Analysis of vacuum fluctuation in milking units

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Abstract

For the vacuum conditions measurement of the clusters the vacuum sensors, placed on 4 points of this clusters were used. Evaluated was the vacuum course particularly in the liner chamber and in the claw within total pulse time in both maximum and minimum phase according to ISO 6690. The measurement was carried out under laboratory conditions and measured values were recorded. Evaluated were 5 different serial produced clusters with the claw volume of 150, 200, 300, 420, 450 and 500 cm^3.

By the flow- rate of 5 $l.min^{-1}$ the vacuum decrease in the liner chamber of the clusters was 1.4 – 3.3 kPa and in the claw 1.7 – 5.3 kPa depended the claw type. By the flow rate of 12 $l.min^{-1}$ vacuum decrease in the liner chamber of the clusters was 4.1 – 11.2 kPa and in the claw 3.9 – 11.6 kPa.

In evaluation of the vacuum fluctuation within total pulse time no evidential difference was found in comparison with the vacuum fluctuation evaluated only for maximum phase .
The measurements will continue by measuring in the milking parlour during the real milking.

Key words: *Measurement, vacuum fluctuation, milking units, milking*

Introduction

The vacuum courses recognition in different points of the milking set and various milking intensity is one of possible ways how to obtain information on milking machine impact on the teat milk gland and to find suitable parameters for technical parameters effect assessment of variant design of the milking units.

The goal of the realised work was to specify the measuring methodology and comparison of selected milking units from the vacuum fluctuation aspect in different points of the milking system in dependence on milk flow rate. For this purpose the milk is replaced by water.

Method

The measuring was carried-out in laboratory for the milking device testing at the VUZT Prague. The tested milking sets were set up from 10 various milk claw and 5 sets of teatcups. The claws technical parameters are presented in Table 1 and teatcups in Table 2.

The identification code of the tested milking set consists of 2 letters of which the first letter identifies the used claw by Tab. 1 and the second letter identifies the tested teatcups. The measuring was carried-out at the working vacuum of 42 and 50 kPa and at flow rates 1–14 l/min. The rate of pulsation was adjusted for all measurements to 50 pulses/min at pulsation ratio 60:40 and alternate pulsation. For each measuring was chosen 30 s time period for assessment, always after the situation stabilization in the milking set. The vacuum course was recorded in the under teat chamber, pulsation chamber, in claw and in the milking line situated 700 mm under the mountpice lip. The medium flow was evaluated during measuring for each teatcup individually. By this method the affect of eventual irregular media flow through the individual teatcups was excluded. The vacuum levels in particular points of the milking device were scanned by the tensometric sensors with accuracy of 0.3 kPa. The sampling velocity was adjusted to find out 300 values per second in each measured point.

Results

The vacuum course within all time of pulse was evaluated in the time of bouth maximum and minimum phase at nominal vacuum of 50 kPa. The specification of the pulsation curve parameters is based on the pulsation curve definition according to the CSN ISO 3918. Part of the main obtained results is summarized in the graphs in Fig. 1–2.

By the flow- rate of 5 l/min the vacuum decrease in the liner chamber of the clusters was 1.4–3.3 kPa and in the claw 1.7–5.3 kPa depending on the claw type. By the flow rate of 12 l/min vacuum decrease in the liner chamber of the clusters was 4.1–11.2 kPa and in the claw 3.9–11.6 kPa. In evaluation of the vacuum fluctuation within total pulse time no significant difference was found in comparison with the vacuum fluctuation evaluated only for maximum phase.

The more significant vacuum decrease was recorded for claws C and I caused by their different construction. From aspect of the vacuum course in dependence on the flow-rate the best evaluation is evident at the claw A with original teatcup A. Other claws tend more to the vacuum decrease with growing flow-rate, but the differences are not too high.

Similarly was carried-out evaluation of identical milking units at vacuum nominal value of 42 kPa. The vacuum decrease character in dependence on the flow-rate is in fact equal as presented by the graph in Fig. 3 where the vacuum decrease is expressed percentually (nominal vacuum is 100%)

The results have confirmed the original hypothesis that construction and design of the milking unit are influencing the vacuum level during milking and thus also quality of milking process. The differences are evident mainly at high milking intensity. For this reason the attention will be paid to the following research with goal to optimise the milking parameters.

