Alteration of Polyethylene Pipe Wall Thickness after Squeezing using Squeeze off-tool

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When great damages occur on gas-pipes, a quick intervention is often needed, as close to the place of damage as it can be. That is the reason why recently it has more and more been used a procedure of squeezing the pipe using a squeeze-off tool and thus stopping the flow. After the damage has been removed, the deformed pipe returns to the original shape by using re-rounding clam and the flow is established yet again. After the above-described process, the pipe is permanently deformed, as far as shape and thickness are concerned. The size of the deformation is important for the assessment of further use of the existing pipes or for determining the parameters for the newly-projected pipes. So far, the researches have been dealing with the hydrostatic and stress states after the squeezing of the pipe. The subject of this research is the decrease of the pipe thickness after the squeezing, and the goal is to help the designers of distributive plastic gas-pipes to determine the pipe wall thickness, as well as to help the managers of distributive networks so that they would know what happens to the existing gas-pipes after the intervention on the pipe.

Keywords: sqeeze – off tool, polyethilene gas pipe

Polyethylene (PE) is a thermoplastic material produced through polymerization of ethylene and it belongs to a group of polymers. The use of polyethylene pipes for different systems for the distribution of fluid (gas pipeline, water piping) is becoming more and more important, thanks to the advantages it has over other materials: low specific gravity (easy to transport and set up), good flexibility (good terrain adjustment), smooth inner surface (small losses of pressure and no forming of sediment after long time), high resistance to corrosion, temperature of use up to +60°C and resistance to low temperature [1].

Stopping off the gas flow is managed by squeezing the polyethylene gas pipe with a squeeze-off tool. After the intervention on polyethylene gas pipe, the squeeze-off tool is loosened, and the re-rounding pipe is used across the surface of the pipe. The re-rounding pipe restitutes the circular section of the pipe in order to decrease the loss of energy. While squeezing the polyethylene gas pipe, deformation occurs, as well as changes in thickness of the material, figure 1a.

The previous researches have shown that the compression of the wall of polyethylene gas pipes larger than 30% can lead to damaging the pipe, by mechanism called slow crack growth, especially with pipes that are more resistant to the mechanism of damage in slow crack growth. With polyethylene pipes that are less resistant to the mechanism of damage in slow crack growth, damages of pipes can be caused when the compression of pipe walls is less than 30%. Likewise, it has been determined that the length of squeezing does not have larger effects on the damage of the pipes [2]. To prevent permanent pipe deformation, the Rule Book DVGW – GW 332 recommends that the squeezing ratio

$$SR = \frac{r}{2\delta}, \qquad (1)$$

should not be smaller than 0.8 [3]. In this way, compression of the pipe wall does not exceed 20%. In the equivalent (1) the magnitudes are:

r - distance between the cylinder squeeze-off tools and
δ - pipe wall thickness [m].

During the squeezing of the pipe, the endpoints suffer a considerable deformation that can be noted visually, figure 1a, and which is called squeezing-off ear. Damages of polyethylene pipes are, in fact, made on the endpoints of a squeezed pipe, under the surface of "squeeze-off ear" of the pipes. After the release of the pipe under the squeeze-off tool, there is usually a visual control of damages exactly on the squeeze – off ear [4- 7]. Pipes of thickness smaller than 10 mm can successfully be squeezed, while thicker pipes wrinkle [8].

Testing of stress and hydrostatic have been done, aiming at researching the influence of squeezing of the pipe on short and long-term characteristics of the pipe. Influences of squeezing ratio, outside diameter of the pipe and geometry of the squeeze-off tool have been varied. Hydrostatic tests were done after squeezing the pipe to examine the degree of damage on the pipe [9]. Difference in deformity of new and old pipes does exist, which has been investigated by examining damages on old polyethylene gas pipes on those places at which squeeze-off tool has been used [10].

