Lubricant Performance in the Machining of Austempered Ductile Iron

Overview
Quaker Chemical Corporation, an international industrial fluid production company, focuses on continued efforts in research and development to provide top quality service to their customers. One of the current projects is to analyze three different lubricants in order to determine which, if any, yields the most favorable results when used for machining ADI. Quaker Chemical Corporation hopes to reduce tool wear on cutting inserts, improve surface roughness, and minimize changes in the microstructure when machining ADI.

Objectives
- Analyze the effectiveness of 3 Quaker Chemical lubricants (Quakeral 700-G3, Quakercool 7020-CG, NB4104-31) on ADI
- Observe lubricant performance on flank wear, surface finish, hardness, and microstructure
- Determine the best lubricant with respect to each performance measure

Approach
- Met with representatives to determine customer needs as well as receive raw materials
- Reviewed the older Quaker Chemical Corp project involving ADI and formulated hypotheses.
- Made a consensus decision on the scope and approach of the experimentations.
- Generated pert chart to outline schedule for the semester.
- Purchased tool holder, cutting inserts, and prepared raw materials for experiments.
- Created a Mastercam model for creating tool paths and set machine parameters.
- Began machining without lubricant for baseline comparison on the SL-30 in the FAME lab, and adjusted machining parameters to obtain sufficient tool wear for analysis.
- Titrated and mixed lubricants as progress was made in machining by Total Alkalinity Titration.
- Machined 2 cylinders per lubricant in the SL-30 to have several replicates for data accuracy.
- Compared results to previous ADI study and validated trends in the results.
- Quantified volume of material removed to analyse results as a function of material removed.
- Completed data analysis for tool wear and surface finish using Excel charts, and Minitab Box-Cox Transformations were done to linearize the relationships.
- Samples were cut from parts using water jet cutter in the Learning Factory.
- Examined microstructure and hardness properties; documented and analysed results.
- Visited the sponsor to present findings, and completed final report.

Outcomes
- Quakeral 700-G3 is the superior lubricant for machining ADI where minimum flank wear for tool inserts is the primary concern
- The type of lubrication does not have an effect on the hardness of the material or the formation of martensite
- Lubricants yield higher average values of surface roughness than the dry run, but the differences between the three lubricants are insignificant