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Tribologija kao nauka i tehnologija
Tribology as Science and Tehnology

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GENEX HOTELI

ZBORNIK - PROCEEDINGS

UTICAJ SILE DRŽANJA PRI DUBOKOM IZVLAČENJU TANKIH LIMOVA

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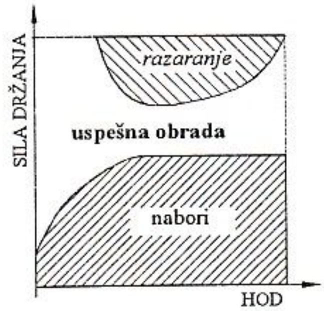
Obradivost tankih limova dubokim izvlačenjem limitirana je pojavom defekata dve vrste. S jedne strane je pojava nabora, a s druge razaranje, odnosno lom u kritičnoj zoni predmeta obrade. Do nabiranja dolazi na obodu komada, usled delovanja pritisnih tangencijalnih napona. Razaranje se dešava posle dostizanja graničnih iznosa napona, odnosno deformacija, na kritičnim mestima u zoni prenosa deformacione sile. Nabiranje je moguće smanjiti ili potpuno otkloniti primenom dovoljno velike sile držanja. Međutim, povećanje sile držanja utiče na povećanje deformacione sile i time se povećava verovatnoća pojave razaranja. Da bi se izbegla takva situacija, u kojoj rešenje jednog problema izaziva nove, teže probleme, potrebno je identifikovati najvažnije uticajne faktore, integralno analizirati značaj njihovog uticaja i dati rešenja mogućeg upravljanja procesom obrade. Izolovano posmatranje delovanja pojedinih faktora (naročito pri numeričkih simulacijama) dovodi do grešaka u procenama i zaključcima.

Uticajne faktore moguće je podeliti na sledeći način. Prvo: materijal sa svim karakteristikama koje treba detaljno poznavati; drugo: geometrija predmeta obrade uključujući geometriju razvijenog stanja; treće: alat i mašina, u okviru čega su dva bitna elementa - sila držanja, odnosno obezbeđenje pravilnih vrednosti specifičnog pritiska držača i primena odgovarajućih maziva u tačno određenim zonama komada t.j. alata.

Tokom analize treba pratiti dubinu izvlačenja, kao najznačajniji kvantitativni pokazatelj i distribuciju deformacija na komadu. Distribuciju deformacija treba sagledavati vezano za graničnu deformabilnost koja je naročito uslovljena uticajem složene istorije deformisanja.

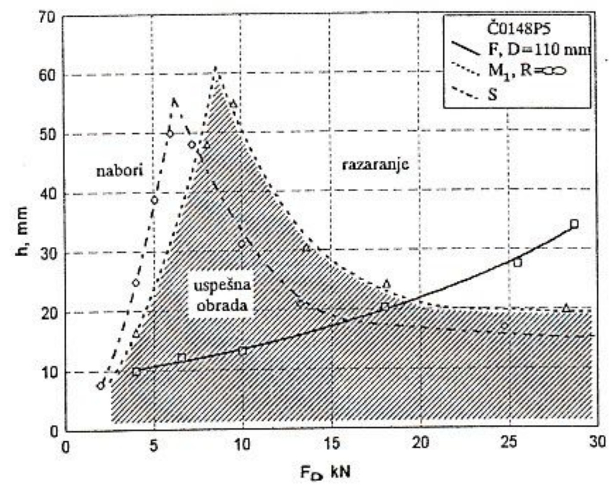
Sila držanja je značajna jer je njome relativno lako upravljati, a utiče na tok i uspešnost procesa. Najčešći i najjednostavniji slučaj je da se ona drži konstantnom tokom izvlačenja pri čemu vrednost odgovara optimalnoj. Zadnjih godina se ulažu napori ka iznalaženju najpovoljnijih zakona promene sile držanja zavisno od hoda izvlakača, odnosno vremena /1, 2/. Koriste se različite numeričke simulacije, koje uglavnom, zbog neuzimanja u obzir svih pomenutih uticaja, ne pokazuju slaganje sa eksperimentima /1, 2/. Sl. 1 pokazuje prostor u kome je moguće ostvariti zavisnost sile držanja od hoda. Na sl. 2 prikazani su rezultati određivanja optimalnih vrednosti konstantne sile držanja sa uzimanjem u obzir uticaja kontaktnih uslova. Realizovano je čisto duboko izvlačenje sa razvijenim stanjem prečnika 110 mm i izvlakačem prečnika 50 mm, pri brzini deformisanja 20 mm/min. Smanjenjem trenja na držaču omogućava se porast dubine izvlačenja sa porastom sile držanja. Povećanjem trenja optimalna sila držanja se smanjuje, čime postaje izraženija težnja ka nabiranju.

Značaj karakteristika materijala ilustruje istraživanje vršeno sa nerđajućim limom od Č4580 koji pokazuje veliku sklonost ka pojavi nabora. Modelno ispitivanje na kvadratnom izvlakaču 40x40 mm (razvijeno stanje je kružno prečnika 95 mm) obuhvatilo je tri vrednosti specifičnog pritiska držača: 5,44 ; 5,9 i 6,9 MPa.



Sl. 1 Zavisnost sile držanja od hoda izvlačenja

Najbolji rezultati su postignuti maksimalnim pritiskom pri čemu treba smanjiti trenje na držaču kvalitetnim mazivom kako bi se izbeglo razaranje.



