The Effect of Surface Conditions on Friction by Tip Test

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Abstract

In the present investigation, a tip test based on upsetting and backward extrusion was utilized to characterize the effect of surface roughness of the billet and forming tools, and the type of lubricants on friction. For the test, cylindrical specimens made of aluminum alloys of 6061-O and 2024-O, and single punch and two die sets with different surface topologies, were used with four lubricants such as VG32, VG100, corn oil, and grease. The load levels and tip distances were measured for both materials, and compared with each other to determine shear friction factors at the punch and counter punch interfaces separately, depending on the variation in surface topologies and lubrications using finite element simulations. As a result, a linear relationship among the dimensionless load, tip distance, and shear friction factors at the punch and counter punch interfaces was derived for the experimental conditions investigated. The slope change of this linear relationship from negative to positive clearly depends on the variation in surface conditions at the billet/punch and billet/counter punch interfaces. Also, it was demonstrated that the dimensionless tip distance for the frictionless case can be extrapolated from the experimental data. This value can be used for characterizing the relative effect on friction due to surface conditions at the punch and counter punch, and lubrication quality of the lubricant for the given processing conditions.

Keywords: aluminium alloys, billets, dies (machine tools), extrusion, finite element analysis, friction, lubricating oils, shear strength, surface roughness, tip test, friction measurement, tip distance, backward extrusion, surface roughness, surface topology

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