The research will also be focused to measuring of the vacuum course during milking under real conditions and comparison with laboratory measuring results.

One of the first operation measurement of the vacuum course in the under teat chamber, claw and milk line with contemporary measuring of milk flow-rate intensity is presented in graph in Fig. 4.

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Table 1.

Basic technical data of claws

Code of claw	Shape		Volume (cm^3)	Weight (kg)	Diameter of inlets (mm)	Diameter of outlet (mm)	Air admission (l/min by 50 kPa)	Automatic shut-off valve	Notice
	ground plan	side view							
A	orbicular	half-ball with slope	420	0.412	11	15.5	6	Yes	
B	orbicular	cylinder	195	0.153	8	13.5	6	Yes	
C	trapezoid	trapezoid	450	0.614	14	15	8	Yes	upper outlet
D	orbicular	sidelong cylinder	200	0.295	9	16	6.2	Yes	
E	orbicular	sidelong cylinder	300	0.512	10	18	6	Yes	
F	orbicular	sidelong cylinder	300	0.506	10	18	7.1	No	
G	orbicular	sidelong cylinder	450	0.566	12	17	6	Yes	
H	orbicular	two half-ball	350	0.462	10	14	6.1	Yes	faint tangential inlets
I	orbicular	half-ball with cone	500	0.809	14	16	5.8	Yes	
J	orbicular	truncated cone	300	0.418	10	16	6.1	No	tangential inlets

Table 2.

Parameters of teatcups used for measuring								
Teatcup code	Weight of one teatcup (g)	Pulsation chamber volume (ml)	Diameter of mouthpiece lip (mm)	Lenght of liner (mm)	Lenght of short milk tube (mm)	Diameter of short milk tube (mm)	Internal volume of liner (ml)	Volume under teat (ml)
A	316	95	26	315	150	12	90	50
B	290	90	23	310	170	11	95	56
C	263	90	21	325	160	13	110	66
D	413	130	23	320	150	14	110	64
E	539	90	23	350	135	11	120	84

Fig.1 Average vacuum values within whole pulse time in the under-teat chamber of evaluated claws in dependence on flow-rate

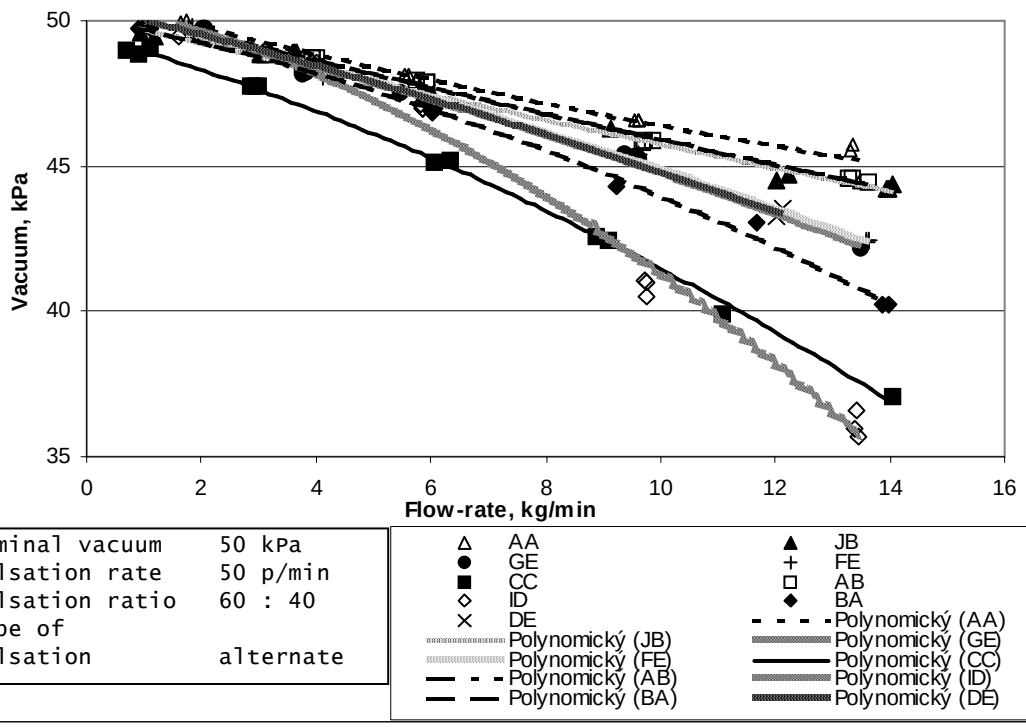
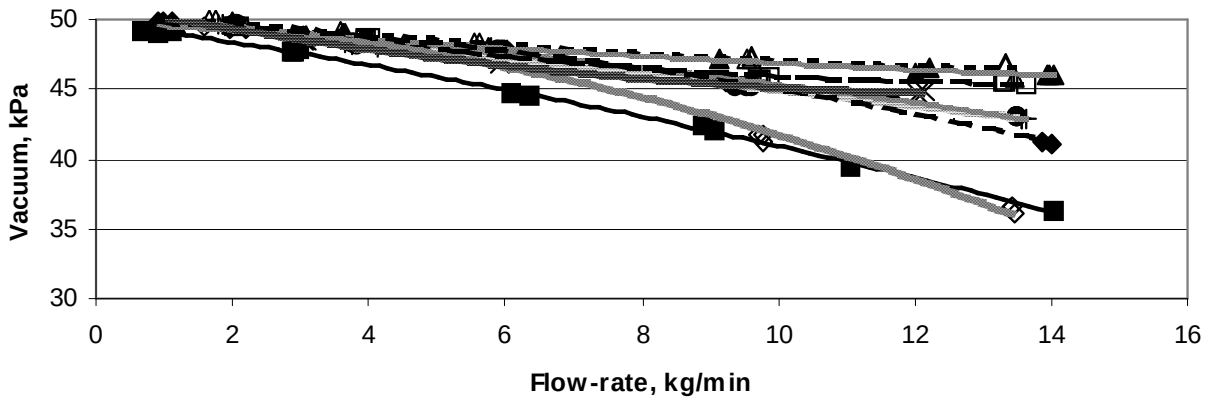


