Calculation of Minimum Mold Thickness in Steel Casting

Jacob Thole Dr. Christoph Beckermann

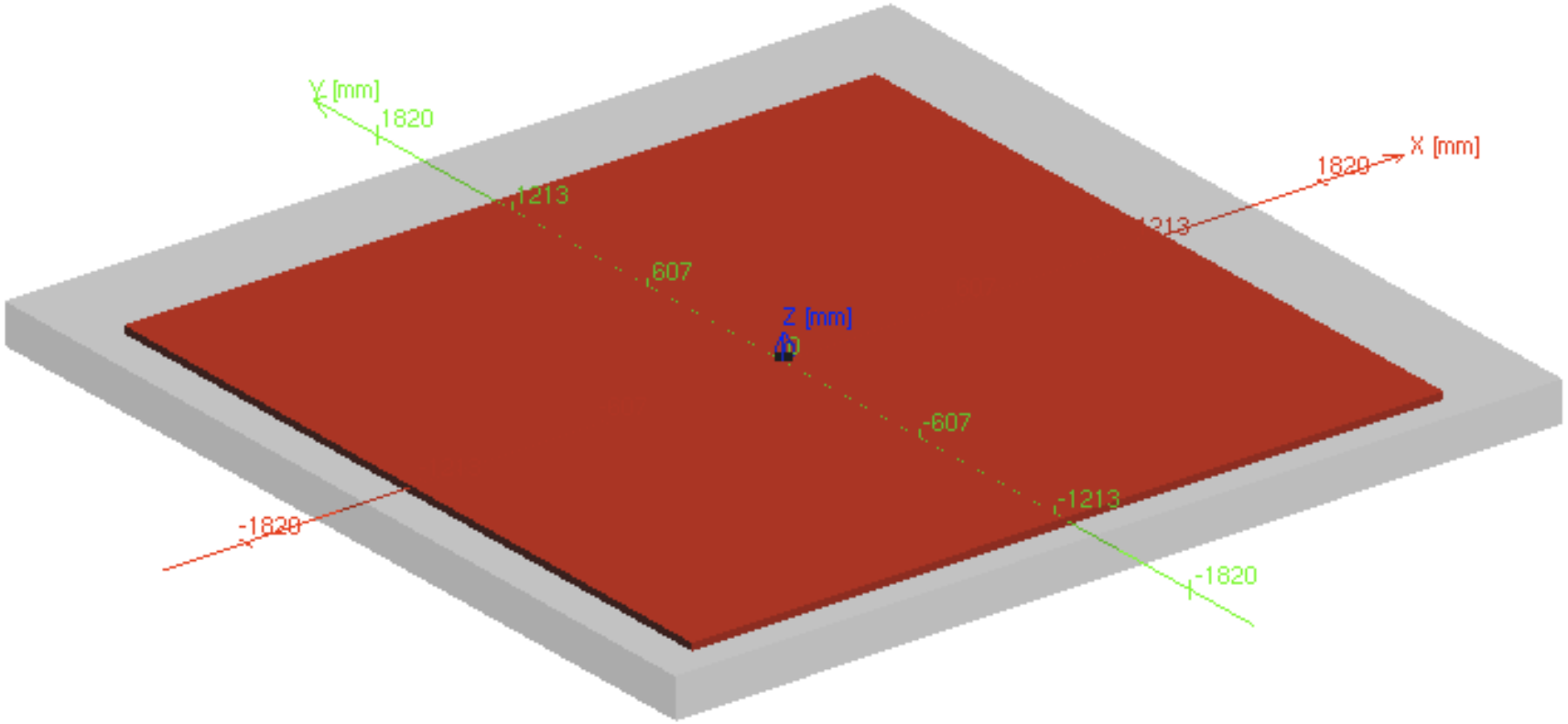
University of Iowa
Department of Mechanical and Industrial Engineering

