Non-linear model-predictive-control for thermomechanical ring rolling

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ABSTRACT

Ring rolling is an incremental process for bulk metal forming for the production of seamless rings which includes a wide range of process variants that can be classified according to the resulting geometry, process route, machine layout, and process temperature [1]. Cold ring rolling is generally suitable to form near net shape metal rings, e.g. for bearings, that have an advantageous microstructure, desired surface hardness and high strength. In order to selectively control and improve properties while also expanding the process window and lowering process forces, the authors propose the application of a thermomechanical ring rolling process. This new process variant combines a semi-warm forming of the ring with controlled cooling directly followed by a cold forming process to produce near net shape rings with a selected microstructure and high strength without additional consecutive heat treatment.

In order to control this proposed process, a new and fast control strategy is necessary that not only controls the geometrical forming of the ring, but also considers temperature development and microstructure formation. The basis for the eventual application of such a control strategy is the application of fast semi-analytical simulation models with a very short response time in combination with the FEA of a thermomechanical ring rolling process. The semi-analytical model is used as a predictor and a parallel FEA or experimental results as a corrector. The aim is to correctly identify transient process parameters needed to achieve defined product properties as a basis for a later implementation in a non-linear model-predictive-control of thermomechanical ring rolling. The new approach will be described in detail and demonstrated numerically and experimentally.

REFERENCES

[1] J. M. Allwood, A. E. Tekkaya and T. F. Stanistreet, “The Development of Ring Rolling Technology, *Steel research international*, **76**, No. 2-3, 111-120 (2005).