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Influence of viscous dissipation on the wear behaviour of plastic mold steels in injection molding

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According to Polaris Market Research “Tool Steel Market Size, Share Global Analysis Report, 2023-2032” the plastic mold segment had the highest market penetration in 2022. It forecasts that this trend will persist until the end of the forecast period in 2032. Even slightly worn-out parts in polymer processing can lead to variations in the produced polymer parts, resulting in them being out of tolerance and rejected. Adjustments in process parameters can keep production going, but wear will continue to happen and ultimately lead to a standstill in production and the necessity to replace the worn part. Reducing wear therefore leads to an extended operation time and a lifetime extension.
The presented study shows the impact of an injection volume rate (IVR) of 100 cm^3/s versus an IVR of 300 cm^3/s on the wear behaviour of five different steels currently used as plastic mold steels using a Polyamide 66 filled with 50%wt. glass fibers in a platelet-wear-test. The process conditions of injection molding can lead to such a high degree of mechanical energy being turned into heat that the resulting temperature in small gaps or slit like sprues or screw flanks can reach a level where the steel loses surface hardness due to tempering effects. Hardness and resistance to abrasive wear are closely coupled, leading to a strong increase in wear when this dissipation effect is occurring. This effect was evident at an IVR of 300 cm^3/s but not with an IVR of 100 cm^3/s as was measured with near surface hardness measurements of the test specimens after wear testing. Besides an increase in wear the secondary hardening peak temperature has a significant effect on the wear behaviour under these conditions influencing the wear behaviour favourable with higher secondary hardening peak temperatures and therefore improve the lifetime.

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