Previous researches have dealt with testing stress states, damages and hydrostatic examinations of polyethylene gas-pipes after the squeezing with a squeeze-off tool. Data on the decrease of wall thickness of polyethylene gas pipes after the squeezing with a squeeze-off tool do not almost exist. Required wall thickness of the pipe is set by the standard DIN 2413 [11]. For the pipes of working pressure amounting to 16 bars, minimal pipe wall thickness values of the pipe outside diameter were defined. For the pipes whose working pressure is larger than 16 bars, minimal pipe wall thickness is defined as:

$$\delta = \frac{0.5 \cdot p_m \cdot D \cdot S}{k \cdot T \cdot V} + C_1 + C_2 \qquad (2)$$

where:

C_1 – addition on the allowed deviation of wall pipe value [mm];

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C_2 – addition to corrosion or attrition [mm];
D - pipe outside diameter [m];
k – protraction limit [bar];
p_m – maximal working pressure [bar];
S - security factor [-];
T – temperature factor [-] and
V - weld joint factor [-].

Relation between pipe outside diameter and pipe wall thickness is defined as the following:

$$SDR = \frac{D}{\delta}. \quad (3)$$

Information on the polyethylene pipe wall thickness after the squeezing of the pipe is very important for the designers of distributive plastic gas pipelines for determining pipe wall thickness and for the managers of distributive networks to know what is happening on the existing gas pipelines after the intervention on the pipe. Decrease in pipe wall thickness after the squeezing with the squeeze-off tool could be taken in consideration in the equation (2) in part: relation to addition in attrition C_2. Even though there are no damages on the pipe wall and the thinner pipe wall is firm enough to bear the gas pressure of the pipe, possibly the decrease in pipe wall thickness is a potential risk from damaging. The latest examinations of samples of damage source of polyethylene gas pipes which were close to water pipes support this idea [12]. During the damage of water piping, there has been leakage of water jet. Water jet, under the pressure, with the soil and sand created erosive slurry that, by obstructing polyethylene gas pipe, led to damage of a pipe.

Exactly for the above-mentioned reasons, experimental researches were done with a goal to determine how much will the polyethylene gas pipe thickness decrease after squeezing it with squeeze-off tool.

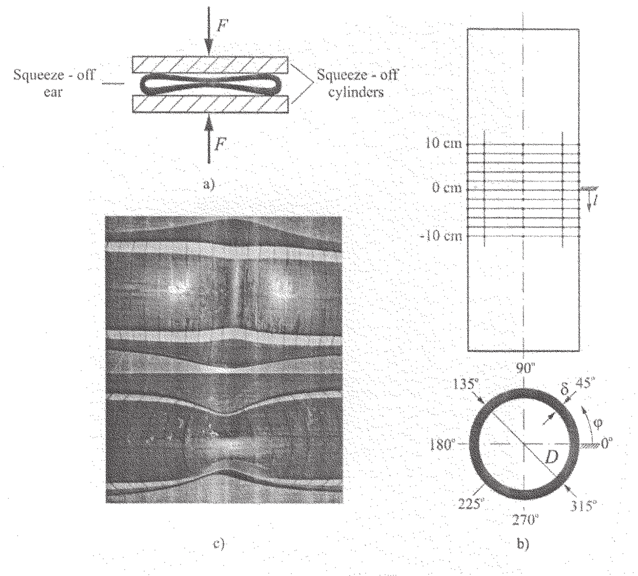

Fig.1. Measuring polyethylene pipe wall thickness before and after squeezing

Experimental part

To determine changes of pipe wall thickness after squeezing, examinations were made on new polyethylene gas pipes with SDR 11, pipe outside diameter ranging from 40 to 160 mm, with thickness PE 80 and PE 100, table 1. The pipes were produced based on the recommendations of EN 1555 Standard [11]. On pipe samples from table 1, length of 1 meter, permanent marker network has been drawn, figure 1b. Network step in volume of the pipe is 45°, whilst the network step along the longitudinal axis of the pipe is 2 cm. At intersecting points of the drawn net, before the squeezing of the pipe, pipe wall thickness has been measured. The pipes were afterwards squeezed with a squeeze-off tool and held under it for one hour. After the release of the squeeze-off tool, elipsoid section of the surface of the cross section of the deformed pipe, figure 1c, was modeled back to the cross section using re-rounding clamp. In the intersecting points of the drawn net, after the squeezing, pipe wall thicknesses was measured, and then the values of the pipe wall thickness before and after the squeezing were compared. The reasearch has been conducted in a laboratoy, under the constant air temperature of 25° C.

