

THE INFLUENCE OF LUBRICANT SYSTEM IN DEEP DRAWING WALLS THICKNESS

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ABSTRACT: Deep drawing process depends on the right choice of the input parameters. The coefficient of friction between the active elements and the blank is a very important factor in getting proper parts in terms of quality. This paper presents the influence of different lubrication systems on affecting the way that the thickness of deep drawing part varies. The paper analyzes three types of lubrication. The experimental results are obtained for deep drawing parts made without any lubrication, with lubricant and with film lubricant.

KEY WORDS: deep drawing, friction coefficient, lubricant

1. INTRODUCTION

Deep drawing is one of the most common processes in metal sheet deformation. Deep drawing is the transformation of a plan blank in to a cylindrical, parallelepiped or complex shape (fig 1). Research in this area is vast and the literature can proof this. Approach to drawing applications range from the study of the influence of parameters deep drawing to applications that can get new ways to optimize the process [1], [2], [3].

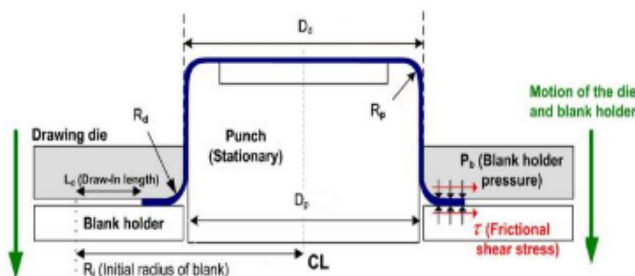


Figure 1. Schematic representation of the deep drawing process [7]

The process of deep drawing is characterized by a very complicated strain, affected by the following parameters[4]:

- material properties;
- geometry of the active elements;
- shape of the blank;
- speed of the punch;
- coefficient of friction.

The quality of deep drawing parts is influenced by certain variables that can be controlled [11]. The flow of material during the deep drawing process depends on the type of lubricant used, witch can

affect the frictional forces between the active elements. Lubricants may also be influenced by temperature tool.

Lubricants play an important role in the process of drawing, reducing the coefficient of friction thus having the role to contribute to the production of quality parts. A good lubricant will decrease failure rate.

In the literature there are two models of friction that can describe friction conditions during the deep drawing process [10]. In figure 2 is shown the relationship between contact pressure and frictional shear stress.

$$\tau_f = \mu p \quad (1)$$

Where τ_f =frictional shear stress, μ - coefficient of friction and p = normal pressure.

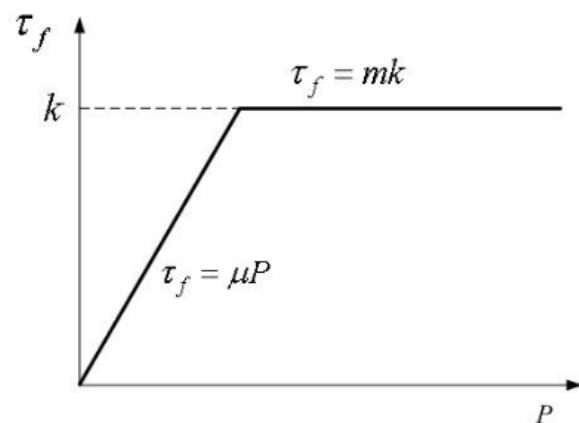


Figure 2. Relationship between contact pressure and frictional shear stress [10]

In equation 2, if $m=0$ we have no friction, if $m=1$ we have a sticking friction condition.

$$\tau_f = f\bar{\sigma} = m \frac{\bar{\sigma}}{\sqrt{3}} = mk \quad (2)$$

Where f =friction factor, m =shear factor, k =shear strength and $\bar{\sigma}$ =flow stress.

The friction is one of the most important parameters affecting the force required to flow the material and the forming process. The coefficient of friction has either positive or negative role in the drawing of the material.

The coefficient of friction between the active elements and elements is a parameter that can positively influence the drawing if correct.

An excessive friction lead to defects such as cracks and friction coefficient too low can cause ripple phenomenon on the flange piece.

2. LUBRICANT TYPES USED IN EXPERIMENTS

The quality of deep drawing part is determined by the surface roughness and the wall thickness profile [7].



Figure 3. Deep drawing part obtained with film system

In research were analyzed three types of friction between the die active elements and the blank:

- no items to reduce the coefficient of friction;
- lubricant luberstone 4211 (fig.4);
- film (fig. 3).

Luberstone 4211 was created to improve the quality of parts obtained by drawing. It can also be used as a lubricant, in the cold working aqueous galvanized pipes. Luberstone 4211 can be applied manually.

The other input parameters in the process of deep drawing, punch radius, die radius and the blank holder force are considered fixed.



