Limits of lubrication in severe stamping operations

Increasingly restrictive legislative initiatives have in recent years brought increased attention to the establishment of safe and environmentally benign manufacturing conditions, without the use of hazardous forming lubricants. The elimination of hazardous forming lubricants necessitates an adoption of new, environmentally friendly tribosystems for severe sheet metal forming processes. Production tests of new tribosystems are however connected to high costs and uncertainties regarding tool life and maintenance. This project presents an analysis of offline evaluation of tribosystem applicability for an industrial production platform from the company AAO Steel, where usage of chlorinated paraffin oils was currently deemed to be necessary. The specified production platform was based on a stamping operation for the production of an exhaust gas recirculation (EGR) component, where a drawbead geometry was implemented in the forming tools.

Numerical analysis was carried out for evaluation of the wear conditions introduced by the different die features and for extraction of central testing parameters. A drawbead test was afterwards designed for the Universal Sheet Tribotester at DTU-MEK for offline replication of industrial forming conditions. Based on the offline simulative tests, the study highlighted several suitable tribosystems for replacement of the hazardous, chlorinated paraffin oil currently used in production.

An analysis of the performance and the tribological function of commercial forming lubricants for punching and blanking operations is furthermore presented in the thesis. Based on a process test, which emulates the forming conditions of a fine blanking operation, the efficiency of different lubricants were evaluated, and a clear correlation between the developed pick-up on the punch and the measured backstroke force was confirmed in accordance with previous studies. Analysis of the physiochemical properties of the forming lubricants highlighted certain intrinsic lubricant properties necessary for facilitation of stable production conditions in punching and blanking processes.

Online process monitoring of sheet metal forming operations can form the basis for condition-based tool maintenance for minimization of the production of scrap and maintenance costs. The project furthermore presents a methodology for evaluation of process conditions using measurements of acoustic emissions. Based on a series of simulative forming tests, the methodology was established for assessment of wear related process deviations commonly seen in different sheet metal forming operations.

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