Fig. 2 Average vacuum values in the under-teat chamber of evaluated claws in dependence on flow-rate in the time of suction (B)



Nominal vacuum	50 kPa
Pulsation rate	50 p/min
Pulsation ratio	60 : 40
type of pulsation	alternate

AA	JB
GE	FE
CC	AB
ID	BA
DE	Polynomický (AA)
Polynomický (JB)	Polynomický (GE)
Polynomický (FE)	Polynomický (CC)
Polynomický (AB)	Polynomický (ID)
Polynomický (BA)	Polynomický (DE)

Fig.3 - Average vacuum decrease in the under-teat chamber in dependence on the flow-rate at nominal vacuum 42 and 50 kPa

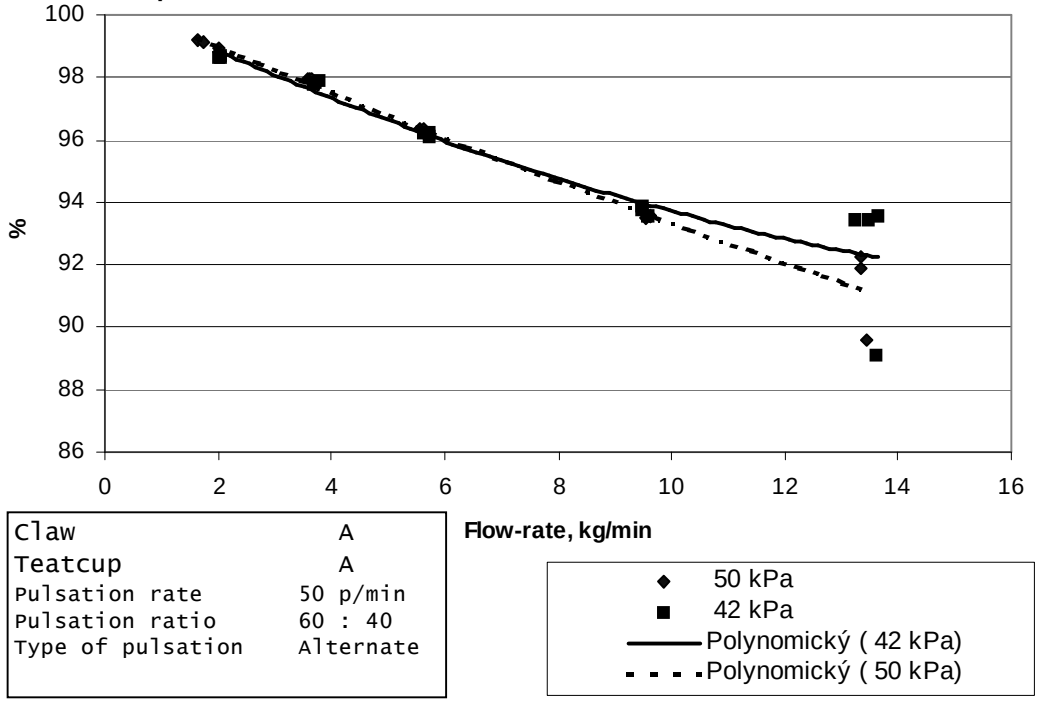


Fig. 4 Course of vacuum in the measuring points of the milking unit and milk flow-rateduring milking of the dairy cow No 216 on farm Trhovy Stepanov

