CASE STUDY

A Performance Evaluation – ANVILOY® 1150 vs. H13

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Die Materials and Simulation

- How can we visualize and understand the effects of ANVILOY® 1150 inserts using MAGMASOFT®?

Die Materials and Simulation

- Volumetric heat capacity $\left(VC_p\rho\right)$
  - Is the capacity of the material to store heat without increasing its own temperature (V is volume)
- Heat diffusivity $\sqrt{kC_p}$
  - A measure of heat absorbing ability of the material
- Thermal diffusivity $\left(\frac{k}{\rho C_p}\right)$
  - A measure of speed of temperature migration in the material

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Die Materials and Simulation

Material	Volumetric heat capacity $(VC_p\rho)$	Heat diffusivity $\sqrt{kC_p}$	Thermal diffusivity $\left(\frac{k}{\rho C_p}\right)$
	Heat storage	*Heat absorption*	*Speed of temperature migration*
H13 steel	1.00	1.00	1.00
W-based alloy (Anviloy)	0.66	1.16	6.84
Mo-based alloy (TZM)	0.59	1.41	7.38
Nickel based superalloy	0.88	0.72	7.01

***Constant volume of 1200cc @~400C**

- Thermal conductivity of ANVILOY® 1150 is about 7x that of H13
- So ANVILOY® 1150 speeds-up heat extraction
- To increase heat storage, use a larger ANVILOY® 1150 piece (increase *V* in the formula)
- Using water in the insert increases heat storage and heat absorption

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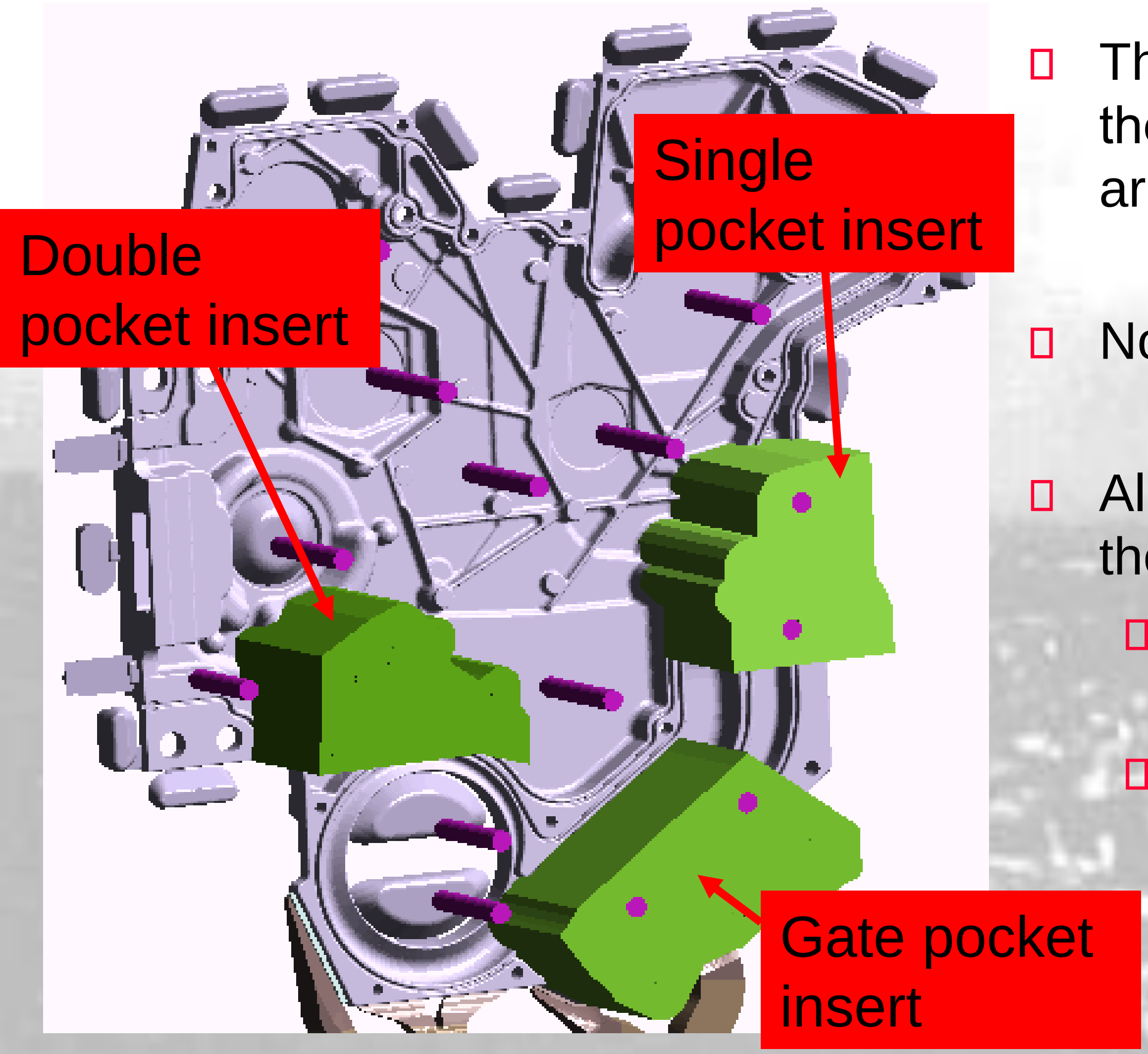
Die Materials and Simulation

