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trenja i habanja*

*Energy and Material Conservation Through
Friction & Wear Reduction*

ZBORNİK - PROCEEDINGS

UTICAJ TRIBO-USLOVA PRI DVOFAZNOM DUBOKOM IZVLAČENJU

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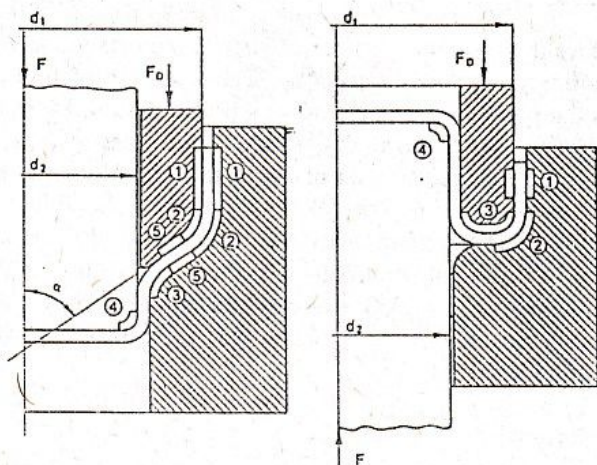
Uobičajeno je da se uticaj triboloških uslova pri obradi dubokim izvlačenjem tankih limova izučava u prvoj operaciji izvlačenja. Pokazuje se da je ovaj uticaj ravnopravan sa uticajem ostalih glavnih elemenata obradnog sistema (mašina, alat, materijal). Kod delova koji se izvlače u više faza, neophodno je pri analizi graničnih mogućnosti oblikovanja, poznavati i potpunu istoriju deformisanja, koja, uopšteno posmatrano obuhvata dva aspekta:

- ostvarivanje uslova za proporcionalno deformisanje u okviru jednog stepena preoblikovanja, odnosno promena ovih uslova pri obradi u sledećoj fazi;

- uticaj parametara procesa (i tribo uslova) na dostizanje kritičnih iznosa stepena deformacije u pojedinim fazama obrade.

S obzirom da se uobičajene analize i tehnološke preporuke odnose na proporcionalne uslove deformisanja, neophodno je uzeti u obzir moguća odstupanja preko dijagrama granične deformabilnosti (DGD), koji se formiraju za poznate, izmenjene uslove.

Na sl.1 pokazana su izvođenja eksperimentalnih alata za drugu fazu obrade, za klasično i suprotnosmerno izvlačenje. S obzirom na raspoloživu opremu, stepen izvlačenja u prvoj fazi od $\beta=80/50=1,6$ nije omogućavao izraženiji uticaj podmazivanja. Međutim, u drugoj fazi, pri $\beta=50/30=1,66$ od izuzetnog značaja je bilo stanje na površinama kontakta.

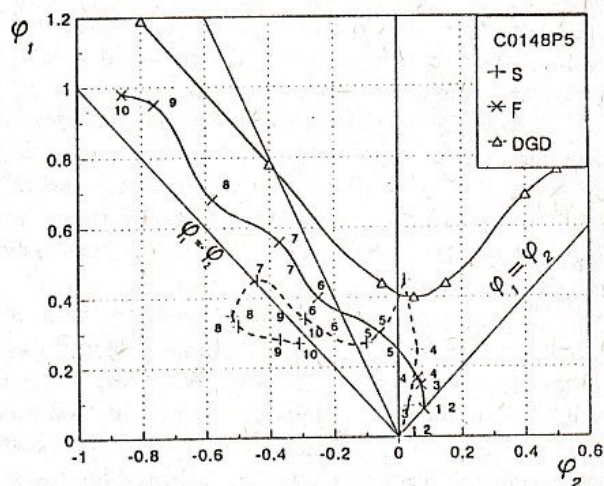


Sl.1. Različiti postupci za realizaciju druge operacije izvlačenja

Pri eksperimentima je korišćen niskouglenični čelični lim Č0148P5, brzina deformisanja je imala vrednost 20 mm/min, a kao mazivo je korišćena folija polietilena (F -kvazihidrodinamičko podmazivanje), ili su

kontaktne površine bile nepodmazane (S). U svakoj fazi je deformisanje bilo proporcionalno; za određenu grupu eksperimenta vršena je složena priprema razvijenih stanja; u jednom slučaju prethodno deformisanje je bilo jednoosno zatezanje, u drugom dvostrano zatezanje u odsustvu trenja. Druga faza izvlačenja, za ovakve uslove, predstavlja treći stepen oblikovanja.

Na sl.2 pokazana je raspodela deformacija u DGD za drugu fazu istosmernog izvlačenja i prethodno nedeformisani lim.



Sl.2. Raspodela deformacija u DGD

Tribo-uslovi, kao i ostali relevantni parametri, izuzetan značaj imaju u graničnim uslovima oblikovanja. Smanjenje trenja na obodu komada u drugoj fazi izvlačenja dovodi do ravnomernijeg deformisanja u glavnom preseku komada, smanjenja stanjenja u kritičnoj zoni i uspešnog oblikovanja (isključivo pri korišćenju folije). Slični odnosi se dobijaju i u slučaju prethodno jednoosno zategnutih limova; u uslovima prethodno dvostrano zategnutih limova, postiže se uspešna obrada nezavisno od sredstva za podmazivanje.

