

Study on the Wrinkling Behavior of Cylindrical Deep-Drawn Cups

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Abstract. This study presents theoretical methods of prediction and experimental investigations on the flange wrinkling of deep drawn cylindrical cups. The prevention of wrinkling in the flange area is most commonly solved by a blank holder. The appropriate suppress of wrinkling is only possible with optimal process parameters, since inadequate blank holder pressure leads to wrinkling occurring, while too much blank holder force can increase the risk of splits. Although some theoretical and semi-empirical aspects as well as experimental process windows on optimal blank holder pressure are known (the most popular optimal blank holder pressure estimation is originated from Siebel (1)), even the exact criterion what we consider to wrinkling is not always trivial. To make the comparison of the applied wrinkling criterion theories, different approaches are collected from the literature. The closed form solutions of the bifurcation method - from Hutchinson and Neale (2) - and the energy-based theory - from Yu and Johnson (3) - are discussed primarily. Besides, geometry and critical wrinkling stress analysis are also studied. The results of the investigated wrinkling criteria were resembled to experimental observations and to finite element calculations done by the Autoform R7 software. Our results show, that the closed form solutions contain such simplifications and boundary conditions, which do not allow the comprehensive application of these models in the industrial practice. Even if, the bifurcation method correlates better to experiments. However, the finite element calculations provide the most wide-spread and most precise wrinkling evaluation, at a workpiece which flange is finally drawn into the die cavity, the interpretation of the numerical results is also not obviously self-evident.

REFERENCES

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