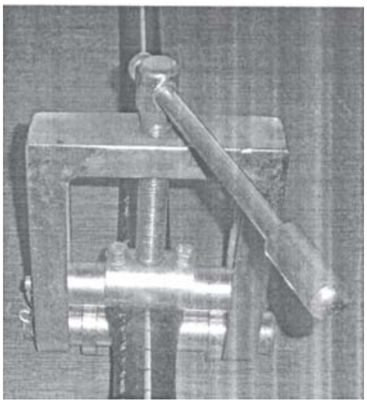

Fig. 2. Manual squeeze - off tool

Squeezing of the pipe was done in accordance with the recommendations given in Rule Book DVGW – GW 332 [3]. Squeeze-off tools ´Georg Fischer´, model S1 and S2, were used for the squeezing. Model S1, figure 2, is used for the squeezing of the pipe of outside diameter 20 to 63 mm and SRD11, whereas the model S2, figure 3, is used for squeezing of the pipe with outside diameter 63 to 160 mm and SRD11 and SRD17. Squeezing ratio SR is set to a value 0.8 by using squeeze-off delimiter. After the squeezing, re-rounding clamps form the same manufacturer were used for restoring the circular section, especially for pipes with outside diameters 63, 110 and 160 mm.

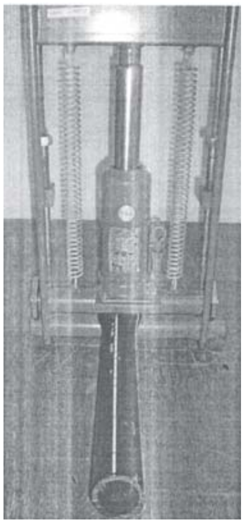

Fig. 3. Hydraulic squeeze - off tool

For measuring pipe wall thickness, ultrasonic thickness gage was used, figure 4, by ´Sonatest´ manufacturer, model Sonagage II, with transducer model SG1.

Head transducer diameter SG1 is 9 mm, and it works on a frequency of 5 MHz, which makes it suitable for measuring thickness of polyethylene. Measuring range of the gage with a conducer SG1 is 1 mm to 150 mm, and sound velocity range is -10°C to 50°C, whilst resolution of the gage is 0.01 mm. Calibration of ultrasonic thickness gage was done on a particular pipe that was measured by using calliper with accuracy of 0.05 mm.

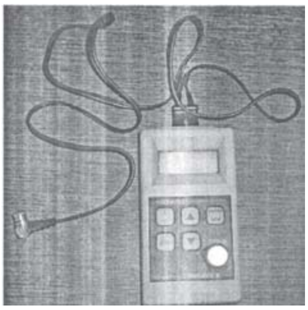

Fig. 4. Ultrasonic thickness gage

Table 1
TESTED SAMPLES OF POLYETHYLENE GAS PIPES

Number	Pipe outside diameter (mm)	Density of polyethylene gas pipe	Number of pieces
1.	DN40	PE 80	2
2.	DN63	PE 80	2
3.	DN110	PE 100	2
4.	DN110	PE 80	2
5.	DN160	PE 80	2
6.	DN160	PE 100	2

Results and discussions

Tables 2 to 7 show the results of wall thickness of polyethylene gas pipes, before and after squeezing it in the intersecting points of the drawn net.

Values in the tables 2 to 7:

l – distance from squeezing point in longitudinal direction of the pipe [cm] and

φ – distance in volume of the pipe [°],

are defined in figure 1b.

