Wall ironing with polymer coated sheet metal

Wall Ironing with Polymer Coated Sheet Metal

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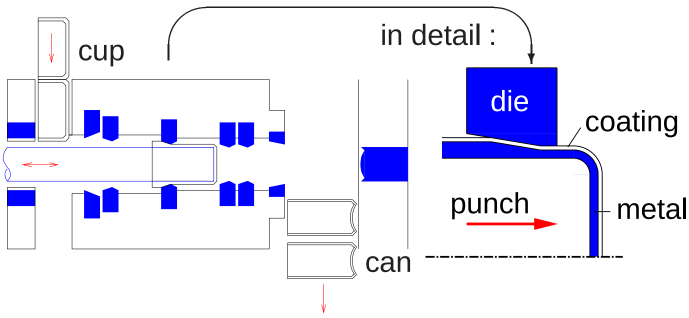
1. Introduction

Standard can making is a metal-forming process, consisting of three steps :

1. deep drawing → cup
2. wall ironing → thin-walled can
3. removal of lubricant/emulsion and lacquering of the cans

New approach *before* deformation, the sheet metal is coated with a polymer layer. This coating combines the functions of environmentally friendly lubricant, protection against corrosion, and emission-free lacquer.



Objective development of a validated model for the wall ironing process of coated metal sheet.

2. Constitutive modelling

A class of elasto-viscoplastic constitutive equations [1], is used to describe the mechanical behaviour of both metal and polymer coating under large deformations, high deformation rates, and high temperatures.

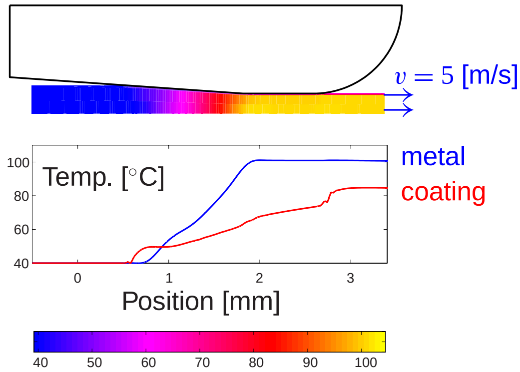
- ◇ metal : Bodner-Partom model
- ◇ coating : compressible Leonov model

3. Numerical method : OS-ALE

Arbitrary Lagrange Euler method based on operator splitting methodology (OS-ALE) includes the iterative scheme:

1. Updated Lagrange step
2. mesh reconditioning step
3. convective step of history variables to new mesh → Discontinuous Galerkin method

Thermo-mechanical coupled analysis :



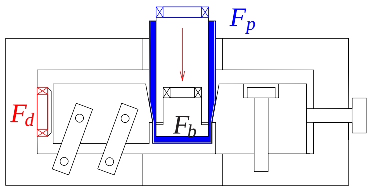
4. Experimental validation

Experimental set-up measures forces :

(1) die force F_d

(2) punch force F_p

(3) bottom force F_b



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geometry: friction coefficients

$$\mu_p = \frac{F_p - F_b}{F_d}$$

$$\mu_d = \frac{F_p \cos(\alpha) - F_d \sin(\alpha)}{F_d \cos(\alpha) + F_p \sin(\alpha)}$$

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OS-ALE simulation

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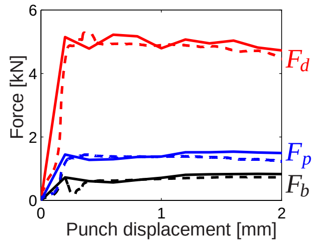
dashed : experiment
solid : simulation



Particle tracking is performed by using a digital image correlation technique [2].

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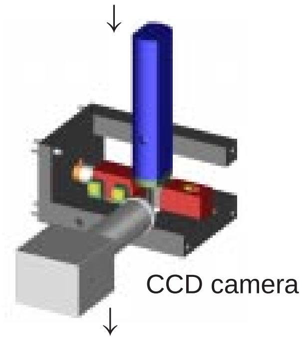

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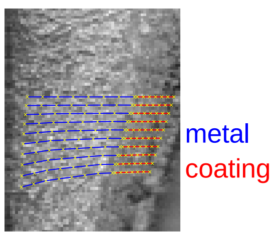

5. Conclusion

Good agreement between numerical and experimental results has been obtained under conditions similar to industrial ones (i.e. large strains, high strain rates, and high pressures)

References

1. M.B. Rubin and A.L. Yarin. On the relationship between phenomenological models for elasto-viscoplastic metals and polymeric liquids. *Journal of Non-Newtonian Fluid Mechanics*, 50:79–88, 1993.
2. H.A. Bruck, S.R. McNeill, M.A. Sutton, and W.H. Peters III. Digital image correlation using Newton-Raphson method of partial differential correction. *Experimental Mechanics*, 29:261–267, 1989.