Applied Process Inc: Cost-effective Manufacturing of Austempered Ductile Iron

Overview
Due to the transformation process and the structure of ADI, the material will easily strain transform to a very hard material under high normal forces. Therefore, due to the high strength and hardness of ADI, machining the material is often problematic. The drilling process can cause extensive tool wear on the cutting edge of the cutting tool.

Objectives
Applied Process Inc. requested our team to find the best combination of tooling and conditions in order to maximize efficiency for companies drilling ADI grades of 900 and 1200. The team collected data on flank and rake wear, and surface roughness of the plates then analyzed the results using regression analysis.

Approach
- Measured hardness of ADI grades 900 and 1200 using the Brinell Hardness Test
- Prepared and replaced CG-7020 coolant for the VF3 CNC machine
- Developed MasterCam programs for removing the mill scale and drilling
- Removed mill scale on ADI plates with VF3 machine making three passes
- Each plate is drilled with six rows of fifteen holes (90 holes total)
- After each row is drilled, tool wear is measured using the stereoscope on 3X zoom
- Once drilling is complete, each plate is cut into five segments to measure surface roughness
- Regression analysis performed on the results

Recommendations
Two separate recommendations can be made for drilling ADI Grade 900 and Grade 1200 using:
- Quaker-Cool 7020-CG with a 7.46% concentration level and through-the-spindle coolant
- KenTip replaceable-drill tips size 0.3125” coated with aluminum-titanium-nitride
- KenTip replaceable-tip drill body size 0.3126”

When considering optimal tool wear:
ADI Grade 900:
Cutting Speed: 1500 rpm
Feed Rate: 12 in/min
ADI Grade 1200:
Cutting Speed: 1125 rpm
Feed Rate: 5.4 in/min

When considering the best surface finish:
ADI grade 900:
Cutting Speed: 1200 rpm
Feed Rate: 9.6 in/min
ADI grade 1200:
Cutting Speed: 697 rpm
Feed Rate: 3.3456 in/min