Lubrication and Tool Wear in the Machining of Austempered Ductile Iron (ADI)

Overview
Quaker Chemical is a company focused on improving the processes performed in the heavy manufacturing industry. Specifically, Quaker Chemical is interested in the growing use of austempered ductile iron (ADI) in the aerospace, automotive, and shipping industries, and which of their products have the best impact when machining it. The purpose of this project was to design an experiment to study the effects of four different types of lubricants while machining different grades of ADI on a CNC turning center.

Objectives
The main purpose of this project was to investigate the effects of different cutting lubricants on the machinability of ADI. In order to complete this project, the effects of microstructure and mechanical properties of ADI on surface roughness and tool wear were examined after machining operations to the samples had been completed. Also, the impact of lubricating additives on heat generation, microstructural transformations, and overall machinability of ADI was studied.

Approach
- Contacted sponsor to discuss which performance measures were the most important
- Designed experiments using a CNC turning center for every combination of lubricant and ADI
- Prepared samples for the CNC machine using a manual lathe
- Collected data during the experiments using a stereoscope for tool wear and a surface profilometer for surface roughness
- Plotted the data for each performance measure for one grade of ADI with each lubricant
- Performed an ANOVA statistical analysis using Minitab to determine if there were any significant performance differences for the lubricants in order to make recommendations to the sponsor
- Collected microstructure images using a scanning electron images (SEM) for pre-machined and post-machined samples to analyze any changes

Outcomes
These recommendations should allow Quaker Chemical to better market its product to their customers

Tool wear outcomes
- QC 7102 + 3%1683 performed best for 900 Grade ADI
- No significant tool wear differences for 1050 Grade ADI
- QC7102 + 3%1731 and Microcut 3680 performed best for the 1200 Grade ADI

Surface Roughness Outcomes
- QC 7102 + 3%1683 performed best for 900 Grade ADI
- QC 7102 performed best for 1050 Grade ADI
- Microcut 3680 performed best for 1200 Grade ADI

SEM images supported conclusions found from the data.