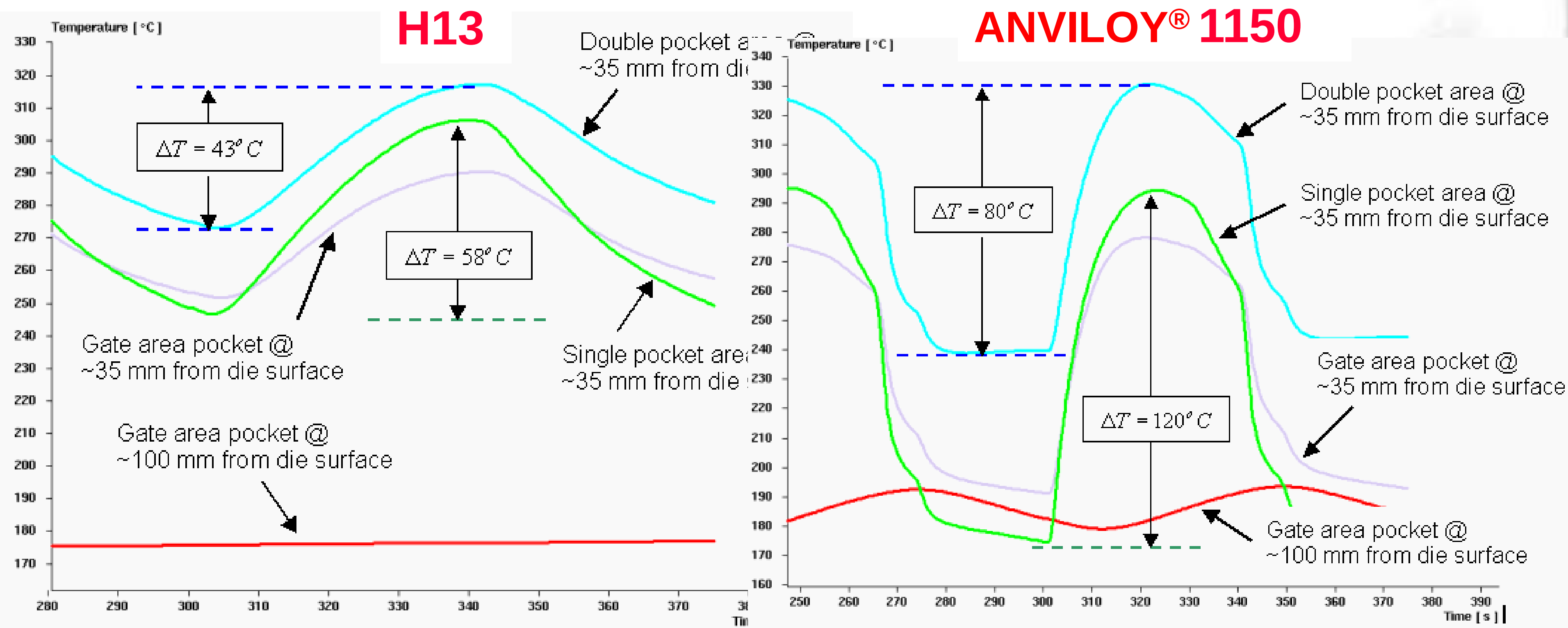


- There is fountain cooling for the “Single” and “Gate Pocket” areas
- No cooling for “Double Pocket”
- All three inserts have thermocouples at
  - 35mm from parting surface &
  - 100mm from parting surface