In the shown results of measuring wall thickness of polyethylene gas pipe, it is noticeable that the thickness is visibly changing under the cylinder of the squeeze-off tool (elevation 0 in fig. 1b), whilst in points left and right along the longitudinal axis of the pipe, the change is negligible. That is way, in the further analysis, it will be taken into consideration only the change in thickness under the squeeze-off tool along the volume of polyethylene pipe.

Figure 5 shows changes in wall thickness of polyethylene gas pipes after squeezing, whilst figure 6 shows relative changes in pipe wall thickness after squeezing, in comparison with the initial wall thickness. As the polyethylene pipes are situated in such a position on the squeeze-off tool that the squeeze – off ears are formed on spots $\phi = 90°$ and $\phi = 270°$, it is clear in figures 5 and 6 that the largest changes in wall thicknesses of polyethylene gas pipes occur precisely around the squeeze-off ears. This discovery is in accordance with the previous researches, which have established that the majority of damages of polyethylene gas pipes after the squeezing occur in the area of squeeze-off ear of the squeezed pipe [4-7].

Table 2
POLYETHYLENE GAS PIPE OF OUTSIDE DIAMETER DN40 AND DENSITY PE80 BEFORE AND AFTER SQUEEZING

		l (cm)	10	8	6	4	2	0	-2	-4	-6	-8	-10
Before squeezing	φ [°]	0	4.89	4.91	4.91	4.93	4.97	5.06	4.93	4.9	4.88	4.89	4.9
		45	4.98	5.05	4.97	5.1	5.01	5.25	4.95	4.95	4.98	4.97	4.96
		90	5.11	5.08	4.98	5.15	5.03	5.06	5.07	4.99	5.08	5.03	5.09
		135	5.14	5.47	5.2	5.19	5.07	5.07	5.12	5.1	5.17	5.12	5.22
		180	5.15	5.14	5.17	5.09	5.07	5.11	5.09	5.06	5.05	5.06	5.57
		225	5.06	5.24	5.26	5.08	5.03	5.08	5.05	5	5.01	5.04	5.17
		270	4.99	4.97	5.01	5.01	5.05	4.96	5.05	4.95	4.95	4.97	5.05
		315	5.01	4.95	4.98	5	4.93	5.02	4.95	4.93	4.94	4.94	4.93
After squeezing		l (cm)	10	8	6	4	2	0	-2	-4	-6	-8	-10
	φ [°]	0	4.69	4.72	4.72	4.66	4.65	4.65	4.64	4.64	4.66	4.67	4.69
		45	4.73	4.89	4.77	4.72	4.71	4.71	4.71	4.74	4.73	4.71	4.73
		90	4.84	4.89	4.88	4.75	4.75	4.76	4.82	4.76	4.74	4.77	4.81
		135	4.91	4.95	4.87	4.84	4.82	4.97	4.81	4.93	4.87	4.82	4.88
		180	4.84	4.87	4.82	4.84	4.81	4.82	4.82	4.86	4.81	4.84	4.84
		225	4.82	4.79	4.86	4.81	4.8	4.82	4.78	4.84	4.76	4.77	4.79
		270	4.84	4.74	4.74	4.72	4.73	4.72	4.71	4.72	4.71	4.73	4.75
		315	4.8	4.81	4.74	4.67	4.72	4.69	4.65	4.67	4.72	4.73	4.72

