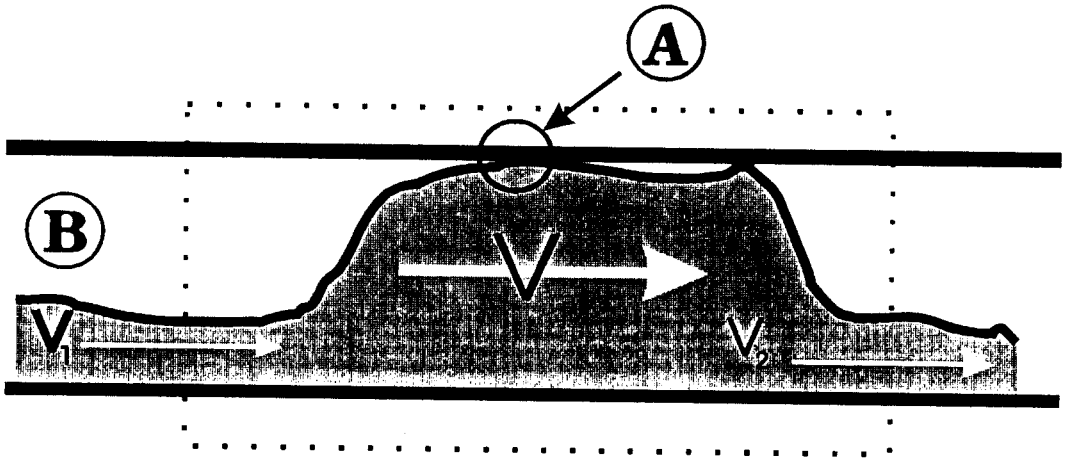


PARAMETERS OF WASHING SYSTEM

FIGURE 1.



FGURE 2.

Characterising giant bubbles

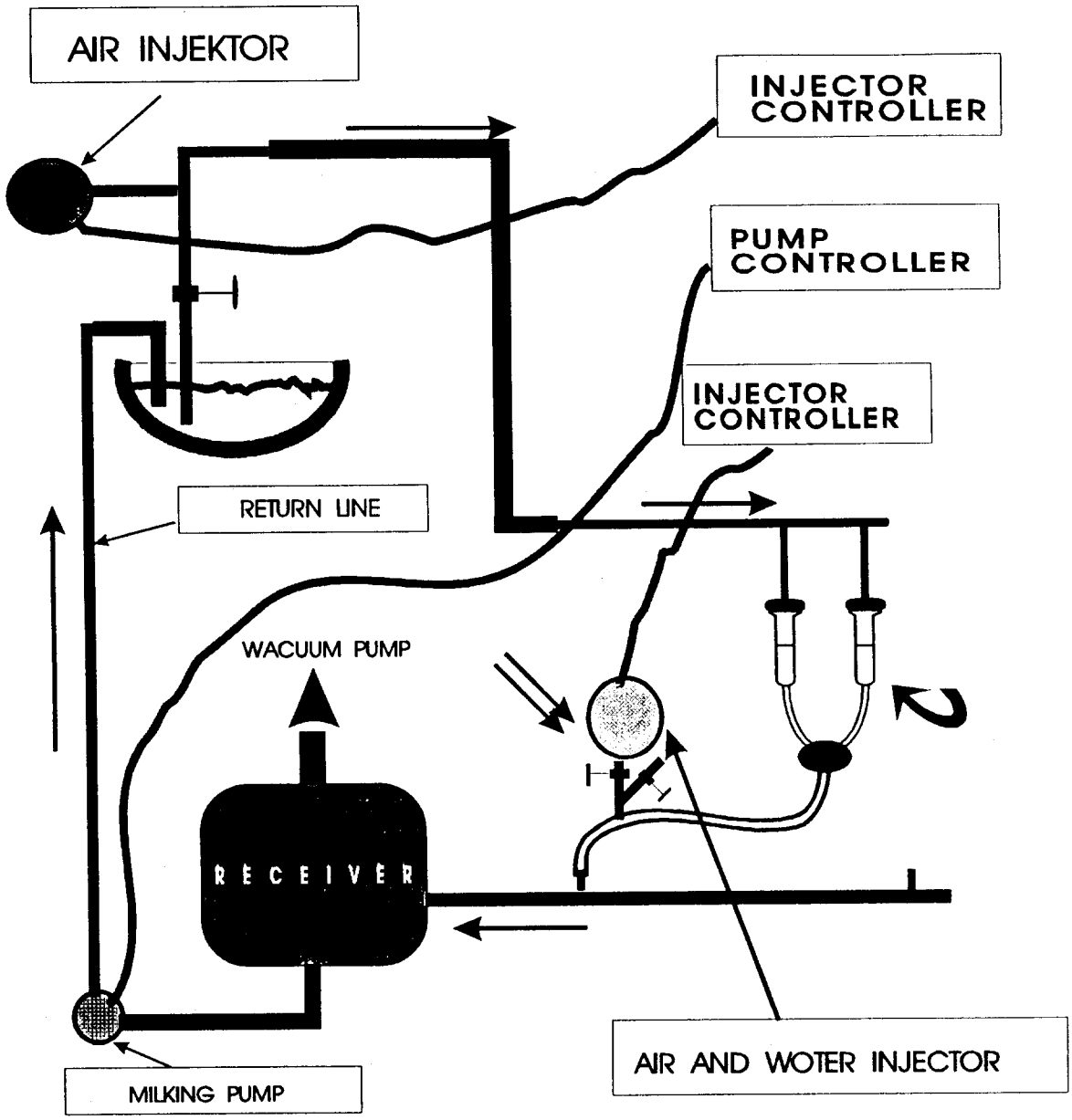


Figure 3.