Figure 4. Deep drawing part obtained with lubricant system
Deep drawing process parameters used in the study are presented in table 1.

Table 1. Deep drawing parameter process

Parameters	Value
Punch radius	3 mm
Die radius	6.5 mm
Blank holder force	9000 N
Lubricant	Without lubrication
	Lubricant
	Film

The study analyzes the deep drawing part from the thickness point of view. The part measurement was made with the coordinate measuring machine.[5][6] It's been analyzed 31 points along the part profile, the points density is higher and radius area (fig. 5).

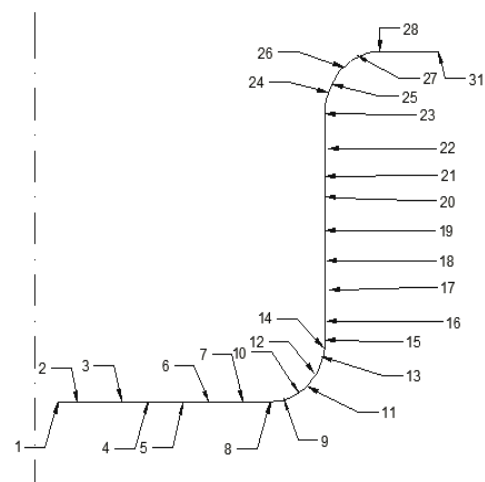


Figure 5. Measurement points locations

For punch radius 3 mm and die radius 6.5 mm were obtained following experimental data (table 2):

Table 2. Values of material thickness measured from the center to the outside parts

	Without lubrication	Lubricant	Film	Regions
1	0.756	0.762	0.782	The bottom part
2	0.758	0.769	0.788	
3	0.759	0.762	0.789	
4	0.761	0.768	0.791	
5	0.767	0.77	0.793	
6	0.766	0.768	0.79	
7	0.765	0.77	0.798	
8	0.772	0.785	0.804	
9	0.74	0.745	0.767	Connecting the wall to the bottom piece
10	0.671	0.681	0.711	
11	0.654	0.652	0.674	
12	0.636	0.67	0.677	
13	0.79	0.806	0.832	
14	0.736	0.763	0.733	
15	0.725	0.726	0.755	Side wall
16	0.732	0.717	0.751	
17	0.745	0.723	0.762	
18	0.729	0.717	0.756	
19	0.737	0.731	0.767	
20	0.718	0.721	0.759	
21	0.72	0.739	0.771	
22	0.766	0.786	0.813	Connecting the wall to the flange
23	0.826	0.812	0.861	
24	1.036	1.019	1.046	
25	1.053	1.043	1.072	
26	1.192	1.17	1.208	
27	1.256	1.215	1.273	
28	1.06	1.026	1.062	
29	1.124	1.091	1.12	
30	0.899	0.876	0.925	Flange
31	0.899	0.879	0.943	

3. EXPERIMENTAL DATA ANALYSIS

The study area was divided into 4 typical zones for a deep drawing part. The influence of this parameter

on the variation in thickness of the workpiece can be viewed using the graph in figure 6.

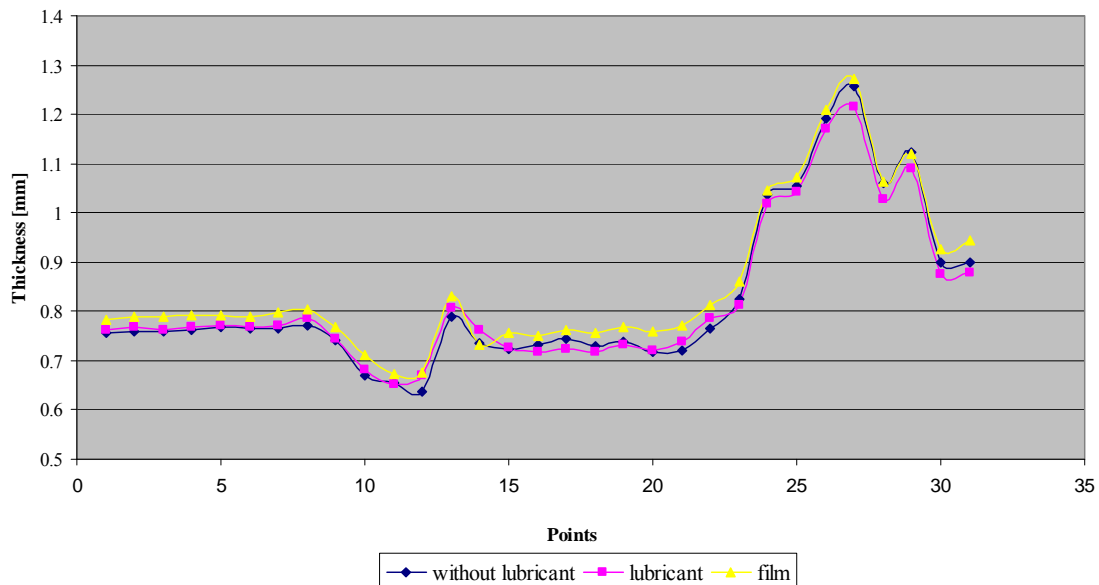


Figure 6. Thickness variation of the deep drawing piece using three lubricate systems

Initial thickness of the blank is 0.8 mm and the diameter is 188 mm. A significant thinning appears in the bottom piece and sidewall connection and a thickening in the flange material.