Die Materials and Simulation

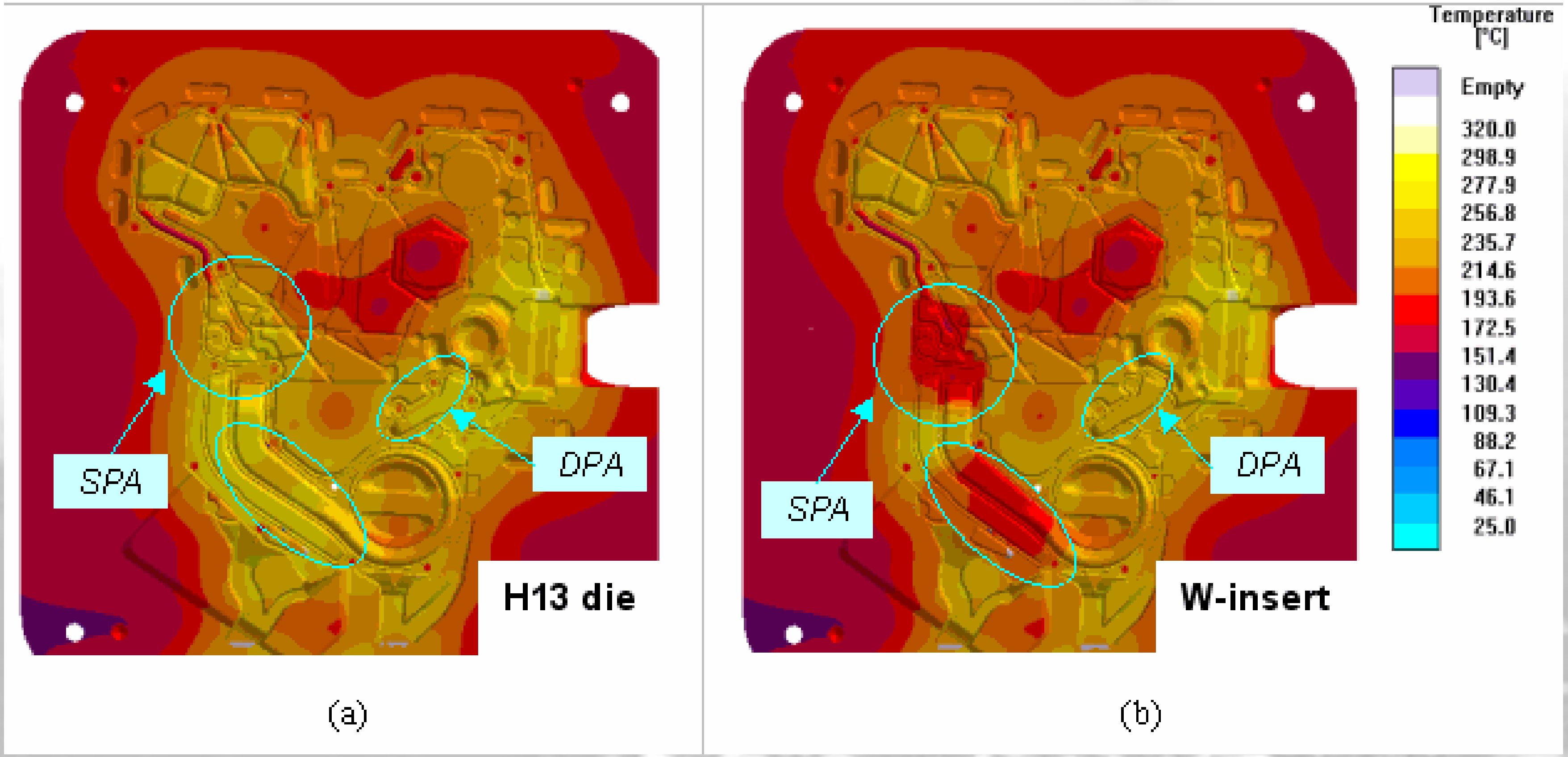
- Simulation 1: All H13, No inserts
- Simulation 2: ANVILOY® 1150 inserts into the H13 die
- H13 and ANVILOY® 1150 data was taken from the MAGMASOFT® database
- All process parameters were kept identical

Thermocouple Results



- Notice the delta-T's throughout 1 cycle
- Peak minimum for H13=250ºC, ANVILOY® 1150=180ºC
- With water (green) vs without water (blue)
- Clearly indicates that the initial die temperature is 70C lower using ANVILOY® 1150.
- This increases the difference in temperature between the Aluminum casting and the insert, forcing the casting to cool faster.