Sl. 2 Zavisnost dubine izvlačenja od sile držanja pri različitim kontaktnim uslovima

Opsežnija eksperimentalna istraživanja promenljive sile držanja tek predstoje. U publikovanim radovima /1, 2 i mnogi drugi/ uglavnom se istražuje uticaj linearnih zavisnosti sile držanja od hoda. Dosadašnji rezultati pokazuju izvesne prednosti opadajuće zavisnosti (od odgovarajuće vrednosti na početku do nule na kraju procesa).

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THE INFLUENCE OF THE BLANK HOLDER FORCE IN DEEP DRAWING OF THIN SHEETS

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The formability of thin sheets by deep drawing is limited by appearance of defects of two kinds. First, there is appearance of wrinkling, and second, there is fracture, that is a crack in the critical zone of the working-piece. Wrinkling appears on the flange of the working-piece as the consequence of the activity of compressive tangential stresses. The fracture takes place after reaching the limit values of stresses, i.e. of strains in critical section in the zone of transfer of deformation force. It is possible to reduce or completely eliminate wrinkling by using sufficiently large blank holder force (BHF). However, the increase of BHF influences the increase of deformation force and thus increases the possibility for the appearance of fracture. In order to avoid such situation in which the solution of one problem causes new, more difficult problems, it is necessary to identify the most important influential factors, to give integral analysis of their influence and to give solution for the posible control over the forming process. Isolated observation of the activity of some factors (especially at numerical simulations) leads to mistakes in evaluations and conclusions.

The influential factors could be divided in the following manner. First: material with all its characteristics which should be known in detail; second: geometry of the working piece including the geometry of the blank; third: tool and machine, which include two important elements - BHF, i.e. the realization of the correct values of the specific holder pressure, and the application of adequate lubricants in precisely determined zones of the working piece i.e. tool.

During the analysis, the depth of drawing should be observed, as well as the most significant quantitative indicator, and also, strain distribution on the working piece. Strain distribution should be evaluated in connection with forming limit which is strongly depends on the deformation history.

The BHF is significant because it is relatively easy to be controlled, and it also influences on the course and the success of the process. The most frequent and the simplest case is that the holder force be held constant during the drawing process while the value should be optimal. In recent years no efforts have been spared in order to find the most convenient laws of change of BHF, depending on punch displacement, i.e. time /1, 2/. Different numerical simulations are being used; in most cases they do not correspond to the experiments /1, 2/ because is disregard of described influences. Fig.1 shows the space in which it is possible to achive the dependence of the BHF on punch travel. Fig.2 shows the results of the determining the optimal values of constant BHF with regard to the influence of the contact conditions. Pure deep drawing has been realized with blank diameter of 110 mm and the punch with the diameter of 50 mm, with deformation speed of 20 mm/min. Reduction of the friction on the holder makes possible the increase of the drawing depth with the increase of BHF. By the increase of friction, the optimal BHF becomes reduced, and thus the possibility for wrinkling becomes more prominent.

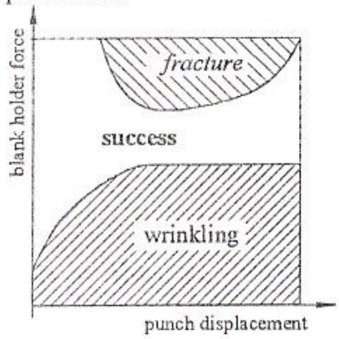

Fig.1 BHF dependence on the punch travel

The significance of the characteristics of materials is illustrated by research in which the stainless steel Č4580 was used; this steel shows strong tendency to wrinkling. The investigation model with square punch 40x40 mm (blank shape is circular with diameter of 95 mm) included three values of specific pressure: 5.44 ; 5.9 and 6.9 MPa. The best results have been achived by using maximal pressure and in that case the friction on the blank holder should be reduced by using quality lubricant in order to avoid tearing, i. e. fracture.

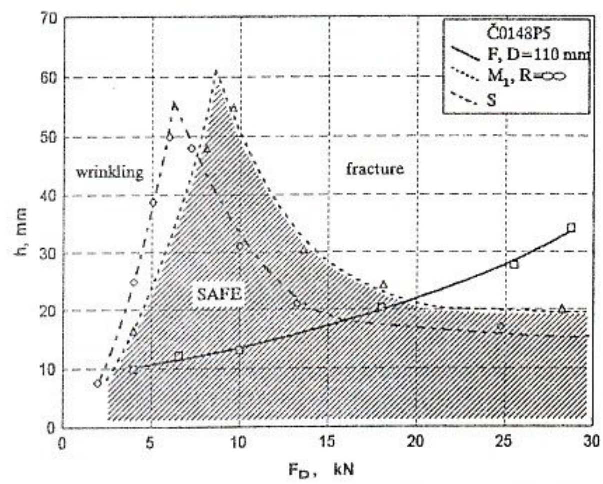

Fig.2 Dependence of the drawing depth on BHF in different contact conditions

More comprehensive experimental researches of the variable BHF are forthcoming. In papers which are published /1, 2 and more others/ it is usually the influence of linear dependencies of BHF on travel that has been investigated. The results so far show certain advantages of falling dependency (from adequate value at the beginning to zero at the end of process).

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