

IME-301

Dr. Laura Sullivan

Thursday 1:20pm

LAB #4- Graphs

Team Members

Francis Carr

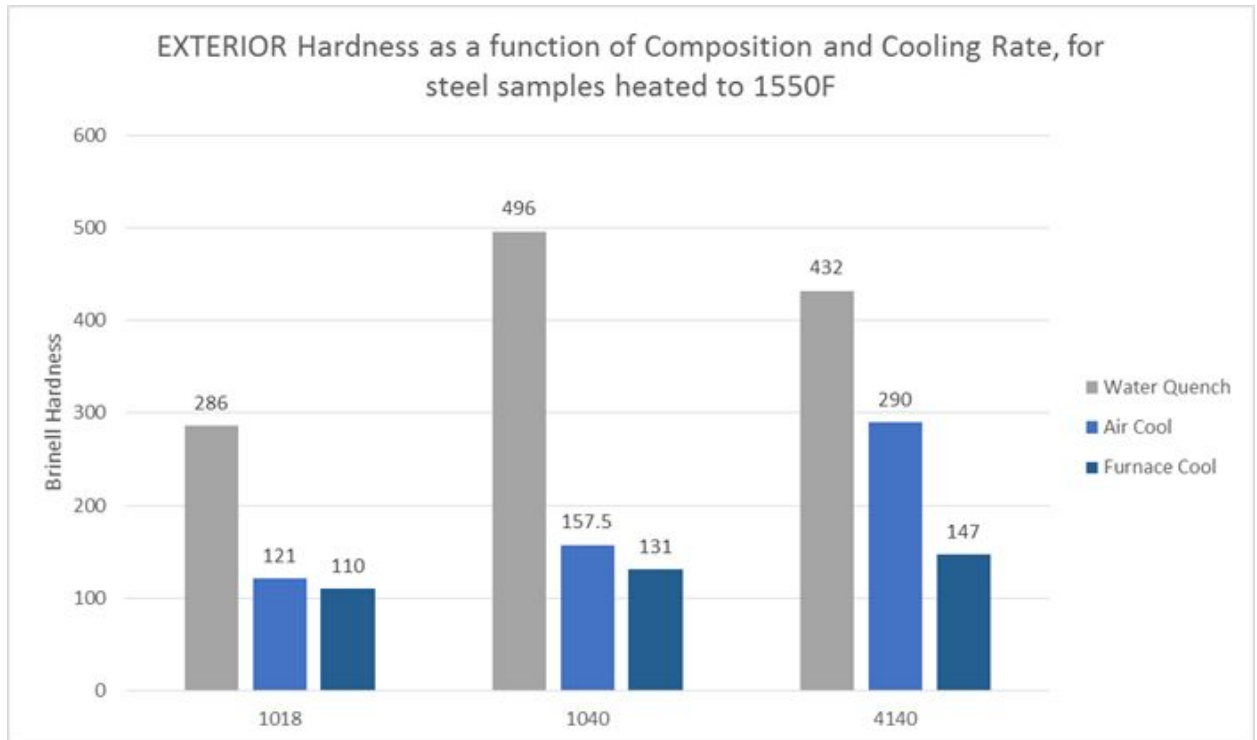
Carter Childs

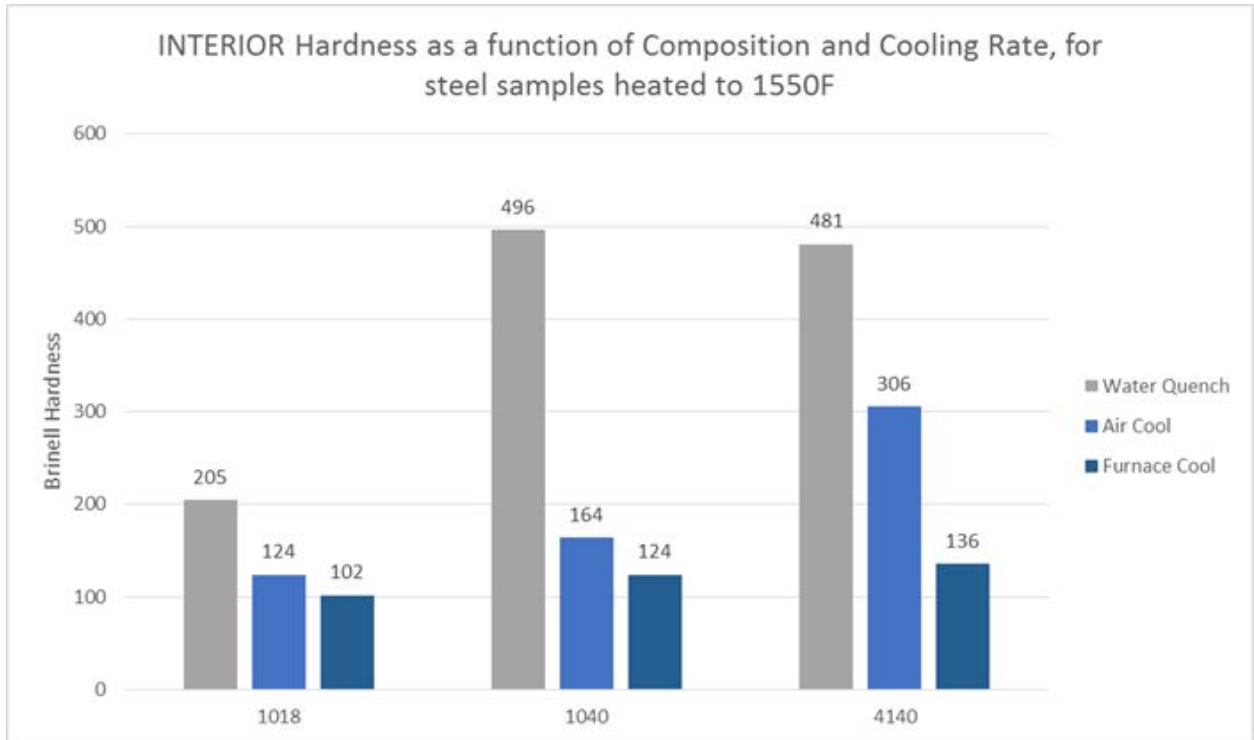
Robert Connolly

Ian Villaroman

Considering the hardness of steel specimens with different amounts of carbon, quenched using water, air, and the furnace...

**Data**





## Discussion

Hardness is expected to increase with higher % carbon content. The data from the Exterior and Interior measurements confirm this expectation. Per every cooling operation, the hardness increases from 1018 to 1040. 4140 Water Quench and Furnace Cool shows minimal change in hardness, however, the air cool 4140 has much higher hardness than the 1040 with the same carbon content. This must be because of the alloying elements contained in 4140.

Shorter Cooling rate should result in higher hardness. Our data confirms this, as the Water Quench is hardest for all material types. Air Cool is the second hardest, followed by the furnace cool which was the softest for 1018, 1040, and the 4140.

## Sources of Error

Sources of error for the **material**

- 1) Assumption: Every sample began the same
- 2) Material samples are not homogenous there will be variations between lab groups and sections.
- 3) Material properly measured might be related to a flaw

Sources of error for the **equipment**

- 4) Process conditions may vary because of variation in equipment.
  - a) Temperature calibration of furnace will vary from each individual furnace.

- 5) Test conditions may vary
  - a) Hardness tester calibration varies from each individual machine.
- 6) Inaccurate measurement due to machine
  - a) Load cell was accurate
  - b) Extensometer not accurate which caused an effect on the E, elongation.
  - c) Digital caliper was accurate
- 7) Operator - Process error
  - a) Inconsistencies and errors involving quenching
- 8) Operator - testing error
- 9) Operator error

Additional sources of error possible during laboratory process

- Extra flack incorrectly measured on the hardness testing machine
- Polishing/Grinding too much of the surface of the material to the point where the
- Polishing the incorrect side needed to take hardness test measurements
- Polishing little to no material off the material sample.
- Using incorrect tool for hardness testing
- Misinterpretation of the Rockwell B scale for Rockwell C scale
- Incorrect conversions of Rockwell to Brinell hardness scales