January - 29 - 2008

Objective

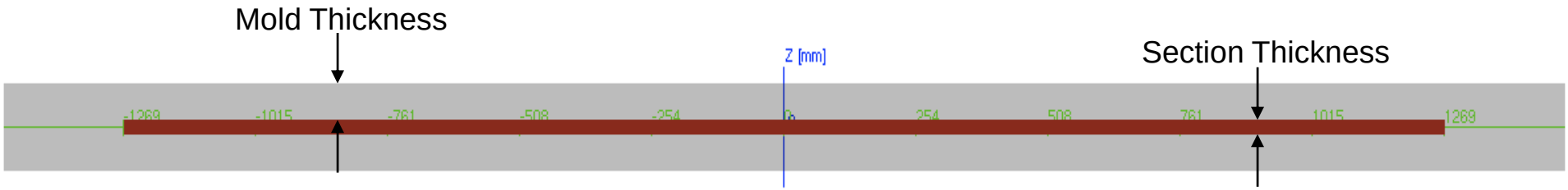
- Calculate thickness of sand required to keep the surface temperature of the mold below 100˚C until a 5 mm thick solid steel shell has formed in a steel casting section of a given thickness.

Geometry

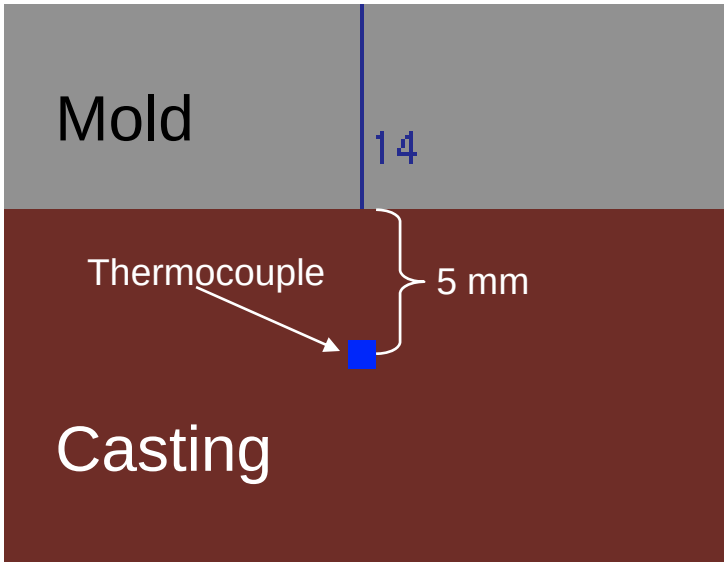


ISO view of the 1” x 100” x 100” steel casting.
Varied thickness of plate from 1” to 10”.

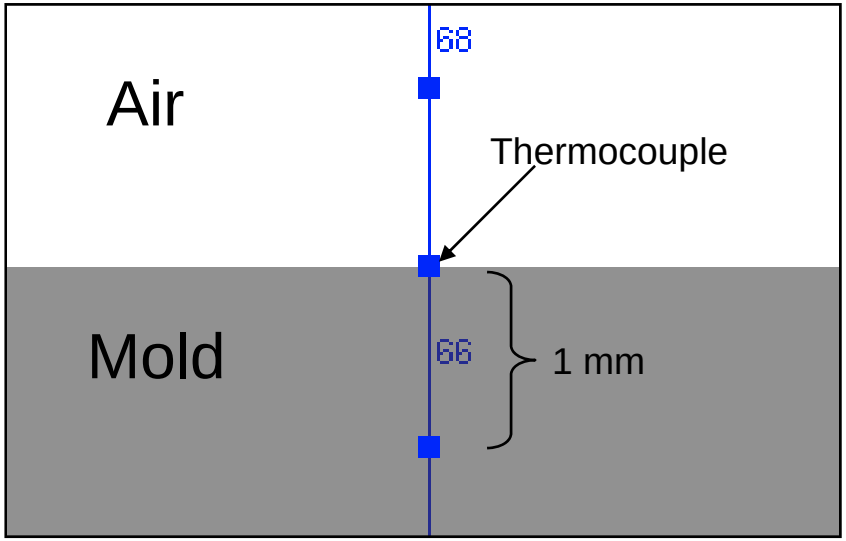
Thermocouple Locations



Scale view of a 1” x 100” x 100” casting



Thermocouple placed 5 mm into steel casting.