Table 3
POLYETHYLENE GAS PIPE OF OUTSIDE DIAMETER DN63 AND DENSITY PE80 BEFORE AND AFTER SQUEEZING

		l (cm)	10	8	6	4	2	0	2	4	6	-8	-10
Before squeezing	φ [°]	0	7.1	7.11	7.1	7.08	7.09	7.1	7.09	7.11	7.12	7.11	7.09
		45	7.11	7.12	7.09	7.09	7.07	7.11	7.11	7.1	7.11	7.1	7.09
		90	7.05	7.1	7.03	7.03	7.07	7.03	7.14	7.03	7.06	7.08	7.06
		135	7.03	7.03	7	7.01	7	7.03	7.08	7	7.06	6.96	7
		180	6.92	6.94	6.9	6.89	6.9	6.9	6.95	6.94	6.93	6.9	6.9
		225	7	7	6.99	6.97	7	7	7.02	7	6.99	6.99	6.99
		270	6.97	6.96	6.93	6.91	6.93	6.93	6.96	6.94	6.91	6.93	6.95
		315	7.09	7.08	7.07	7.04	7.03	7.04	7.08	7.09	7.08	7.08	7.07
After squeezing		l (cm)	10	8	6	4	2	0	-2	-4	-6	-8	-10
	φ [°]	0	6.11	6.11	6.14	6.03	6.06	5.92	6.1	6.12	6.12	6.12	6.11
		45	6.09	6.09	6.07	5.97	6.01	5.8	6.07	6.09	6.11	6.1	6.09
		90	6.01	6.07	6.01	5.94	5.95	5.57	6.01	6.1	6.05	6.04	6.01
		135	6.01	6.02	5.99	5.88	5.93	5.63	6.03	6.04	6.04	6.02	6.03
		180	5.94	5.96	5.94	5.95	5.9	5.8	5.96	5.97	5.95	6.01	6.08
		225	6.03	6.02	6	6.03	5.95	5.74	6.05	6.07	6.03	6.08	6.05
		270	6.08	6.08	6.06	6.09	6	5.74	6.1	6.1	6.1	6.1	6.1
		315	6.15	6.13	6.1	6.04	6.06	5.78	6.12	6.13	6.13	6.15	6.18

Table 4
POLYETHYLENE GAS PIPE OF OUTSIDE DIAMETER DN110 AND DENSITY PE100 BEFORE AND AFTER SQUEEZING

		l (cm)	10	8	6	4	2	0	-2	-4	-6	-8	-10
Before squeezing	φ [°]	0	9.91	9.97	9.97	10	10.05	10.04	10.04	10.08	10.04	10.01	10.1
		45	9.97	10	10.1	10.02	10.08	10.09	10.12	10.13	10.08	10.07	10.08
		90	9.96	9.98	10.16	10.03	10.04	10.12	10.16	10.17	10.13	10.11	10.12
		135	9.7	9.7	9.74	9.76	9.78	9.78	9.79	9.85	9.78	9.78	9.81
		180	9.89	9.85	9.88	9.9	9.91	9.9	9.94	9.91	9.97	9.95	9.9
		225	9.88	9.9	9.9	9.92	10.01	9.97	9.99	9.97	9.95	9.96	9.95
		270	10.1	10	10.09	10.1	10.1	10.12	10.13	10.1	10.1	10.1	10.1
		315	10.1	10.1	10.21	10.16	10.18	10.18	10.33	10.19	10.17	10.16	10.18
		l (cm)	10	8	6	4	2	0	-2	-4	-6	-8	-10
After squeezing	φ [°]	0	9.93	9.93	9.98	10	10.03	9.8	10.1	10.08	10.06	10.03	10.03
		45	10	10.01	10.07	10.07	10.07	9.27	10.08	10.11	10.12	10.12	10.12
		90	10	9.98	10.01	10	10.02	9.29	10.02	10.12	10.16	10.11	10.12
		135	9.68	9.69	9.7	9.74	9.75	9.61	9.84	9.8	9.73	9.79	9.76
		180	9.82	9.81	9.83	9.9	9.93	9.79	9.98	9.91	9.91	9.93	9.95
		225	9.89	9.95	9.94	9.94	10	9.66	9.96	9.98	9.99	10	10
		270	10.02	10.04	10.06	10.09	10.07	9.83	10.08	10.12	10.15	10.18	10.15
		315	10.08	10.09	10.14	10.12	10.19	10.07	10.3	10.23	10.19	10.17	10.2