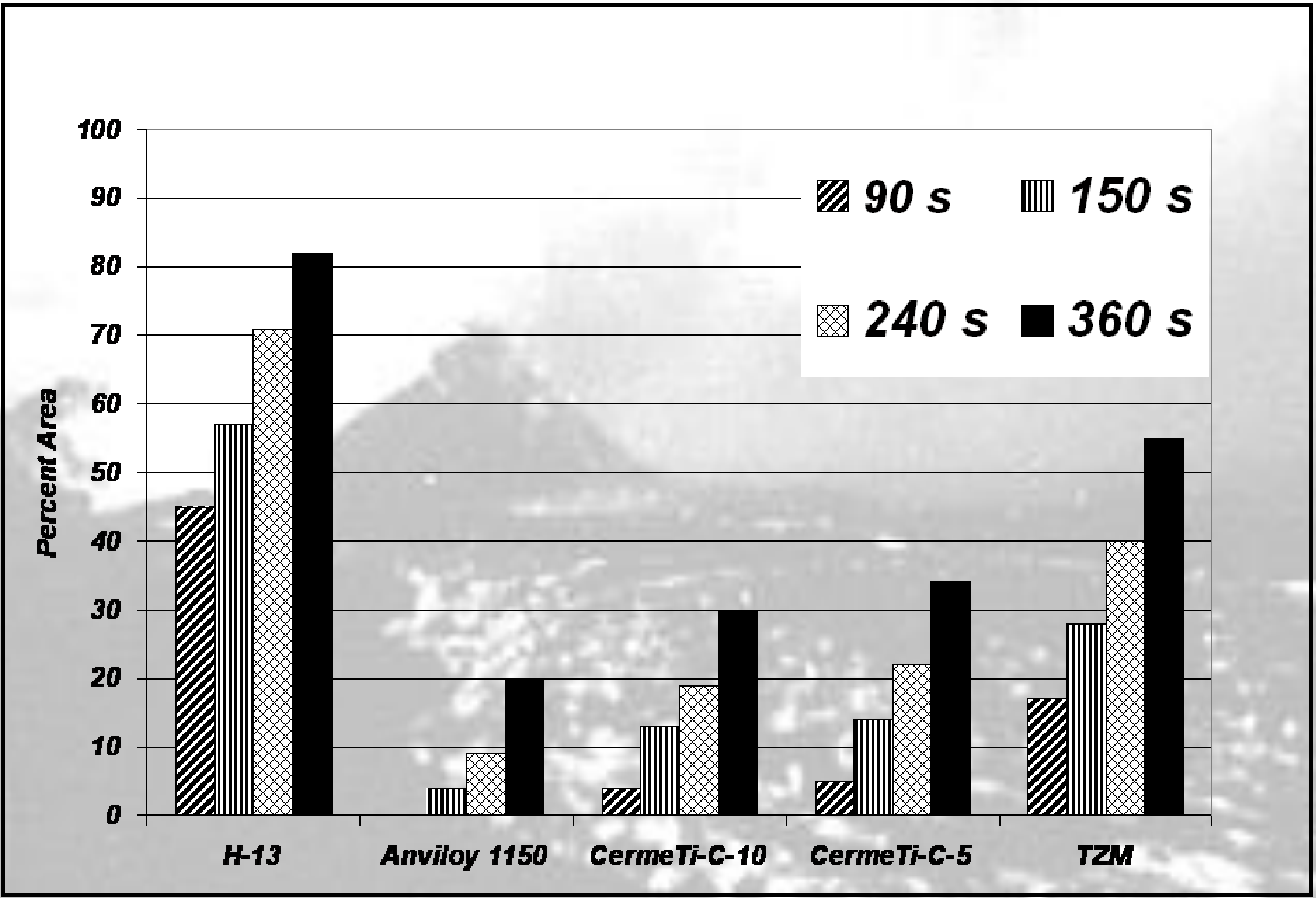
Impact on the Die Temperature



- Die temperature at the end of the cycle
- Die 80-100ºC cooler when ANVILOY® 1150+water is used

