Studies on micro plasto hydrodynamic lubrication in metal forming

The influence of work piece surface topography on friction and lubrication and final surface quality in metal forming operations is well known and has been pointed out by many researchers, see Schey (1983) and Bay and Wanheim (1990). This is especially the case when liquid lubrication is applied, where increased surface roughness facilitates the lubricant intake and mechanical entrapment. The potential of these mechanisms is, however, not fully utilized due to lack of understanding of the influence of individual parameters on the tribological system. In recently developed surface characterization models the potential entrapment of a lubricant in closed reservoirs is used as a parameter to predetermine the formability of a sheet metal, Steinhoff et al. (1996), Geiger et al. (1997) and Schmoeckel et al. (1997). In experimental studies on friction in metal forming applying the strip drawing test, Kudo et al. (1976 and 1982) discovered that the friction stress increased with the product of lubricant viscosity and drawing speed in the mixed lubrication regime. Mizuno and Okamoto (1982) noticed the same phenomenon in compression-sliding experiments, and proposed the explanation to be trapping of lubricant in closed pockets in the surface and subsequent permeation of the viscous lubricant into areas of contact between the flattened work piece asperities and the tool surface. They named this lubrication mechanism MicroPlasto HydroDynamic Lubrication (MPHDL). In studies of plane strip drawing of aluminum strips provided with artificial lubricant pockets by local indentation Azushima and Kudo et al. (1990, 1991, 1995) verified this mechanism applying a transparent die. They showed that lubricant escape from the pockets was influenced by the degree of reduction, drawing speed and lubricant viscosity. The pioneering work on MPHDL by Kudo and Azushima and Mizuno and Okamoto has inspired the present authors to further research in this field carrying out experimental studies continuing and elaborating the work by Azushima and Kudo by showing the influence of work piece material, friction and pocket geometry and establishing a mathematical model predicting the onset of lubricant escape. The present paper presents an overview of these studies on MPHDL in metal forming carried out at the Technical University of Denmark.

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