Modelling, Simulation and Experimental Study of Ultrasonic Vibration Assisted Grinding of AISI D2 Tool Steel Using Eco-friendly Cutting Fluids

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Doctor of Philosophy

By

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Chapter 8

Major Conclusions

8 Major conclusion: take away of the current research

- **UVADG mode is more effective than CDG mode for grinding AISI D2 tool steel.** This is due to the discontinuous micro-shearing action of the abrasive grit in UVADG mode, which results in shorter and straighter grinding chips and a lower grinding temperature. As a result, UVADG mode can produce a ground surface with better integrity.
- **UVADG mode can reduce grinding forces and equivalent plastic strain.** This is again due to the discontinuous micro-shearing action of the abrasive grit in UVADG mode. The lower grinding forces and equivalent plastic strain can lead to longer tool life and improved surface integrity.
- **Reduced grinding forces:** UVADG was effective in significantly decreasing grinding forces compared to traditional dry grinding (CDG) and traditional wet grinding (CWG) modes due to its intermittent cutting activity and very little plastic deformation.
- **Improved surface roughness:** The surface roughness in UVADG was lower than in CDG and CWG at each downfeed. The reduction in surface roughness parameters (R_a, R_q, and R_z) in UVADG was up to 43.23% in comparison to CDG and 26.94% in comparison to CWG.
- **Enhanced bearing area curve (BAC):** Ultrasonic vibration-induced overlapping resulted in a higher BAC ratio (88.71%) and a steeper BAC in UVADG mode. This BAC ratio represents the ground surface under UVADG mode, which has significant antifriction and antiwear characteristics.

- **Lower grinding temperature:** UVADG produced the lowest grinding temperature compared to CDG and CWG modes. This is due to the short contact time between the grinding wheel grits and workpiece and cools the grinding zone through convective heat transfer to the surrounding environment.
- **Al_2O_3 NPs are an effective additive for improving the grindability of work material in surface grinding operations.** Al_2O_3 NPs increase the pH value, density, thermal conductivity, and viscosity of the cutting fluid, which leads to improved lubrication and cooling performance.
- **UVAMQL grinding with highly concentrated Al_2O_3 NFs is the most efficient grinding method.** This method produces the lowest grinding force and surface roughness, and it also generates the smallest and most discontinuous chips.
- **UVAMQL grinding mode produces a ground surface with better bearing and fluid retention characteristics.** This is due to the higher Sbi and Sci values of the ground surface under UVAMQL grinding mode.
- **UVAMQL grinding mode produces a lower grinding temperature than MQL grinding mode.** This is due to the short contact time between the grinding wheel grits and workpiece and the convective heat transfer to the surrounding environment using eco-friendly cutting fluids.
- **Dry grinding causes the most microhardness variation and thermal damage.** This is due to the high amount of heat generated during dry grinding.
- **UVAMQL-NFs ground samples have higher RMS and peak values, according to MBN results.** This is due to the lower hardness of the UVAMQL-NFs material, which makes it easier for magnetic domain walls to move.

- **UVAMQL-NFs based samples have the highest permeability and lowest coercivity, according to HL analysis.** This is also due to the easier domain wall movement in the UVAMQL-NFs material.