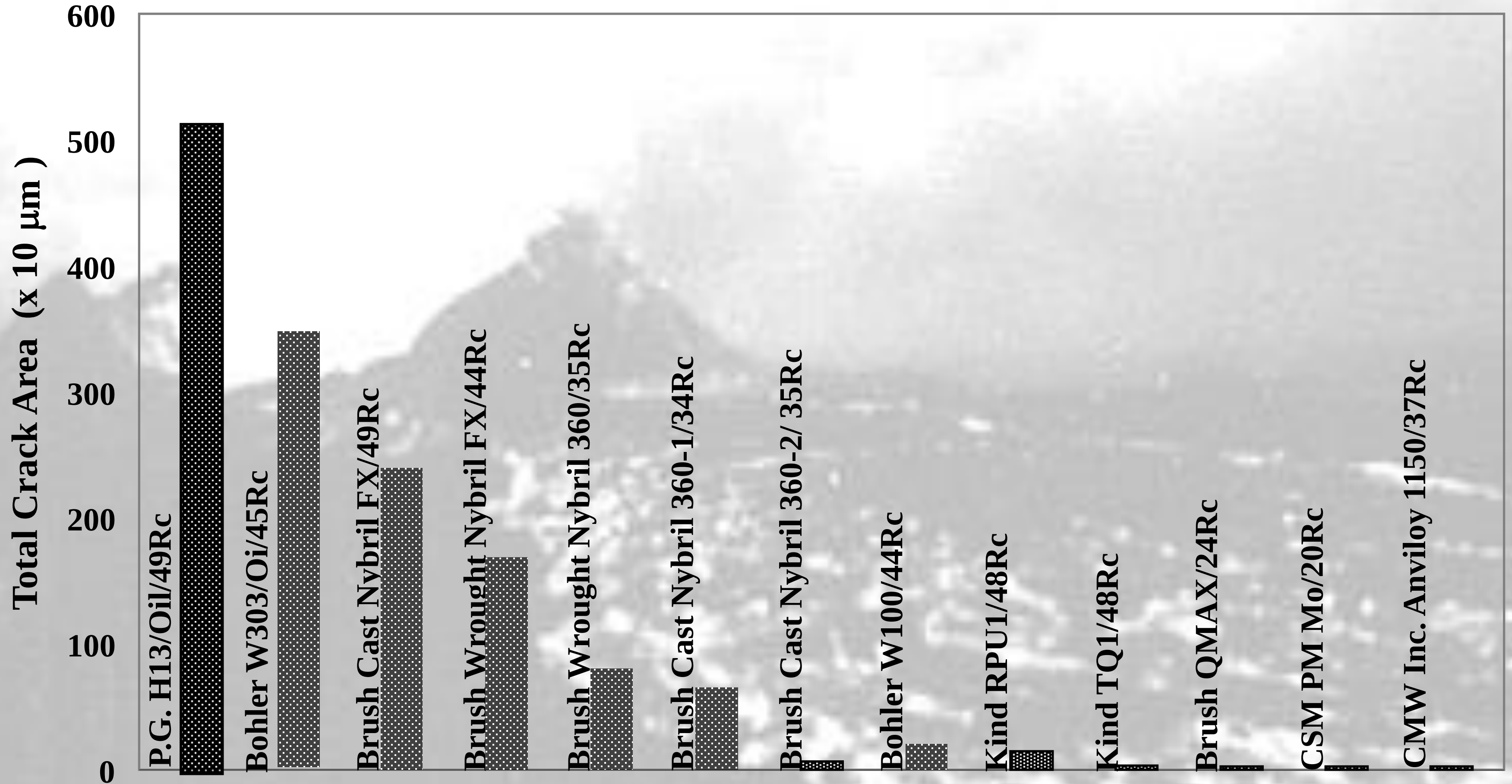
Soldering Tendencies Of Alternate Non-Ferrous Die Materials

Sumanth Shankar and Diran Apelian, Metals Processing Institute, WPI Worcester, MA 01609, 2000



Total Crack Area After 15,000 Thermal Fatigue Cycles (1"x1"x7")

