ICRF
Ingot Casting Rolling Forging 2018
3rd International Conference
16–19 October 2018 in Stockholm

Optimization of ingot geometry, casting technology and chemical composition of a 20 tons 42CrMo4 ingot to minimize A-segregation and increase material homogeneity

Ovidiu Bogdan, Industrial Soft
Montreal, Canada

Outline

A Segregation in Steel Ingots
Analysis Tools
- Online Ingot and Mold Design
- Online Solidification Simulation and Segregation Analysis
- Segregation Prediction Technique

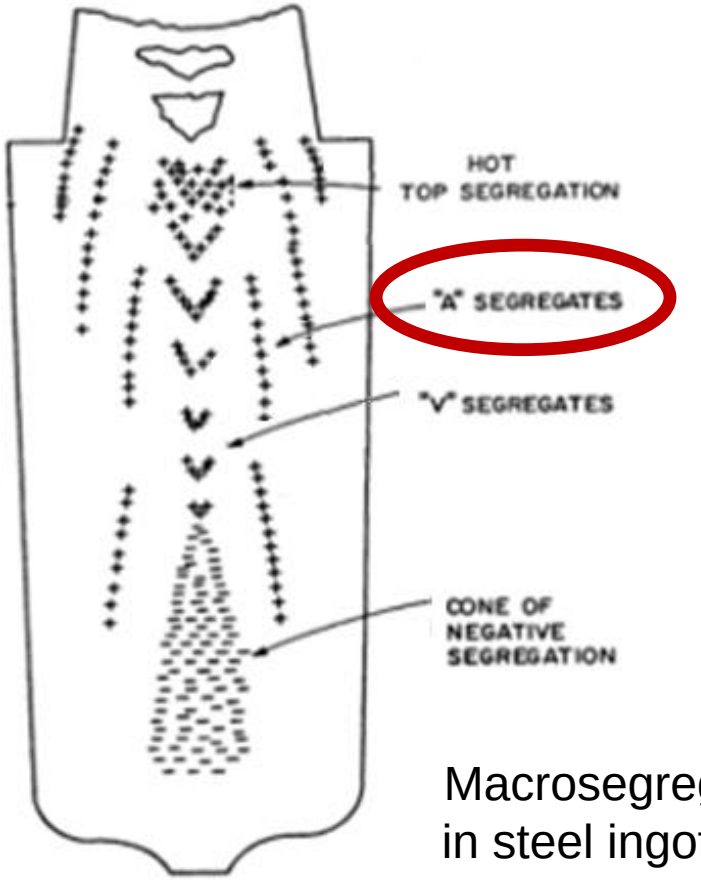
Optimization of Ingot Geometry
- H/D ratio, Ingot Taper, Hot Top Size

Optimization of Casting technology
- Pouring Temperature, Exothermic Material

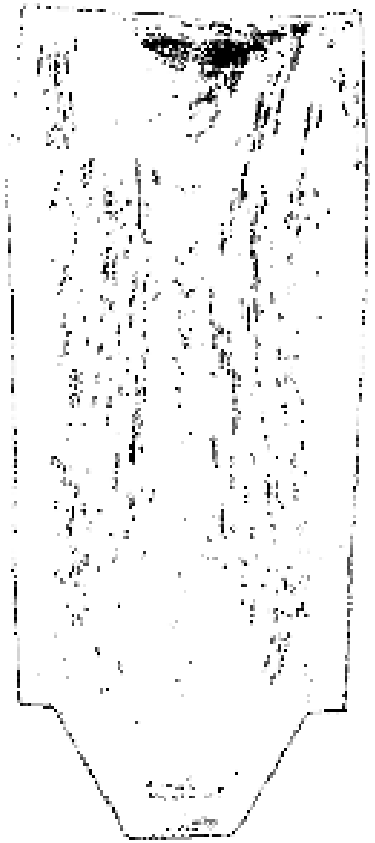
Optimization of Chemical Composition
- C, Si, Mn, Cr, Mo