In order to make the necessary observations and conclusions the chart from figure 6 was divided into four different areas such:

- for the lower part piece (fig.7):

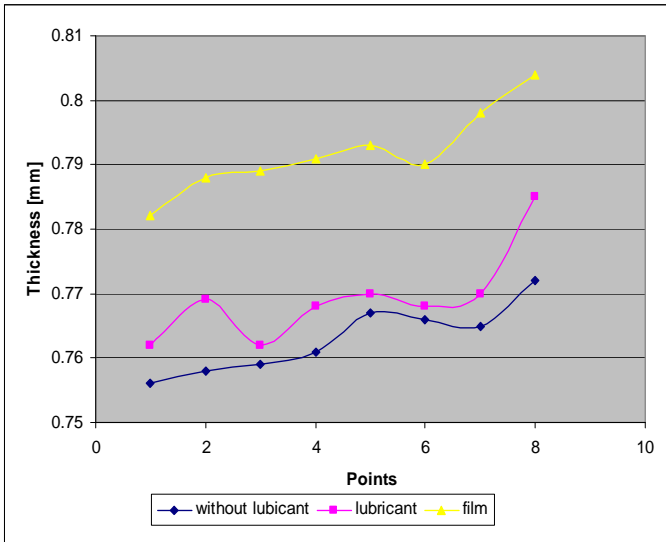


Figure 7. Thickness variation of the bottom part according to the selected type of lubricant

According to the chart, it can be seen that in the experiments which have not used any lubricant, the thinning of the piece is most pronounced, very close to these values but slightly higher is the thickness variation for the experiments with lubricant.

When using film as a means of reducing friction between the active elements and elements were obtained best results.

For the connection of the bottom part to the side wall the graph values are showed in fig. 8:

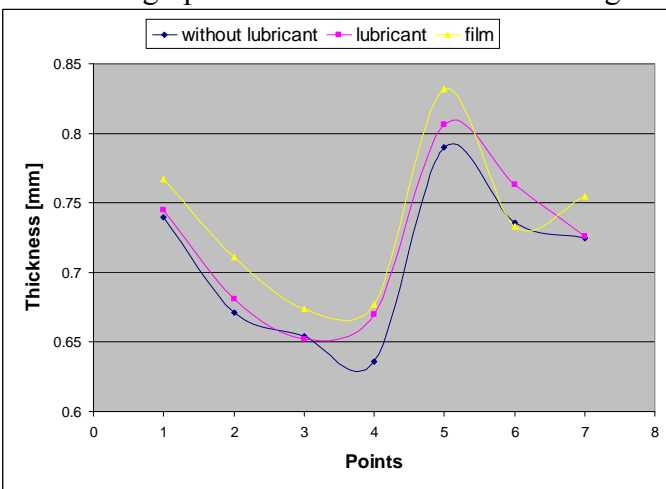


Figure 8. Thickness variation of the radius of the lower part and the side wall connection based on the selected type of lubricating

As in the first area studied the use of film is the best choice to reduce the coefficient of friction, which would lead to a greater thickness of this zone.

It can be seen that the thickness piece for the film obtained is relatively close to that which is obtained by the blank with grease lubrication.

- For the sidewall (fig.9)

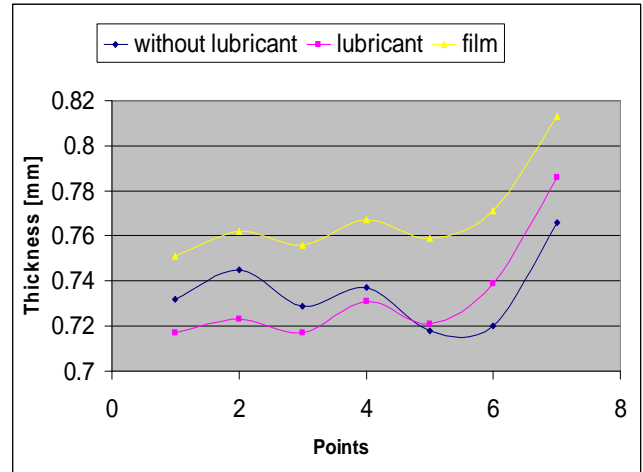


Figure 9. Thickness variation sidewall deep drawing part

In the upper part of the sidewall thickness begins to exceed 0.8 mm standard thickness of the blank, but only for the part obtained using film.