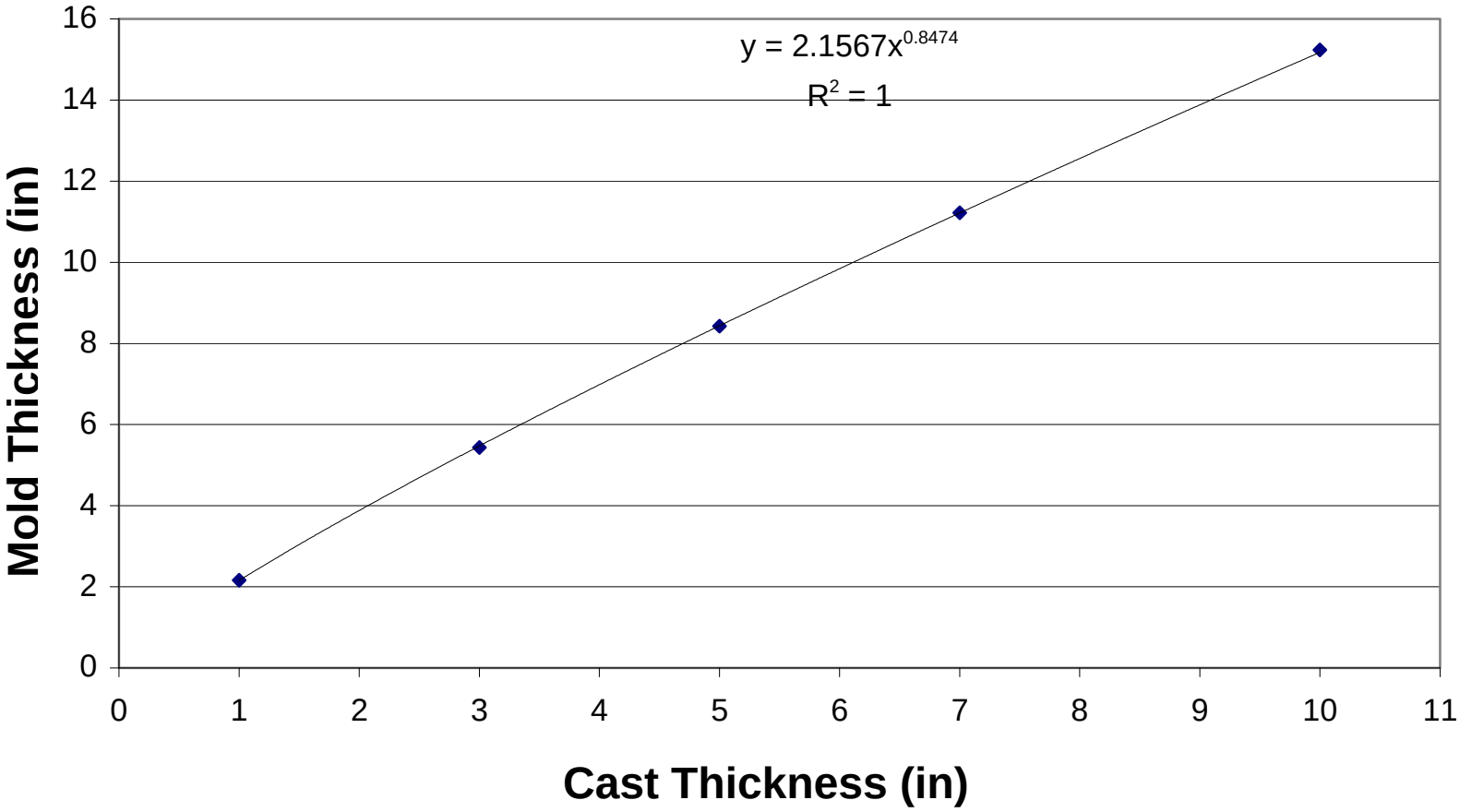


Thermocouples placed at the surface of the mold.