Table 5
POLYETHYLENE GAS PIPE OF OUTSIDE DIAMETER DN110 AND DENSITY PE80 BEFORE AND AFTER SQUEEZING

		l (cm)	10	8	6	4	2	0	-2	-4	-6	-8	-10
Before squeezing	φ [°]	0	10.56	10.54	10.6	10.56	10.56	10.54	10.58	10.58	10.55	10.54	10.56
		45	10.53	10.53	10.54	10.55	10.53	10.51	10.54	10.53	10.52	10.52	10.44
		90	10.45	10.46	10.47	10.47	10.43	10.43	10.45	10.47	10.48	10.44	10.42
		135	10.6	10.57	10.58	10.59	10.56	10.55	10.6	10.6	10.59	10.6	10.59
		180	10.58	10.55	10.57	10.58	10.55	10.57	10.58	10.59	10.58	10.58	10.59
		225	10.58	10.57	10.6	10.61	10.58	10.55	10.53	10.58	10.57	10.57	10.57
		270	10.45	10.47	10.47	10.46	10.46	10.45	10.5	10.52	10.44	10.45	10.48
		315	10.45	10.46	10.45	10.46	10.44	10.42	10.46	10.44	10.45	10.45	10.44
		l (cm)	10	8	6	4	2	0	-2	-4	-6	-8	-10
After squeezing	φ [°]	0	10.54	10.5	10.59	10.57	10.67	10.06	10.61	10.55	10.55	10.57	10.59
		45	10.54	10.54	10.56	10.56	10.54	9.68	10.54	10.49	10.56	10.58	10.57
		90	10.5	10.48	10.5	10.5	10.47	9.56	10.47	10.62	10.51	10.5	10.5
		135	10.58	10.57	10.59	10.65	10.65	9.94	10.61	10.61	10.62	10.62	10.61
		180	10.57	10.55	10.51	10.61	10.63	10.01	10.64	10.59	10.6	10.59	10.6
		225	10.59	10.57	10.59	10.62	10.55	9.38	10.51	10.51	10.59	10.59	10.63
		270	10.48	10.5	10.49	10.5	10.47	9.34	10.47	10.48	10.51	10.49	10.51
		315	10.46	10.45	10.48	10.47	10.48	9.83	10.6	10.48	10.48	10.49	10.49

Table 6
POLYETHYLENE GAS PIPE OF OUTSIDE DIAMETER DN160 AND DENSITY PE80 BEFORE AND AFTER SQUEEZING

		l (cm)	10	8	6	4	2	0	-2	-4	-6	-8	-10
Before squeezing	φ [°]	0	14.13	14.11	14.09	14.12	14.09	14.09	14.11	14.12	14.14	14.14	14.14
		45	13.96	13.94	13.95	13.94	13.95	13.94	13.98	13.97	13.97	14.01	14
		90	14.02	14.02	14.01	14.01	14.02	14	14.02	14.05	14.04	14.05	14.05
		135	14.15	14.15	14.13	14.13	14.13	14.17	14.14	14.14	14.19	14.16	14.17
		180	14.2	14.19	14.19	14.19	14.23	14.18	14.2	14.2	14.21	14.22	14.22
		225	14.18	14.18	14.17	14.18	14.18	14.17	14.18	14.19	14.2	14.2	14.21
		270	14.29	14.29	14.29	14.28	14.28	14.28	14.3	14.31	14.32	14.32	14.32
		315	14.23	14.22	14.22	14.23	14.21	14.22	14.24	14.25	14.26	14.26	14.26
		l (cm)	10	8	6	4	2	0	-2	-4	-6	-8	-10
After squeezing	φ [°]	0	13.98	13.98	14.03	14.13	14.21	13.73	14.18	14.08	14.03	14.01	14.01
		45	13.85	13.84	13.84	13.92	14.01	13.8	13.99	13.88	13.85	13.86	13.89
		90	14.01	13.97	13.93	14.01	13.89	13.21	13.62	13.99	14.05	14.04	14.03
		135	14.06	14.06	14.06	14.1	14.06	13.51	14.07	14.06	14.1	14.13	14.13
		180	14.06	14.09	14.14	14.2	14.34	13.87	14.2	14.15	14.11	14.08	14.12
		225	14.08	14.09	14.11	14.15	14.22	13.82	14.16	14.12	14.11	14.1	14.13
		270	14.28	14.22	14.19	14.21	14.08	13.48	14.13	14.19	14.3	14.32	14.31
		315	14.16	14.15	14.18	14.15	14.11	13.71	14.18	14.18	14.18	14.2	14.19