Literatura:

1. Stefanović, M., Tribologija dubokog izvlačenja, Monografija, Jugoslovensko društvo za tribologiju, Kragujevac, 1994.
2. Devedžić B., Stefanović, M., Effects of Friction and Deformation Path on Stretch-Formability of Sheet Metal, Proceedings of 2nd Int. Conf. of Plasticity, Stuttgart, 1987., 437-444.

INFLUENCE OF TRIBO-CONDITIONS IN TWO-PHASE DEEP DRAWING

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Influence of tribological conditions in metal forming by deep drawing of thin sheets has been regularly studied in the first operation of deep drawing. It turns out that this influence is equal with the influence of other main elements of the machining system (machine, tool, material). For parts that are drawn in several phases, it is necessary, in analysis of limiting capabilities of forming, to know also the complete history of deformation, which, generally speaking, consists of two aspects [1]:

- realization of conditions for proportional deformation within the frames of one phase of forming, namely changes of these conditions during machining in the next phase;
- influence of the process parameters (and tribo-conditions) on reaching the critical values of deformation in separate phases of machining.

Keeping in mind that the usual analyses and recommendations are related to the proportional conditions of deformation, it is necessary to take in to account the possible deviations by the forming limit diagrams (FLD), which are constructed for known, changed conditions [2].

In Figure 1 are shown different realizations of experimental tools for the second phase of deep drawing, for classical and reverse drawing. With respect to the available equipment, the drawing ratio in the first phase of $\beta = 80/50 = 1.6$, did not allow the more expressed influence of lubrication. However, in the second phase, a $\beta = 50/30 = 1.66$ the status on the contact surfaces was extremely important.

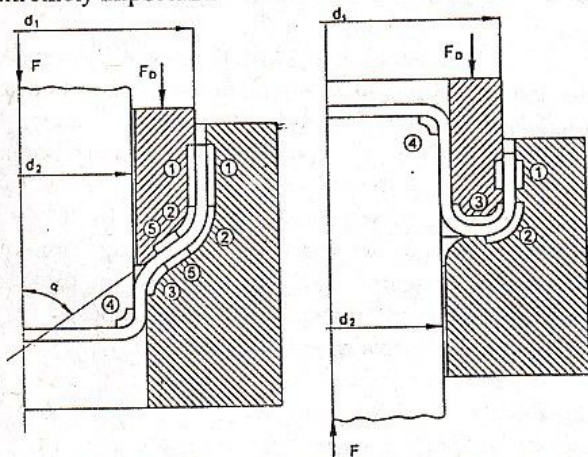


Figure 1. Different procedures for realization of the second operation of deep drawing

In experiments we used the low carbon thin sheet Č0148P5, the deformation speed has value 20 mm/min, and as a lubricant was used the polyethylene foil (F - quasi-hydrodynamic lubrication), or the contact

surfaces were not lubricated (S). In each phase, the deformation was proportional; for certain group of experiments the complex preparation of the blanks was performed; in one case the previous deformation was uniaxial stretching, in the second the two-way stretching with absence of friction. The second phase of drawing, for these conditions, represents the third level of forming.

In Figure 2 is shown the distribution of deformations in FLD for the second phase of drawing and previously non deformed thin sheet.

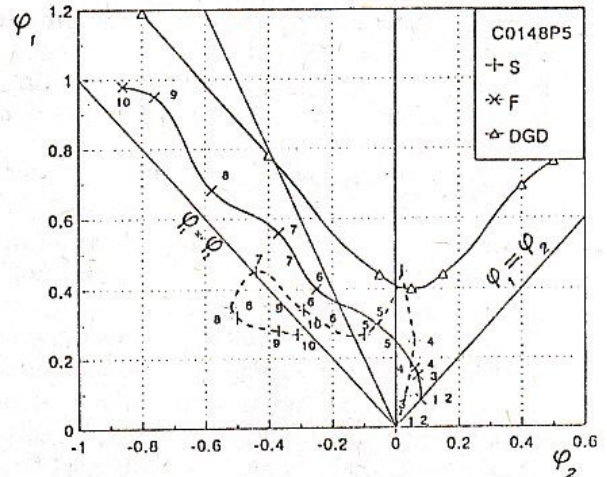


Figure 2. Deformation distribution in FLD

The tribo-conditions, as well as the other relevant parameters, has the extreme importance in the limiting conditions of forming. The decrease of friction on the part's flange in the second phase of drawing leads to more even deformation in the main cross-section of the piece, decrease of thinning in the critical zone, and the successful forming (exclusively when the foil was applied). The similar relations are obtained also for the case of previously uniaxially stretched thin sheets; in the conditions of previously two-way stretched thin sheets the successful machining is achieved regardless on the applied lubricant.

References:

1. Stefanović, M., Tribology of Deep Drawing, Monograph, Yugoslav Society for Tribology, Kragujevac, 1994.
2. Devedžić, B., Stefanović, M., Effects of Friction and Deformation Path on Stretch-Formability of Sheet Metal, Proceedings of 2nd Int. Conf. of Plasticity, Stuttgart, 1987, pp. 437 - 444.