

## **PARAMETRIC OPTIMISATION OF CONICAL CUPS IN WARM DEEP DRAWING OF MONEL 400**

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### **ABSTRACT**

The objective of the current work was to analyse the plastic behaviour of MONEL-400 alloy to manufacture conical cups under warm temperature conditions. The experimental procedure for the finite element analysis was carried out as per Taguchi's techniques using DEFORM-3D software. 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 analyse the finite element analysis results on the influence of process parameters punch velocity, coefficient of friction, temperature and sheet thickness on the stresses and strains developed in the sheet, height of the cup and damage of the sheet 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 trails.

The present project work was carried out in two phases. Initial phase is modelling of dies and numerical simulation of deep drawing process with finite element analysis and final phase analysis of results by using ANOVA technique and 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 conical cups were punch velocity 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. Formability of conical cups becomes difficult with less thickness sheets. Stresses induced are lower than the ultimate tensile strength of the material.

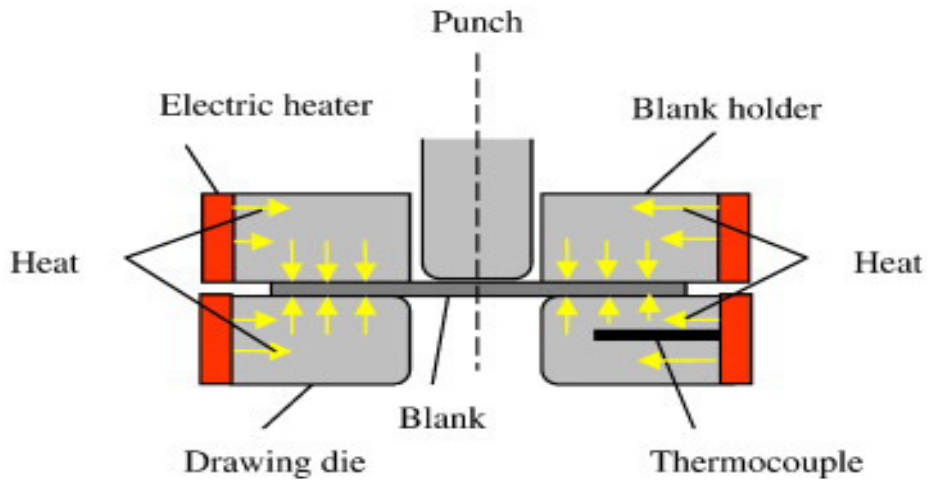


Figure 1: Typical industrial setup for warm deep drawing

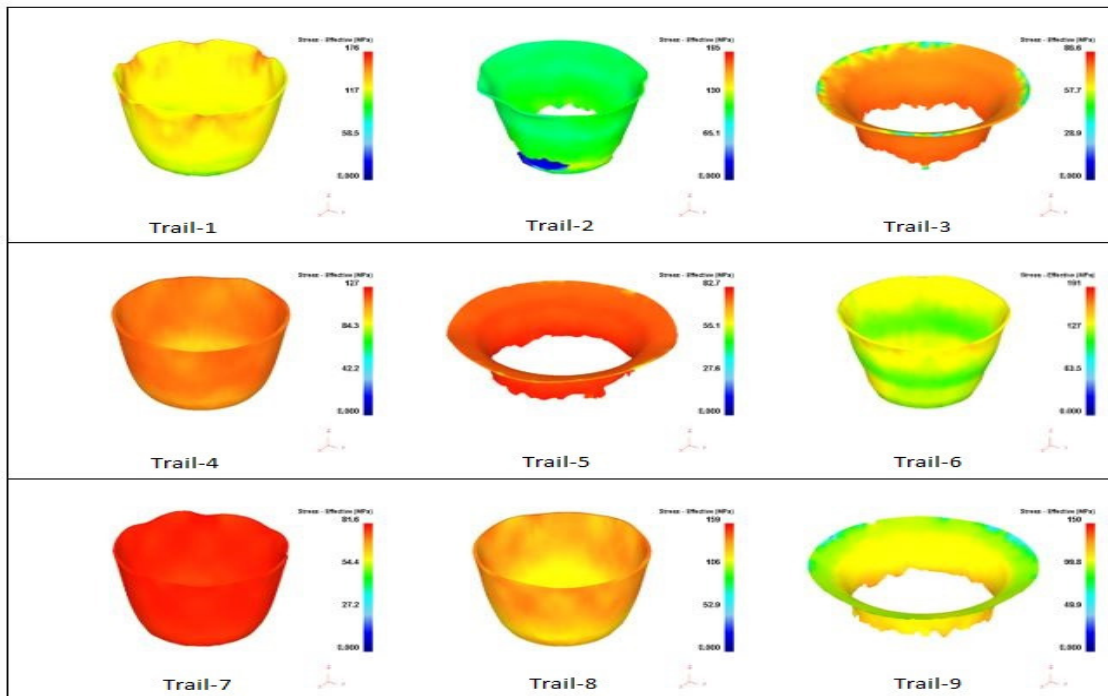


Figure 2: Effective Stresses of all the experiments

In this project work, from the results of Finite Element Analysis it is clearly observed that the successful drawn cups are obtained for trail condition of 8. The input parameter conditions of the successful drawn conical cup are punch velocity (5mm/s), coefficient of friction (0.3), temperature (600°C) and sheet thickness (1.2mm). The input parameter of temperature has got more influence on the effective stress. The other parameters like Sheet thickness, temperature and punch velocity are responsible for the influence on drawn cup height. Punch velocity and friction has got influence on the damage of the cups. Damage in the drawn cups is less with the higher thickness sheets and at higher temperature and friction. Forming limit diagram is obtained from the different trail conditions. Wrinkles formation in the drawn cups is observed less with the higher friction value and increased sheet thickness.

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