Table 7
POLYETHYLENE GAS PIPE OF OUTSIDE DIAMETER DN160 AND DENSITY PE100 BEFORE AND AFTER SQUEEZING

		l (cm)	10	8	6	4	2	0	-2	-4	-6	-8	-10
Before squeezing	φ [°]	0	14.37	14.38	14.4	14.41	14.38	14.4	14.45	14.46	14.47	14.47	14.47
		45	14.33	14.36	14.35	14.44	14.35	14.38	14.35	14.39	14.4	14.45	14.41
		90	14.67	14.69	14.72	14.75	14.73	14.73	14.75	14.77	14.77	14.75	14.78
		135	14.75	14.77	14.78	14.8	14.79	14.79	14.86	14.81	14.86	14.85	14.84
		180	14.66	14.69	14.7	14.72	14.72	14.71	14.74	14.75	14.76	14.76	14.76
		225	14.72	14.79	14.77	14.78	14.79	14.8	14.81	14.83	14.83	14.83	14.81
		270	14.83	14.89	14.9	14.9	14.93	14.91	14.92	14.93	14.93	14.93	14.94
		315	14.76	14.79	14.8	14.8	14.82	14.81	14.83	14.82	14.82	14.84	14.85
		l (cm)	10	8	6	4	2	0	-2	-4	-6	-8	-10
After squeezing	φ [°]	0	14.27	14.31	14.29	14.43	14.63	13.92	14.57	14.45	14.43	14.43	14.44
		45	14.3	14.28	14.37	14.39	14.4	13.2	14.35	14.42	14.43	14.44	14.49
		90	14.63	14.69	14.69	14.72	14.69	13.6	14.64	14.75	14.79	14.84	14.83
		135	14.65	14.7	14.75	14.83	14.96	14.27	14.96	14.86	14.8	14.78	14.79
		180	14.57	14.61	14.66	14.75	14.94	14.24	14.89	14.78	14.72	14.7	14.71
		225	14.7	14.76	14.78	14.81	14.82	13.56	14.7	14.83	14.83	14.82	14.83
		270	14.82	14.87	14.93	14.92	14.9	13.51	14.86	14.94	14.96	14.97	15.01
		315	14.69	14.72	14.76	14.83	14.95	14.23	14.96	14.85	14.8	14.83	14.87

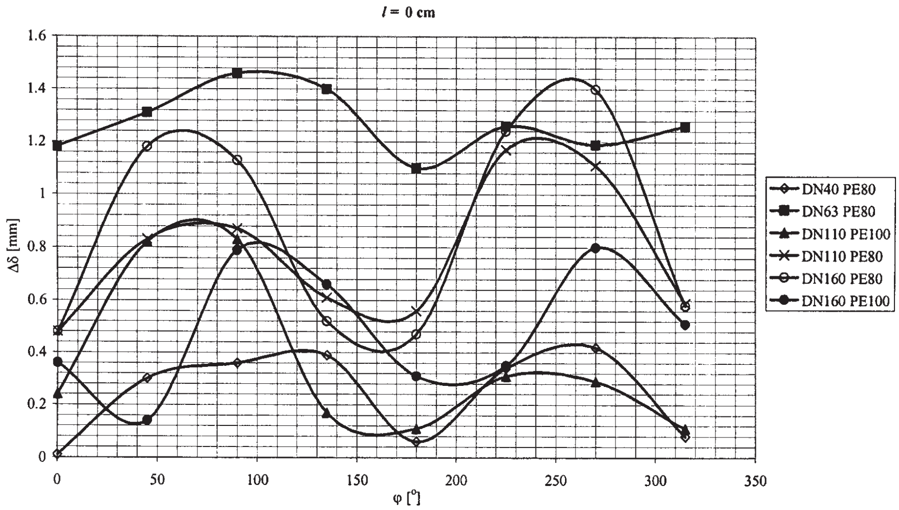

Fig. 5. Change in wall thickness of polyethylene gas pipe after squeezing with squeeze-off tool

