

PROCESS PARAMETER OPTIMISATION FOR WARM DEEP DRAWING OF INCONEL 600 CYLINDRICAL CUPS

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ABSTRACT

The objective of the current work was to estimate plastic behaviour of Inconel-600 alloy to manufacture cylindrical cups under warm conditions. The design procedure for the finite element analysis was carried out as per Taguchi's techniques using DEFORM-3D software. The sheet thickness and temperature had influenced the damage of the cup during forming. Warm deep drawing forming operation is sheet metal forming operation, in which simple fixed sheet is deformed into a desirable shape by a punch which is hydraulically controlled. This process offers the possibility of production of complex parts in a single operation.

Experiments were designed using the Taguchi technique and ANOVA method was employed to estimate the influence of process parameters sheet thickness, punch velocity, coefficient of friction and temperature on the stresses and strains developed in the sheet, damage of the sheet, height of the cup obtained and to find significant process parameters affecting the formability. A forming limit diagram (FLD) has been drawn out of the results to analyse the fracture phenomenon. The forming limit diagram were presented for the all the cups.

The present project work was carried out in two phases. Initial phase is numerical simulation of physical process with finite element analysis and final phase analysis of results for

understanding its formability. The finite element analysis was carried out using DEFORM-3D software.

The major warm deep drawing process parameters which influenced the formability of cylindrical cups were temperature and sheet thickness. The majority of thickness reduction takes place within the wall region of the cup but not within the flange or bottom region of the cup. Stresses induced are lower than the ultimate tensile strength of the material.

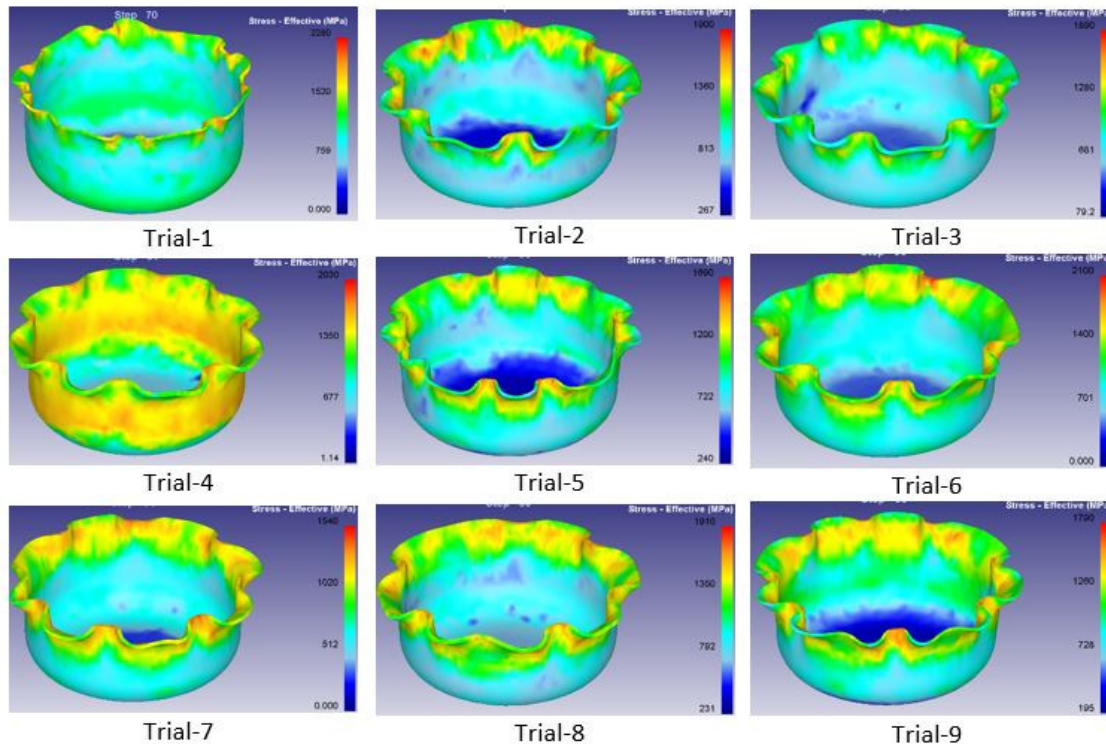


Figure 1: Effective Stress under different operating conditions

- The major process parameters which could influence the deep drawing capability of Inconel-600 cylindrical cups, were punch velocity and temperature.
- The damage of the cups was found to be less with the sheet thickness of 1.2mm when compared to 1mm and 8mm sheet because of availability of more material.
- Effective strain was found to be decreasing with increase in coefficient of friction.
- Effective stress also continuously decreased with increase in temperature. This could be due to the softening of metal with rise in temperature.

- Effective strain was found to be least with 1.2mm sheet and with 0.4 coefficient of friction.
- Effective strain was found to be decreasing with increase in coefficient of friction.
- The cup with punch velocity 3.5mm/s, coefficient of friction 0.2, temperature 700 °C and sheet thickness 1.2mm was found to be best drawn cup in terms of the damage.

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