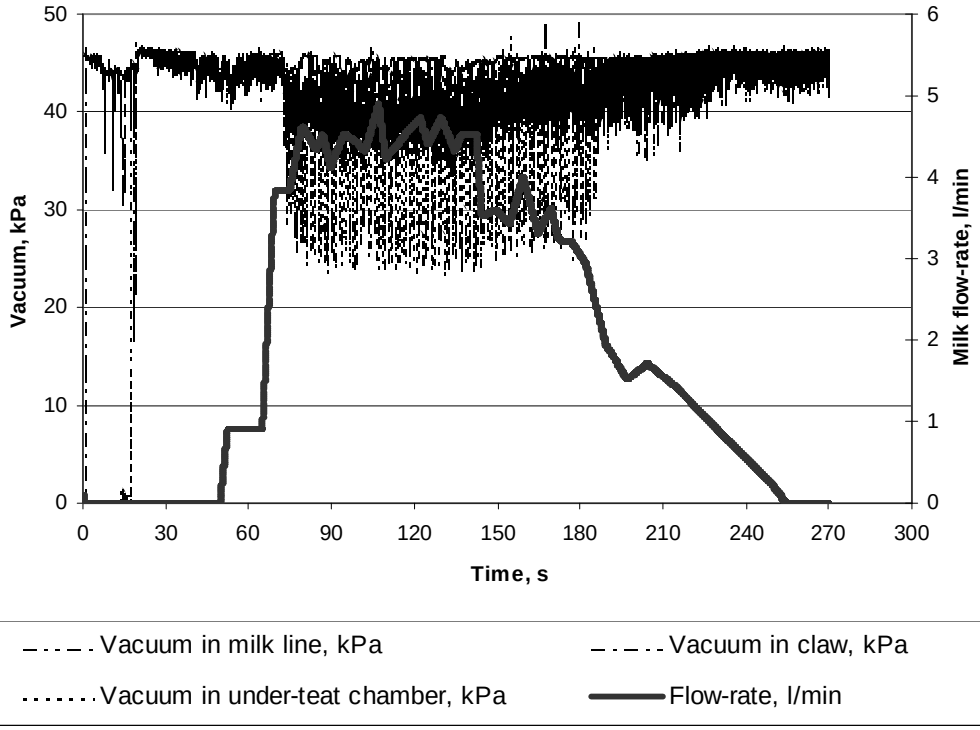
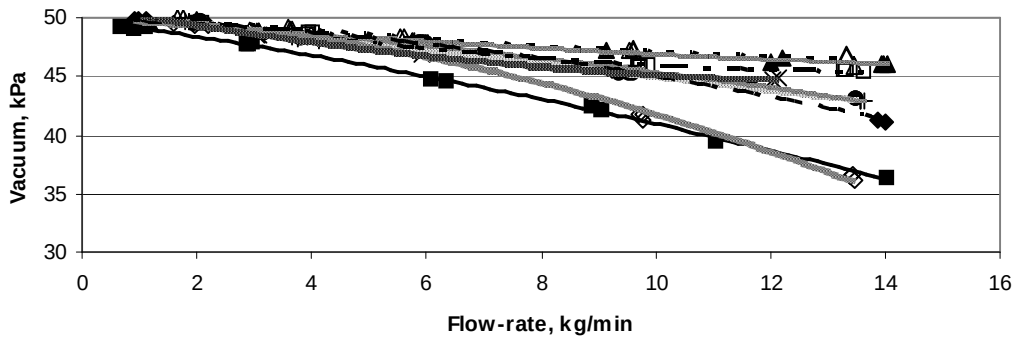
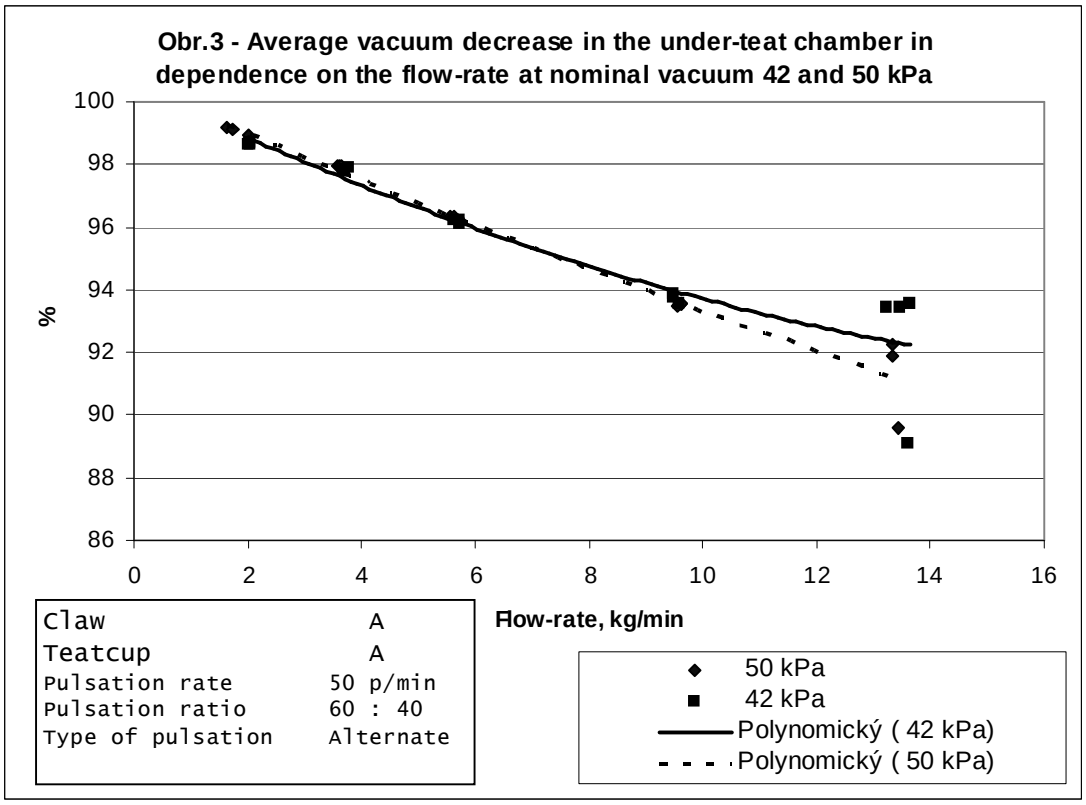


Fig. 2 Average vacuum values in the under-teat chamber of evaluated claws in dependence on flow-rate in the time of suction (B)



Nominal vacuum	50 kPa
Pulsation rate	50 p/min
Pulsation ratio	60 : 40
type of pulsation	alternate

AA	JB
GE	FE
CC	AB
ID	BA
DE	Polynomický (AA)
Polynomický (JB)	Polynomický (GE)
Polynomický (FE)	Polynomický (CC)
Polynomický (AB)	Polynomický (ID)
Polynomický (BA)	Polynomický (DE)


Obr.3 - Average vacuum decrease in the under-teat chamber in dependence on the flow-rate at nominal vacuum 42 and 50 kPa
100
98
96
94
92
90
88
86
%
0
2
4
6
8
10
12
14
16
Flow-rate, kg/min
Claw A
Teatcup A
Pulsation rate 50 p/min
Pulsation ratio 60 : 40
Type of pulsation Alternate
50 kPa
42 kPa
Polynomický (42 kPa)
Polynomický (50 kPa)