Simulation Set-up

- User defined STEEL used for casting.
- Initial temperature of steel: 1620˚C.
- Solidus temperature of steel: 1420˚C.
- User defined furan.new sand used for the mold; initial temperature: 20˚C.
- C1000 heat transfer coefficient.

Calculated Mold Thickness



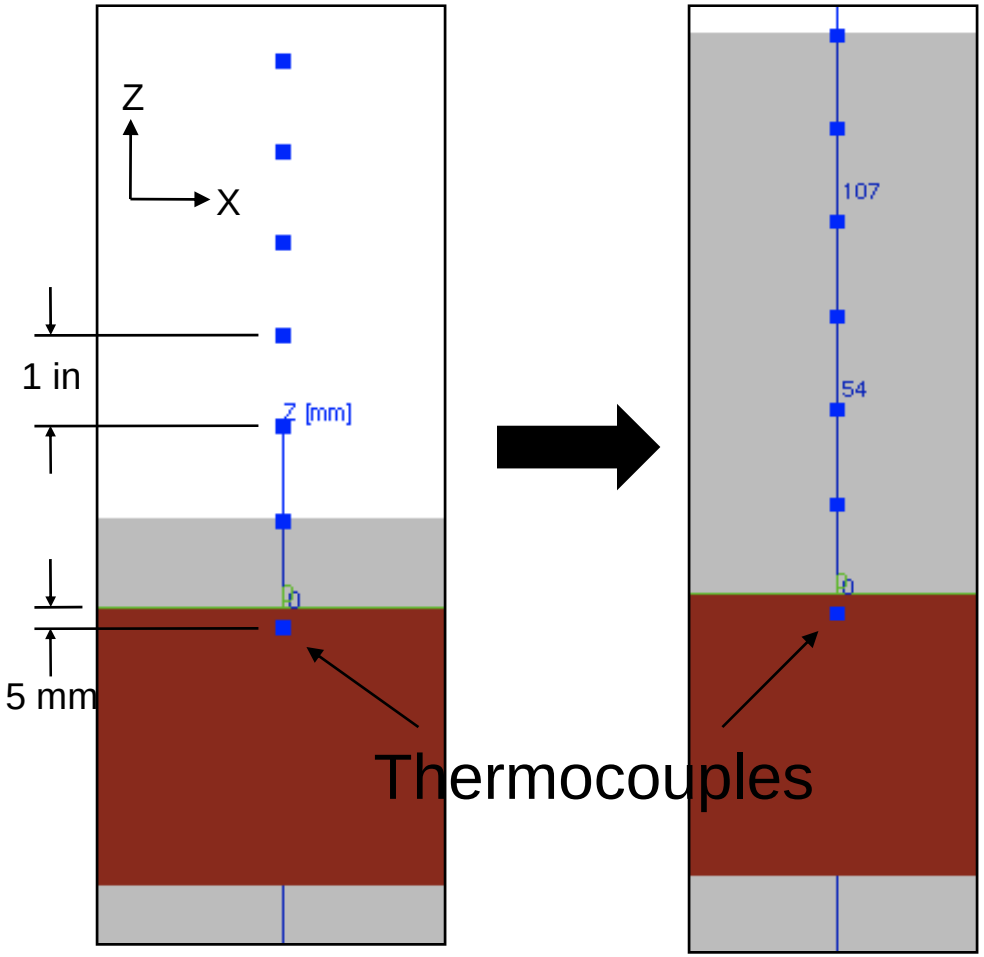
Discussion / Conclusion

- For example, for a 3” thick section, calculations indicate a 6” mold thickness is needed to maintain the mold surface temperature below 100˚C.
- Using the present criterion to determine necessary mold thicknesses would result in overly conservative values.

