EFFECT OF AMBIENT TEMPERATURE ON THE TENSILE STRENGTH OF TEAT CUP LINERS

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We deal with examining the impact of ambient temperature on the tensile strength teat cup liners in this work. We used a new (unused) teat cup liners from different manufacturers, different material composition. Ambient temperature ranged from 0 °C to 35 °C increments, 5 °C. The results shows that the outer diameter of the rubber working under head was 29.08 resp. 29.89 mm, gradually decreased to a value of 23.30 resp. 27.88 mm. The dependence of the tensile strength on the ambient temperature is in all evaluated rubbers (teat cup liners) almost linear shape with a declining trend. Difference in the tensile strength at a ambiet temperature from 0 °C to 35 °C was 9 to 17.3 N on the first groove depending on the manufacturer. Relationship between ambient temperature and tensile strength, tested silicone teat cup liners, was expressed in the equation line form: $y = - 0{,}5729\ x + 107{,}03$ ($R^2 = 0.9719$). We can see from the selected model that the tensile strength decreased by 0,5729 N when ambient temperature increase by 1 °C. The coefficient of determination 0,9719 indicates that 97,19 % of the variability of tensile strength is explained by selected regression model.

Introduction. The oldest evidence of milking livestock are from the period 3100 years BC (Doležal et al., 2000). The method of obtaining milk transferred in terms of the development of very important changes . Sucking milk, which actually provides nourishment to offspring is considered to be the most natural way of obtaining milk. Milking machine, it is not only the deploying teat cup liners on the udder of dairy cow. It is a complex body reaction dairy cow to milking conditions (Tančin, Tančinová, 2008). Polymeric materials (plastics and rubber) used in engineering practice are not mostly pure polymers. It contains different additives, which can largely in positive or even negative way affect their resistance to the action of the ambient environment.

Most previously published works deals with the thermic and thermo-insulation degradation and stabilization of polymers at temperatures processing of these materials. Much less is known about the lifetime of polymer materials at temperatures of their technical usage (Gueskens, 2005). But we can see not only

the depreciation of polymer materials when are using, but also in processing and storage (Poschet, 2007). Tensile strength, which are realized non-destructive manner are including in the physico - mechanical tests of these materials. The meaning is clear - tested teat cup liners can be used without any problems in primary production, resp. for further research. In the primary production sometimes happens that from different reasons comes the destruction of some teat cup liner from the milking set. When is then used new teat cup liner to milking process there are significantly different tensile properties and also traumatising feelings for dairy cow. The factors which significantly affect the health of dairy cow as well as milk quality clearly include: permanent milking improper setting of milking device with inappropriate solutions to some structural component. The literary sources show that a very common cause results which to fall short of expectations is still teat cup liner. For these reasons was a goal of this work a non-destructive way (without damage) evaluated in laboratory conditions tensile strength of teat cup liners exposed to different temperature environments.

Material and Methods. In the group of tested teat cup liners were included new teat cup liners (black, silicone) different weight, shape and material composition. In the laboratory conditions were determined the dimension parameters, as well as tensile strength. Assessment was 8 teat cup liners of each material and rubbers were exposed to thermal environments 0 - 35 °C - by 5 °C. To reach objective result was necessary to construct a test stand, where would by the help of digital tensometric scale - Classical Electronics WE 2108, measured the strength required to stretch the teat cup liner required length dimension (Karas, Gálik, 2003; Karas, Gálik, 2004). Tensile strength of the teat cup liners were identified from the differences lengths teat case and teat cup liner of the each manufacturer.

Results and Discussion. In this work we mainly focused on the working part of the teat cup liner. From the Tab. 1 it is evident that the teat cup liners manufacturers continue the trend of conical shape. The largest outer diameter of the working part of the teat cup liners was just below the head (29,08 mm black teat cup liners and 29,89 mm silicone teat cup liners). The outer diameter gradually decreased to a value 23,30 mm black teat cup liners and 27,88 mm silicone teat cup liners. The difference was 5,78 mm black teat cup liners and 2.01 mm silicone teat cup liners.

Table 1.

Outer diameters of the working researched black teat cup liners

Measuring points									**Difference a-i, mm**
a	**b**	**c**	**d**	**e**	**f**	**g**	**h**	**i**	
Outer diameters, mm									
29,08	28,23	27,57	27,03	25,75	25,34	24,71	24,13	23,30	5,78

Table 2.

