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Advanced Ring Rolling Simulations with Embedded Machine Control Systems

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Radial axial (RAW) ring rolling is a well-established incremental forging process producing seamless rings and shells, both with rectangular as well as profiled cross sections, with high demands in terms of mechanical properties and microstructure, standing out for its productivity. Rolled rings and shells are applied in many industrial fields, e.g. wind power, nuclear industry, general construction of vessels, flanges, valves, bearings. Although finite element (FE) ring rolling simulation coupled with closed-loop control is sometimes reported as state of the art, the process control was only approximated before. Due to this, very large rings and large profiled rings have proven almost impossible to simulate. A direct coupling between FE-simulation and the real RAW machine control overcomes these difficulties by utilizing the sophisticated control algorithms enabling real-world virtual production of such very large rings.
To simulate ring rolling processes as close to reality as possible the real machine control (CARWIN) is embedded in the FE-simulation. This comprehensive physical model with realistic boundary conditions represents all degrees of freedom that can also be found in real-world ring rolling processes without any additional stabilizing measures. It accounts for process limits as well as for limits of the radial-axial ring rolling machine, has an analogous look-and-feel to the control desk in the control cabin and is suitable for rings and shells of all dimensions, even very large ones, with rectangular as well as profiled cross-sections. Feasibility has been proven and the model is validated by industrial ring rolling processes, e.g. 5 tons profiled ring, 22 tons shell, ⌀13 m profiled ring (85 tons).
The machine control including interface to the FE-simulation - Rolltech RPS - operates independent and can be implemented in various commercial FE-softwares. A roll-out to SMS group ring rolling machine operators, with emphasis on accessibility for SME, is prepared currently.

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