New Objective

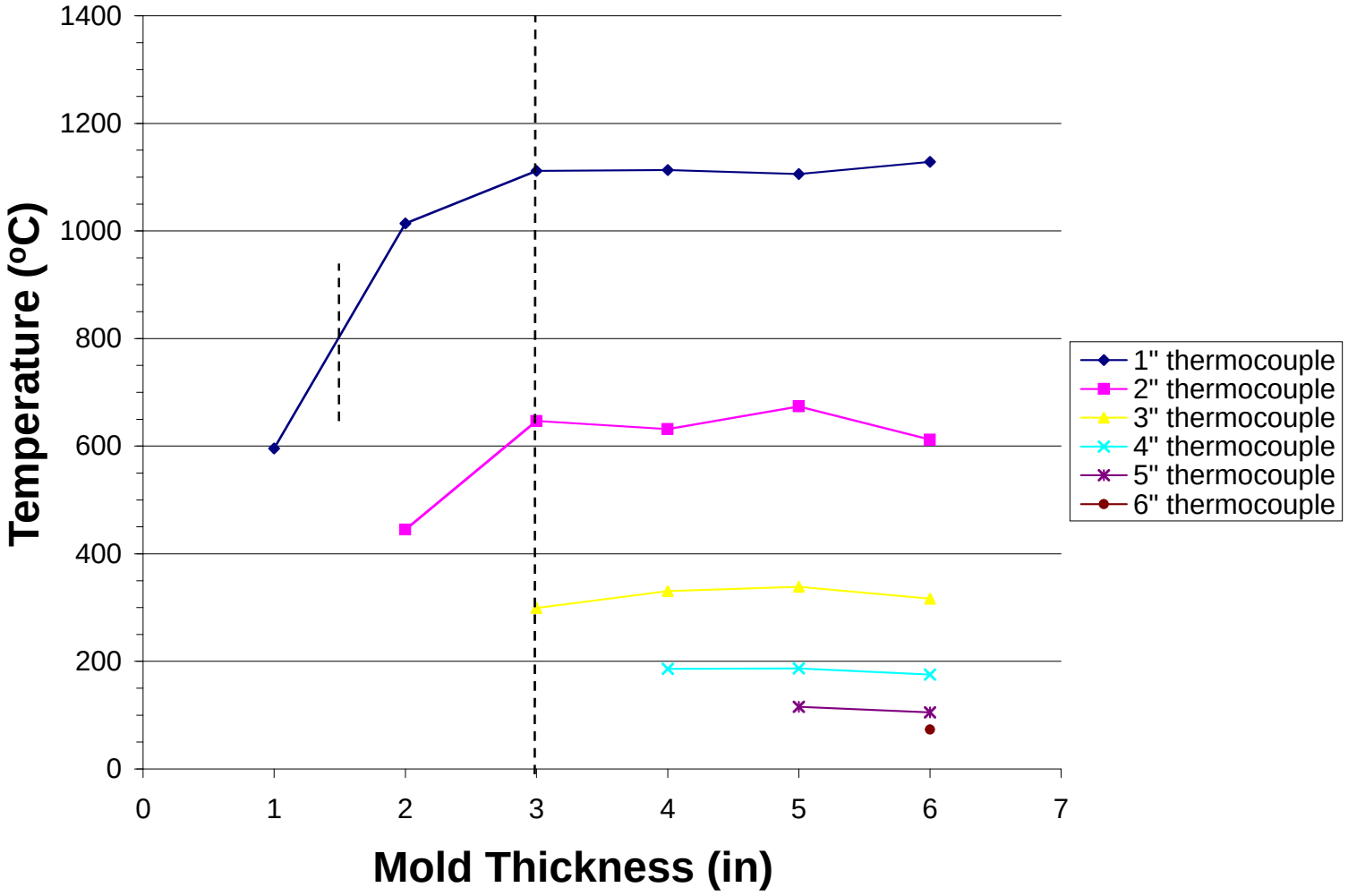
- Determine temperatures within the mold, at the point in time when a 5 mm thick solid steel shell has formed, for various mold and cast steel section thicknesses.