Overview of the cleaning system

CROSS SECTION AREA RATIONS

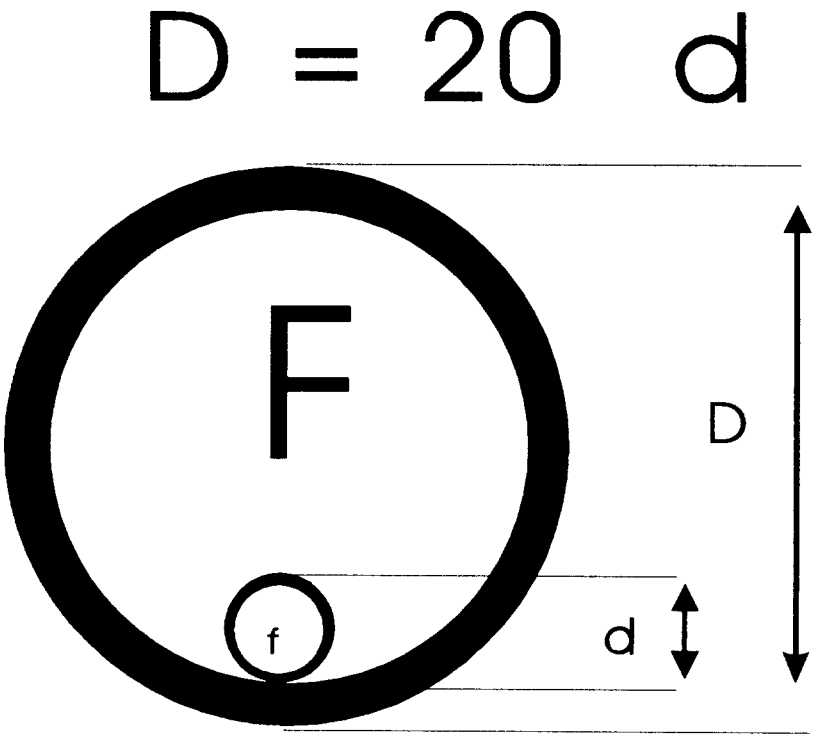


Figure 4.

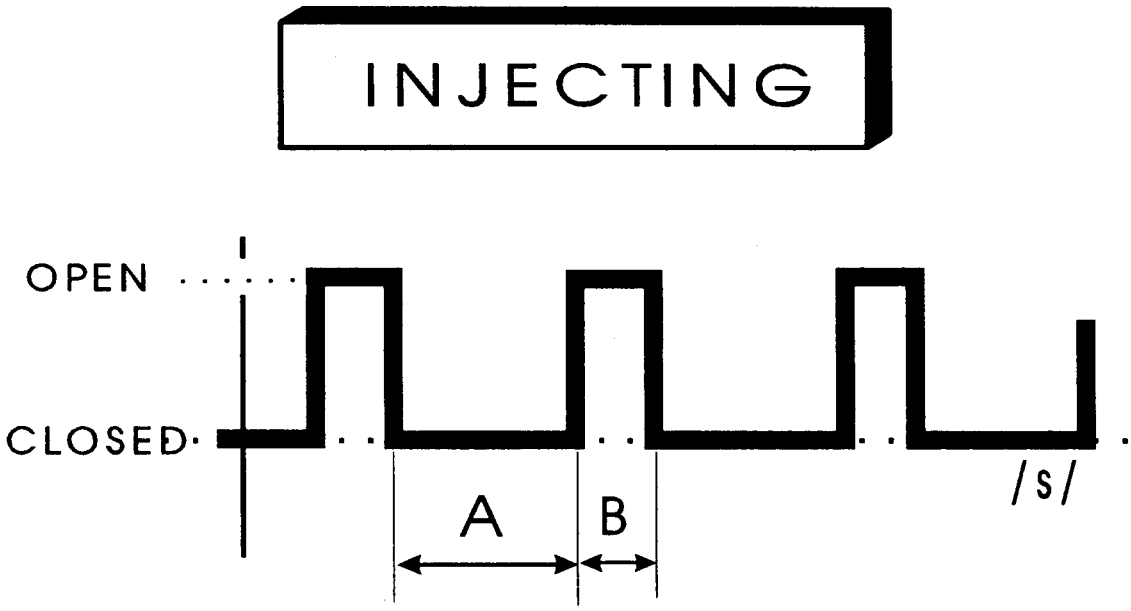


FIGURE 5.

/Impulse signals/