Die Materials for Critical Applications and Increased Production of Castings, John F. Wallace, David Schwam and Xiaofeng Su, Case Western Reserve University, 2000



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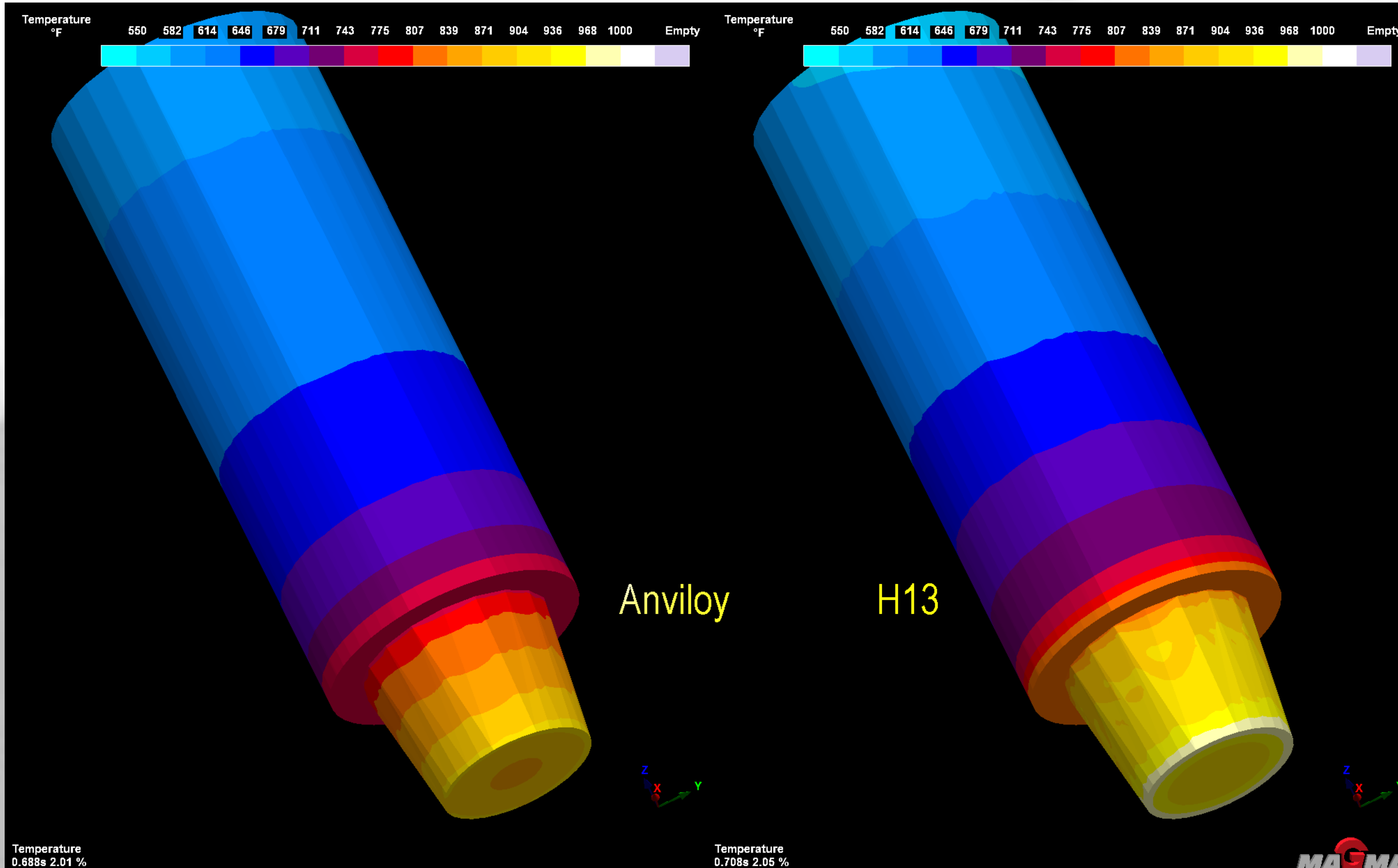
Insert Temperature Comparison

