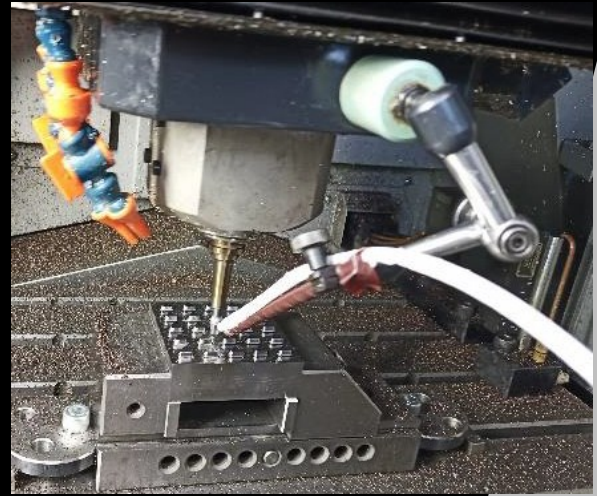




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Case study #4

LCO₂ + MQL cooling enabled longer tool life at higher productivity when milling W360 hardened steel



1. Introduction

- Application: Hard milling of W360 steel
- Milling of hard materials is usually performed dry – thermal shocks



2. Methods

- Delivery of LCO₂ + MQL via outside nozzle
- 6 mm bull end mill, $z = 4$
- $v_c = 100$ m/min; $f_z = 0.11$ mm/tooth, 55% overlap



3. Results

- At $v_c = 100$ m/min (tool manufacturer spec.), dry is best (Fig 1)
- At $v_c = 200$ m/min, LCO₂ + MQL shows extremely good wear mitigation – higher temperatures – cooling is needed (Fig 1)

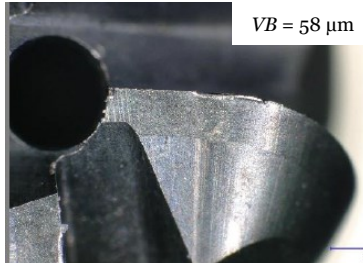


4. Discussion

- Higher heat generation calls for improved cooling
- Variable cooling capability can avoid thermal shocks

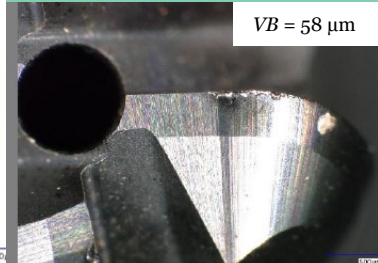
Dry, $v_c = 100$ m/min

VB = 58 μ m



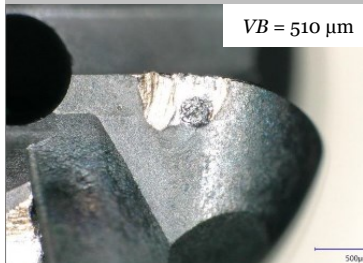
LCO₂ + MQL, $v_c = 100$ m/min

VB = 58 μ m



Dry, $v_c = 200$ m/min

VB = 510 μ m



LCO₂ + MQL, $v_c = 200$ m/min

VB = 77 μ m

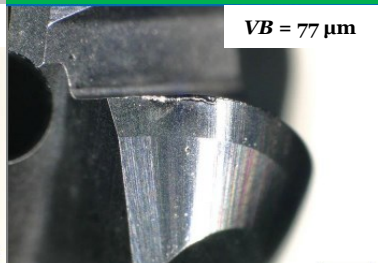


Figure 1. Tool wear under dry and LCO₂ + MQL cooling and lubrication conditions at two discrete cutting speeds.

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