- The connection between flange and the side wall(fig 10).

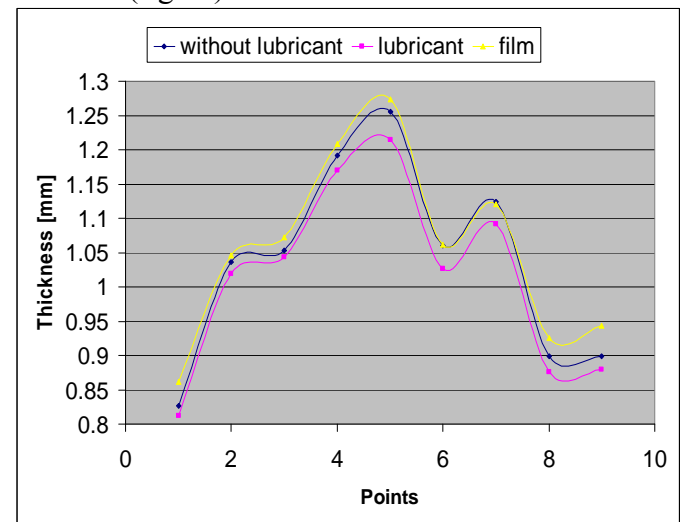


Figure 10. Thickness variation of the connection between flange and the side wall

In the area of connection between bottom part and the side wall it's indicate that the part thickness is higher to avoid tears. In the flange deep drawing part area can appear wrinkling for higher thickness, so the use of film can lead to major defects as wrinkling. This can happen when the blank holder force is to small. The highest value of the thickness is 1.273 mm.

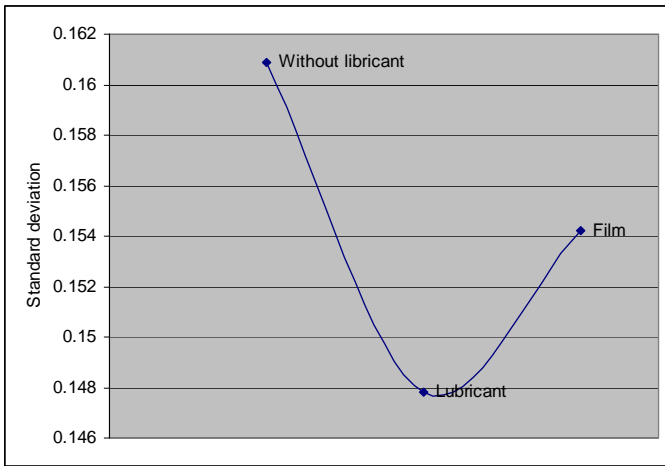


Figure 11. Standard deviation

The standard deviation for each lubrication system is shown in figure 11, and the minimum thickness values are shown in figure 12.

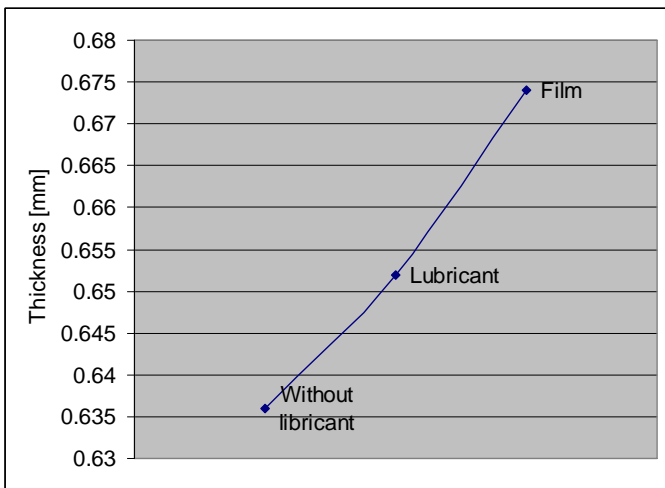


Figure 12. Minimum thickness

The minimum value for the thinning is obtained for the deep drawing parts with no lubricant. It can be seen that for film as system lubricant the thickness is higher than the other.

4. CONCLUSION

The coefficient of friction between active elements and the blank is determined by the lubrication system used. Were used three blank lubrication systems.

The walls profile thickness was measured with the coordinate measuring machine in 31 points. For a better understanding of thickness different between the three lubrication systems, the deep drawing part was split in four parts. The biggest thinning it was obtained when it wasn't use any lubricant, and the smallest thinning it was obtained for film as lubricant system.

In terms of the experimental data we can conclude that the use of film is the best option to analyze thinning material.

5. REFERENCE

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