FLUID LUBRICATION IN THE MACHINING OF CAST ALUMINUM ALLOYS

Overview
It was Quaker Chemical Corporation’s desire to conduct an experiment to analyze the performance differences of three metalworking fluids (Quakeral 383H, Quakeral 700UF, and Quakercool 700MO) in drilling and reaming operations of two different aluminum alloys (319T6 and 356T6), which are commonly used alloys for engine blocks and cylinder heads in the automotive industry. Through the use of the proper metalworking fluid in machining, the machining forces and tool wear can be lowered while also improving reamed hole form and surface finish.

Objectives
Present data-based conclusions regarding machining performance differences between the three metalworking fluids and machinability differences between the two alloys based on:

- Drilling operations
  - Cutting thrust force measurements
  - Built up edge formation
  - Tool wear
- Reaming operations
  - Hole cylindricity
  - Surface finish

Approach
1. Prepare the metalworking fluid emulsions to [8.8%, 9.2%] concentration
2. Perform drilling operations on samples
   - Collect cutting thrust data with a dynamometer
   - Observe tool wear and built up edge formation with a stereoscope
3. Perform reaming operations on samples
   - Measure hole cylindricity via a Coordinate Measuring Machine (CMM)
   - Measure surface finish via a profilometer
4. Analyze data using observational (tool wear and built up edge formation) and statistical tools (regression and paired t-tests for cutting thrust force, hole cylindricity, and surface finish).
5. Draw data-based conclusions based on analysis.

Outcomes
The project analysis and conclusions suggest that:
1. Quakercool 700MO metalworking fluid provides the best performance for all measured AL 319 output parameters, apart from tool wear, and should be used for most AL 319 applications.
2. Quakeral 383H metalworking fluid should be used for AL 356 applications where good surface finish is the highest priority.
3. Quakercool 700MO metalworking fluid should be used for AL 356 applications where low thrust cutting force and best possible cylindricity are the highest priorities.
4. AL 319 provides lower cutting thrust forces and better surface finish, while AL 356 provides better hole cylindricity.