ANVILOY® material transfers heat through the insert much faster compared to H13 material.



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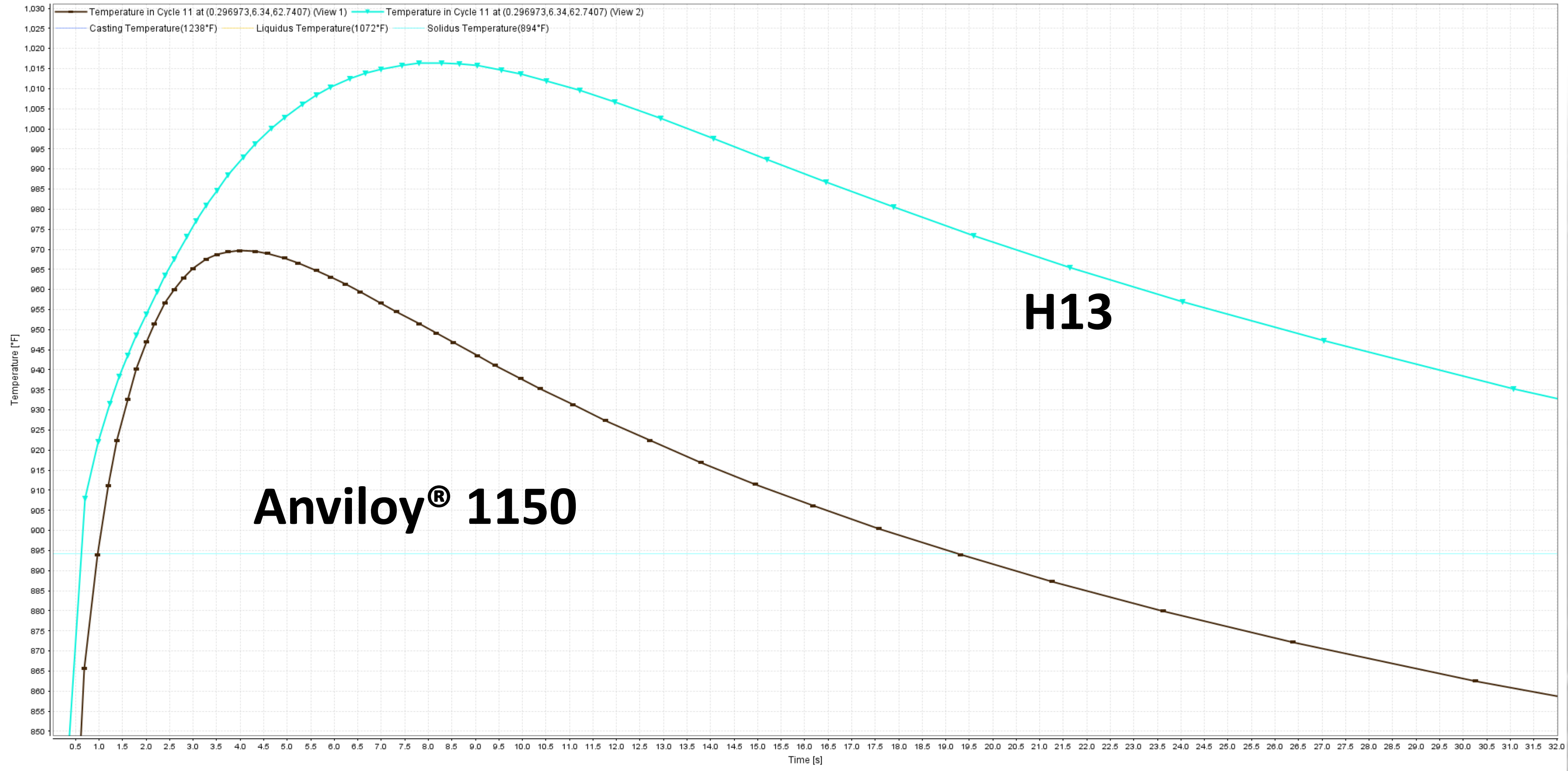
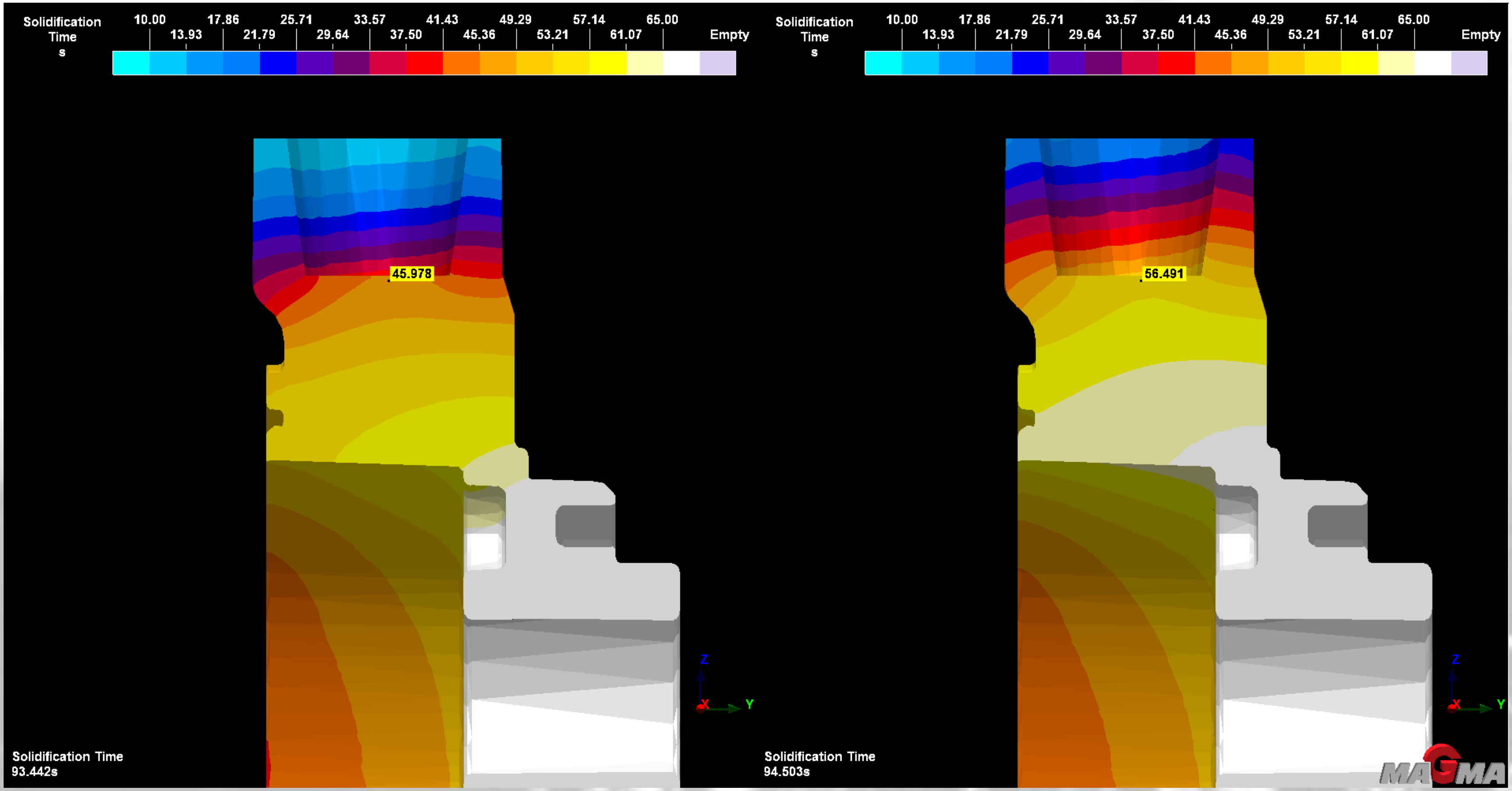
Thermocouple Plots