Outer diameters of the working researched silicone teat cup liners

Measuring points										Difference a-i, mm
a	b	c	d	e	f	g	h	i	j	
Outer diameters, mm										
29,89	29,60	29,42	29,15	29,01	28,90	28,70	28,41	28,08	27,88	2,01

There were included in to the statistical files except researched teat cup liners (A*, B*) for comparison also black teat cup liners randomly selected (C, D, E, F). All the teat cup liners were new, unused and were tested for 1 groove - with the exception of teat cup liner A*, at ambient temperature 0 ^{0}C – 35 ^{0}C by 5 ^{0}C, what is the ambient temperature in the primary production during milking. Ambient temperature was consistent with the teat cup liners. Tab. 3 shows the measured values in a static position - without pulsation. From Tab. 3 we can see the ambient temperature has a significant effect on the tensile strength teat cup liners. For example silicone teat cup liner (B*) was determined at 0 ^{0}C the tensile strength of 33,1 N, at 35 ^{0}C it was 24,1 N, so a difference was 9,0 N. For black teat cup liners (A*) was the difference of the first groove of 17,30 N and the second groove 21,0 N. For comparative teat cup liners (C, D, E, F) was found variation range of 12,9 N, 15,1 N, 12,9 N and 14,4 N. Fig. 1 shows the dependence between tensile strength examined teat cup liners and ambient temperature.

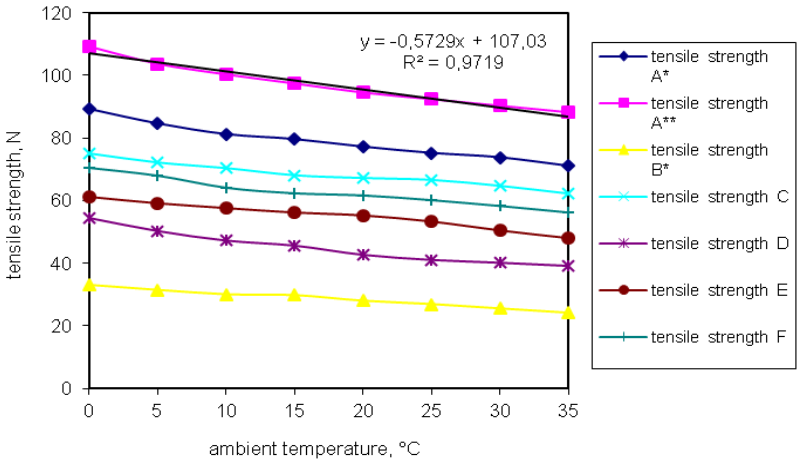

Fig. 1. The ensile strength of researched teat cup liners depending on the ambient temperature.

On the Fig. 1 is the manufacturer silicone teat cup liners (B) the relationship between ambient temperature and tensile strength expressed in the

equation line shape: y = - 0,5729 x + 107,03 (R^2 = 0,9719). The selected model illustrates that the tensile strength at elevated ambient temperature by 1 ° C decreased by 0,5729 N. The coefficient of determination 0,9719 indicates that 97,19 % of the variance tensile strength is explained selected regression model. Karas, Gálik (2003) found that during 24 hours worked on the teat cup liners in winter low temperatures (between 4 - 9 ° C) to 480 min. According to the mentioned authors, low temperatures have an adverse effect on tensile strength teat cup liners. Changes the ambient temperature from 0 °C to 35 °C changes tensile strength of the teat cup liners at 18 N, which match to our results.

Conclusion. The results obtained suggest:

- manufacturers continue to trend of conical working part teat cup liners;
- the tensile strength dependence on the ambient temperature is almost linear shape with a declining trend in all tested teat cup liners;
- the difference in the tensile strength at a temperature range from 0 °C to 35 ° C was from 9 to 17.3 N on the first groove, depending on the manufacturer;
- an increase in temperature of 1 °C will decrease the tension strength of 0,5729 N.

Table 3.

Effect of ambient temperature on tensile strength of new, unused teat cup liners

The ambient temperature, ^{0}C	**Manufacturer teat cup liners**					
	A*/ A**	B*	C	D	E	F
	The tensile strength, N					
	1.groove / 2.groove	1.groove	1.groove	1.groove	1.groove	1.groove
0	89,2 / 109,2	33,1	75,1	54,3	61,1	70,6
5	84,6 / 103,7	31,5	72,2	50,2	59,1	68,1
10	81,2 / 100,3	30,06	70,4	47,2	57,6	64,2
15	79,6 / 97,4	29,8	68,1	45,6	56,2	62,4
20	77,2 / 94,5	28,0	67,2	42,7	55,3	61,7
25	75,2 / 92,4	26,9	66,6	41,1	53,4	60,2
30	73,8 / 90,3	25,5	64,7	40,2	50,6	58,3
35	71,09 / 88,2	24,1	62,2	39,2	48,2	56,2
average	79,1 / 97,0	28,7	68,3	45,4	55,2	62,7
standard deviation	5,80 / 7,12	3,10	4,1	5,2	4,3	4,8

coefficient of variation	33,67 / 50,65	9,59	17,1	27,9	18,6	23,2
max.	89,2 / 109,2	42,6	62,2	54,3	61,1	70,6
min.	71,9 / 88,2	33,1	75,7	39,2	48,2	56,2
variation range	17,30 / 21,0	9,0	12,9	15,1	12,9	14,4

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