Objectives

• Through the application of high heat transfer performance fluids - nanofluids, a practical and environmental benign grinding process is to be developed.

State-of-the-Art

• Nanofluids are a new class of heat transfer fluids engineered by dispersing nanometer-size solid particles in traditional heat transfer fluids to increase thermal conductivity and heat transfer performance.

• From an environmental and economical point of view, there are critical needs to reduce the use of cutting fluid in grinding process. Minimum quantity lubrication (MQL) grinding is to supply a minute quantity of cooling lubricant medium to the grinding zone so that the applied amount of grinding fluid can be reduced tremendously. It is a promising solution, however, it has shortcoming of insufficient workpiece cooling capacity.

Approaches

• Formulation of new nanofluids.

• Characterization of nanofluids thermal conductivity and convection heat transfer coefficient.

• MQL grinding technology is developed to reduce the amount of grinding fluid. Advanced thermal and tribological properties of nanofluids may enable MQL grinding.

Accomplishments

1. Nanofluid Formulation

<table>
<thead>
<tr>
<th>Materials</th>
<th>Average particle size (nm)</th>
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</thead>
<tbody>
<tr>
<td>Aluminum oxide</td>
<td>10 nm, 20 nm, 30 nm, 40 nm, 80 nm, 160 nm</td>
</tr>
<tr>
<td>Aluminum nitride</td>
<td>20 nm</td>
</tr>
<tr>
<td>Diamond</td>
<td>100 nm, 200 nm</td>
</tr>
<tr>
<td>Carbon nanotubes</td>
<td>10-20 nm or 40-60 nm in diameter; 1-2 µm or 5-15 µm in length</td>
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• Most nanofluids can be formulated by two-step physical method.

• Special treatment is necessary in preparation of nanofluids containing multi-wall carbon nanotubes (CNTs). With surfactant along with ultrasonic bathing, multi-wall carbon nanotubes are being able to be dispersed in distilled water or ethylene glycol.

2. Nanofluids Characterization

• Thermal conductivity measured by hot wire method.

• Convection heat transfer coefficient measurement

3. MQL Grinding Using Nanofluids

• Generally, the application of nanofluids can reduce grinding forces, improve the wheel wear (high G-ratio), and generate better surface finish.

Future Work

• Formulation of new nanofluids for practical MQL grinding application.

• Study of convection heat transfer performance of nanofluids.

• Grinding temperature measurement and thermal model development for MQL grinding using nanofluid.

Sponsors

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