Virtual thermocouples placed in the insert near the surface shows the ANVILOY® has a lower temperature due to the ability to transfer heat through the insert much faster then the H13 material

Casting Solidification Rates



- Sliced view of the casting shows the ANVILOY® tungsten insert solidifies the casting region approximately 11 seconds faster then the H13 insert.
- Side scale represents the time it takes for the alloy to solidify in seconds

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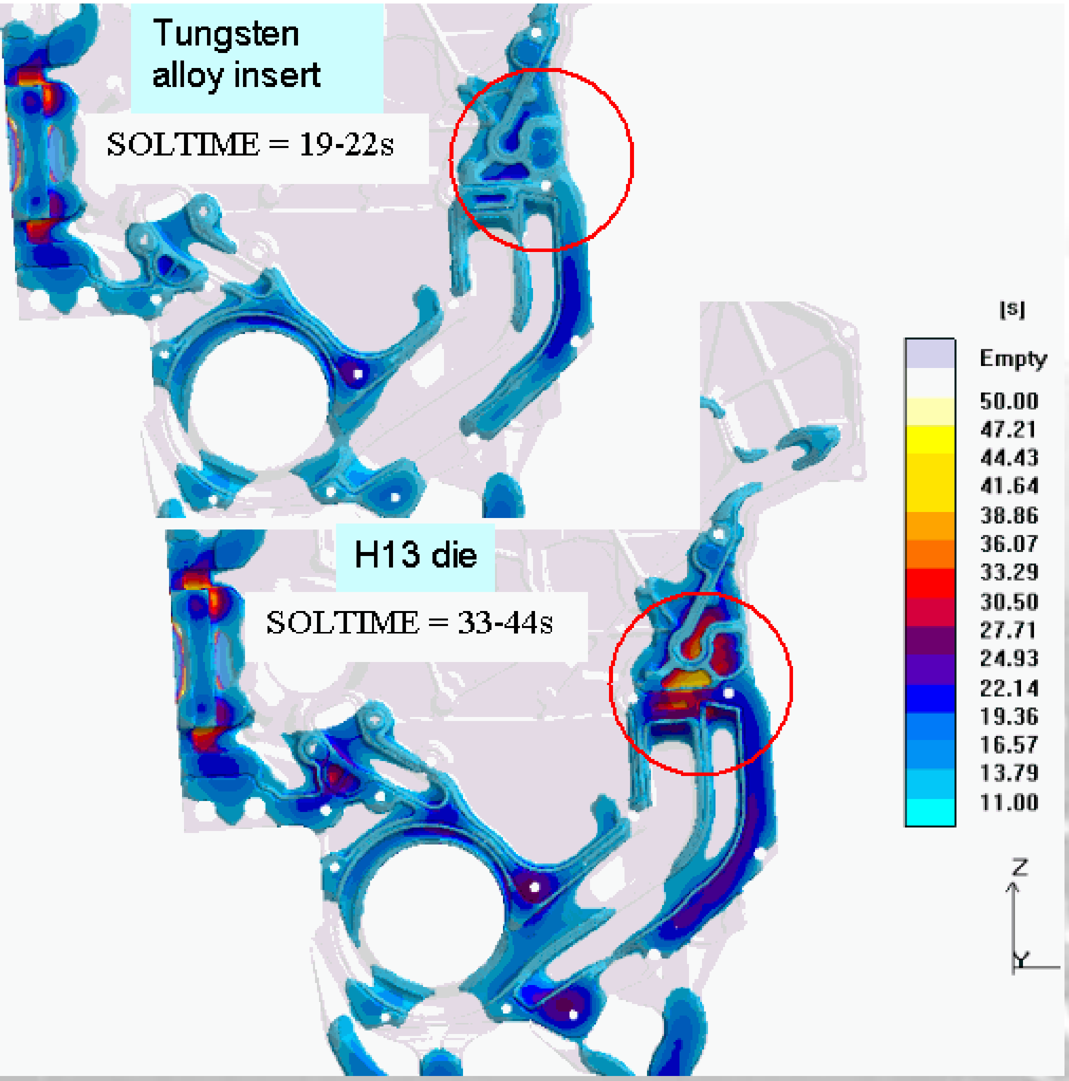
Effect on Local Casting Solidification Time



- Invisible areas are fully solidified
- Notice that the gate freezes-off early making intensification useless in these late solidifying areas.
- SOLTIME is reduced by 50% using ANVILOY® 1150
- This reduces shrinkage porosity
- Potential for earlier ejection of the casting