Method

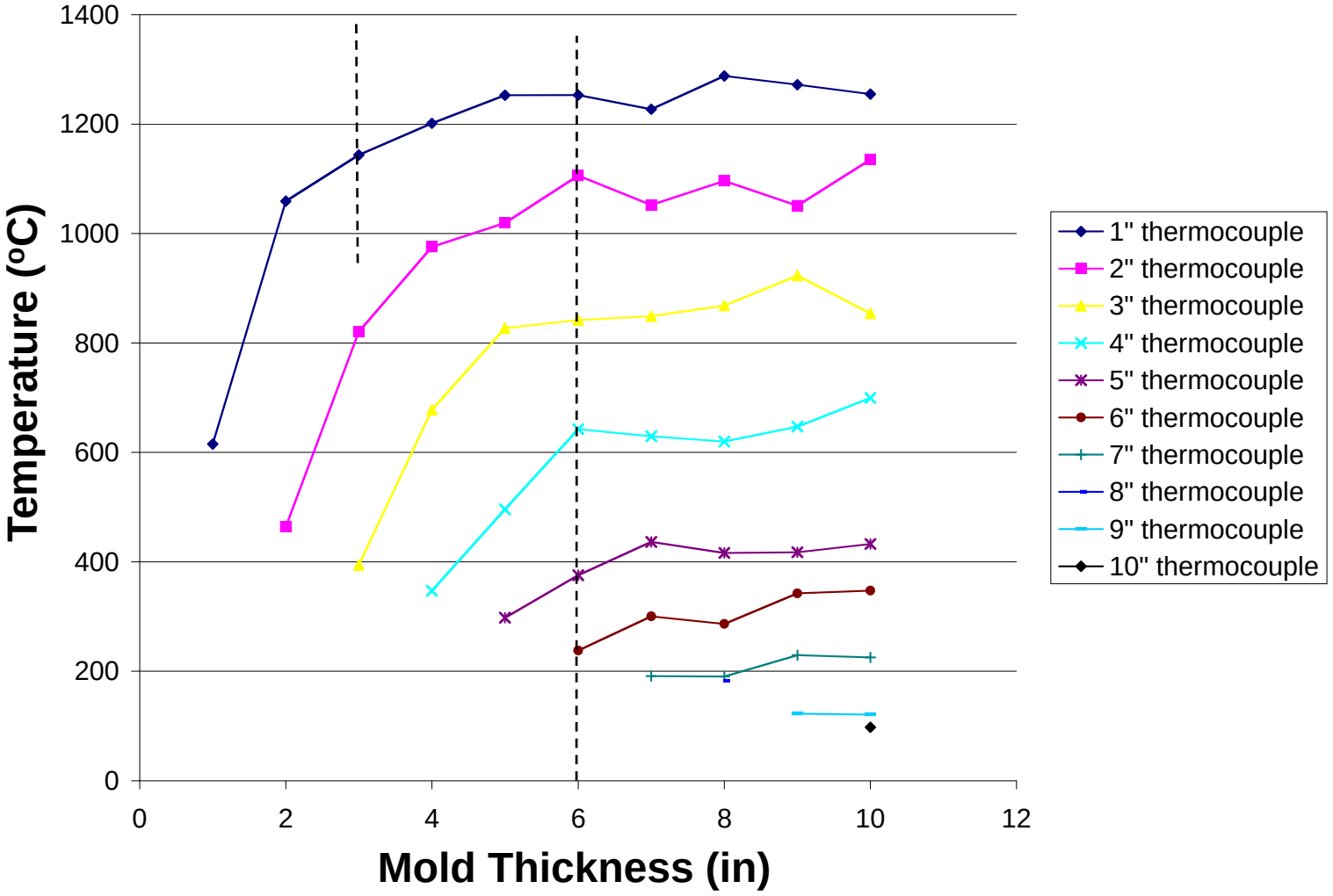


- Varied mold thickness in 1” intervals.
- Investigated two cast section thicknesses: 3” and 6”.

Calculated Mold Temperatures for a 3” Cast Section



Calculated Mold Temperatures for a 6” Cast Section



Discussion

- Mold thinner than cast section:
  - local temperatures in the mold strongly increase with increasing mold thickness.
- Mold thicker than cast section:
  - local temperatures in the mold do not change upon a further increase in the mold thickness.

Conclusion

- Making the mold thicker than the cast section seems unnecessary.
- In fact, the temperature at one inch from the casting surface does not change significantly for mold thicknesses greater than half of the cast section thickness.
- Currently, we only have results for 3” and 6” thick cast sections.