LUBRICATION AND TOOL WEAR IN THE MANCHINING OF AUSTEMPERED DUCTILE IRON (ADI)

Overview
Quaker Chemical Corporation is working to improve the cost-effectiveness of using ADI through the development of machining fluids which extend the machining insert life and produce a cleaner, more uniform surface finish. The effectiveness of the lubricants on quelling the machine-caused phase transformations were assessed through a complete machining trial in which insert life and surface quality were measured for each fluid on both materials (ductile iron and ADI). In addition, an optical evaluation and, where appropriate, a scanning electron (SEM) microstructural evaluation was/were performed.

Objectives
- Develop an experiment that can be used to assess the performance of the three fluids vis-à-vis each other and dry runs
- Determine whether any of the cutting fluids yields superior performance in insert flank wear, surface roughness, and retardation of martensite transformation at machined surface

Approach
- Understood Quaker Chemical’s objectives
- Studied literature regarding ADI and the machining processes to be used
- Reviewed the report of an IE team which did a similar project for Quaker Chemical
- Prepped samples to work in SL-30
- Through experimentation, developed machining conditions that had no chatter
- Created code to machine sample pieces in SL-30 turning center
- Mixed lubricant with distilled water and tested lubricant using titration to ensure proper concentration levels
- Cleaned SL-30 to remove old coolant and replace it with the new Quaker Chemical lubricants
- Machined samples, measuring insert wear and surface roughness measurements after every pass
- Performed mixing of lubricant, cleaning SL-30, and machining for all 3 lubricants (14 samples total)
- Performed a dry run (that is, without lubricant) on remaining 2 sample pieces
- Performed statistical Paired-T test on data collected
- Cut samples from machined samples with water jet
- Etched/polished the cut pieces and performed microstructure analysis using microscope

Outcomes
- GS-520 produced less flank wear than the other two lubricants when machining ductile iron
- No lubricants prevented significant flank wear when machining austempered ductile iron
- All lubricants reduced the flank wear significantly compared to the dry runs on both ductile iron and austempered ductile iron.
- No lubricant distinguished itself in terms of surface roughness when machining ductile iron, but all lubricants noticeably outperformed the dry runs
- The GS-520 had a lower surface roughness than the other lubricants when machining the austempered ductile iron
- The dry run performed substantially better than all the lubricants when machined on austempered ductile iron
- No lubricants retarded the martensite growth more than the others