Numerical Simulation of Full Carburizing Process of an Automotive Gear

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ABSTRACT

The objective of the paper is to present material and numerical models needed to simulate with accuracy the full carburizing process of an automotive gear.

From a numerical point of view, as the carburizing affects only a thin area under the surface, the mesh discretization must be adapted. Consequently, anisotropic mesh is used to describe this zone. The temporal discretization must be also adapted to follow carbon diffusion and thermal evolution.

The material model represents metallurgical phenomena during the complete carburizing process. The initial heating of the part induces phases change due to austenitization. Then while maintaining the temperature, boundary conditions are applied for carbon diffusion. In the same time, austenitic metallurgical grain growth occurs at carburizing temperature. At the end, final cooling determines the properties of the carburized part. The model takes into account the phase changes using phase transformation diagrams locally adapted to chemical compositions and grain sizes.

The objective of this type of simulation is to predict the in-use properties of the gear at the end of the carburizing process. Other important results are the evaluation of distortion and residual stresses. Phase changes induce volume variation and transformation plasticity. During the complete process, the material is modelled with an elasto-viscoplastic behaviour and mixing methods are applied to consider the relative contribution of each phase.

Software: FORGE® - SIMHEAT®

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