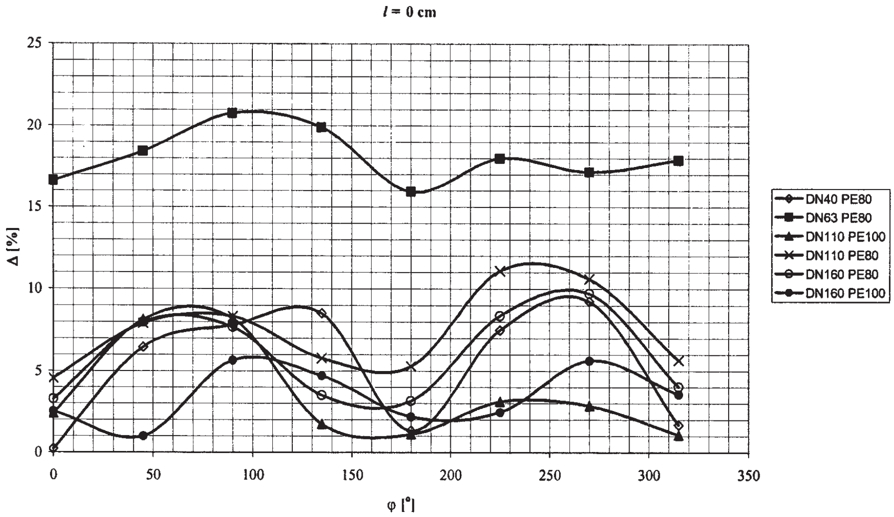

Fig. 6. Relative change in wall thickness of polyethylene gas pipe after squeezing with squeeze-off tool

The largest relative decrease in wall thickness of polyethylene gas pipe happens with pipes whose outside diameter is 63 mm; on the squeeze-off ears it exceeds even 20%. From the pictures 5 and 6 we can conclude that there is a tendency: by increasing the diameter of polyethylene pipe, relative change in wall thickness after the squeezing decreases. Furthermore, pipes with outside diameter 110 mm have larger relative decrease in wall thickness than pipes with diameter of 160 mm.

Note that the pictures 5 and 6 show that polyethylene pipes of higher density can more easily resist the decrease in wall thickness undergoing squeezing. And, pipes of outside diameter of 110 mm and 160 mm, pipes with density PE100 have smaller relative decrease in pipe wall thickness than pipes with thickness of PE80.

Conclusions

Significant decrease in thickness in the process of squeezing polyethylene gas pipes occurs only under the cylinder of the squeeze-off tool (elevation 0 in figure 1b); while the decrease of the pipe wall left and right from the cylinder of the squeeze-off tool, along the longitudinal axis of the pipe is negligibly small. Polyethylene gas pipes mostly become thinner at squeeze – off ear after the squeezing, which is in accordance with the information from the last research. There is a tendency that the polyethylene pipes of larger outside diameter have smaller relative decrease in pipe wall thickness. Likewise, pipes of higher density have smaller relative decrease in pipe wall thickness.

Relative decrease in wall thickness of pipes with outside diameter 63 mm goes over 20%, and for pipes of the outside diameter 110 mm and density PE80, it goes just above 10%, while for the pipes of outside diameter 160 mm and density PE80, it goes as high as 6%. Even though the pipes with a decreased thickness of the wall can bear internal loading and have stress states within the limited range, due to hazards from the surroundings of the polyethylene pipe, the noted pipe wall decreases should surely be taken into account. Polyethylene gas pipes, which use squeeze-off tool to stop the flow, should be advisably redimensioned. In the calculation of the strength of the polyethylene gas pipe, it is needed to increase the value of the ratio for attrition C_2 in the equation (2), so that the wall thickness increases for 20 %. In this way, it would decrease the risk of damaging the polyethylene pipe, at which the flow is stopped using a squeeze-off tool.

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