Conclusions

Macrosegregation in Steel Ingots



Macrosegregation in steel ingots



Sulfur print in sectioned ingots

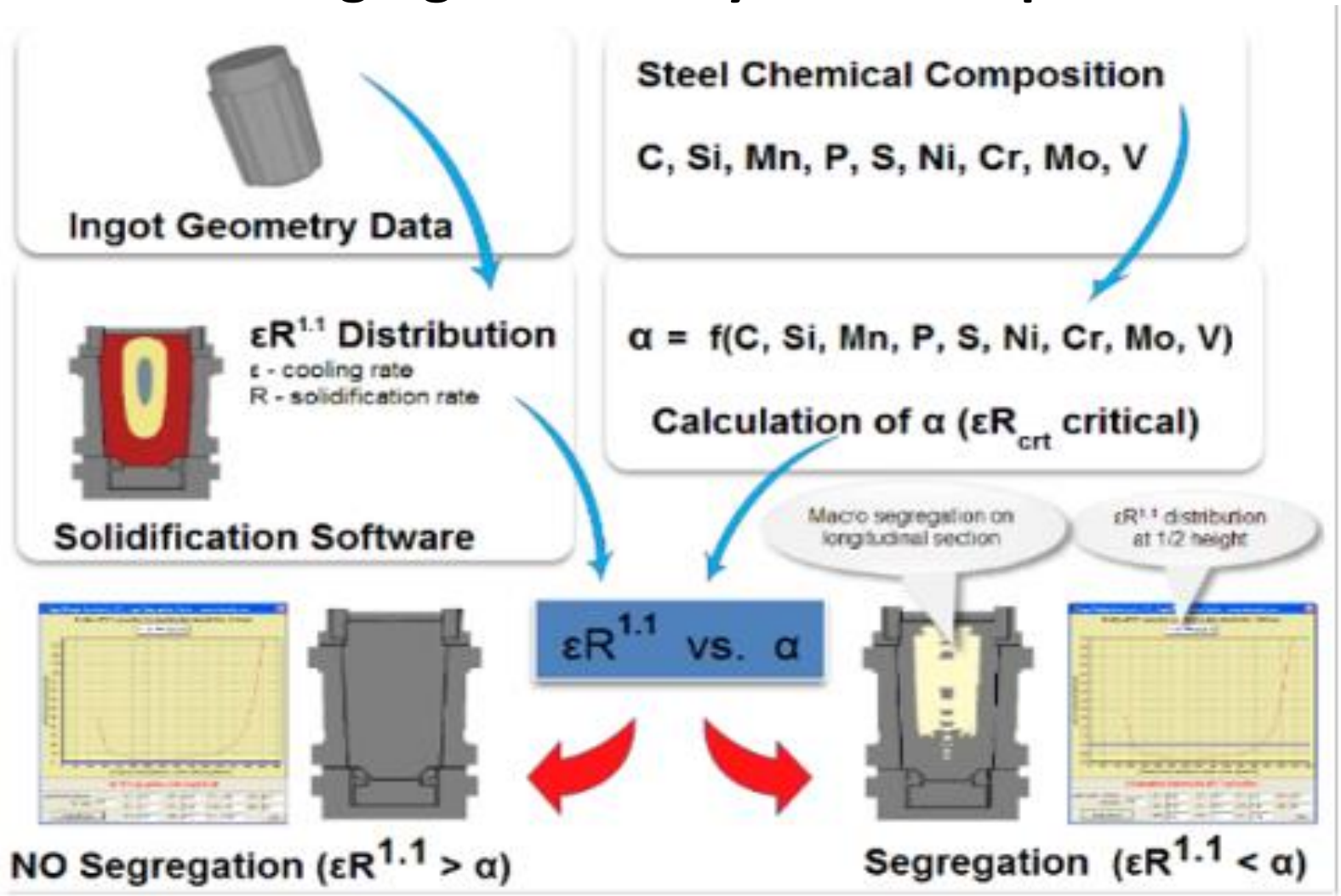
Online Ingot and Mold Design Assistant

Online Ingot and Mold Design Assistant

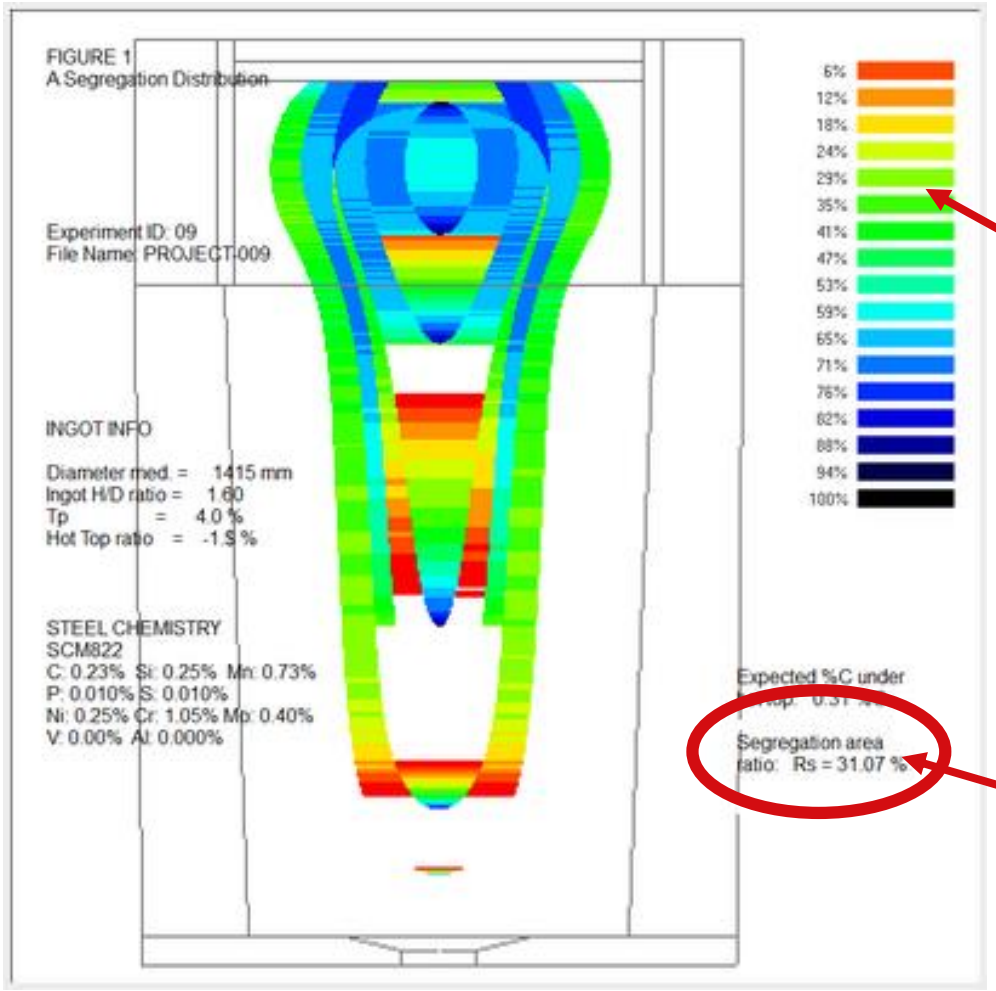
Online Solidification and A Segregation Analysis

Online Solidification and A Segregation Analysis

A Segregation Analysis Technique

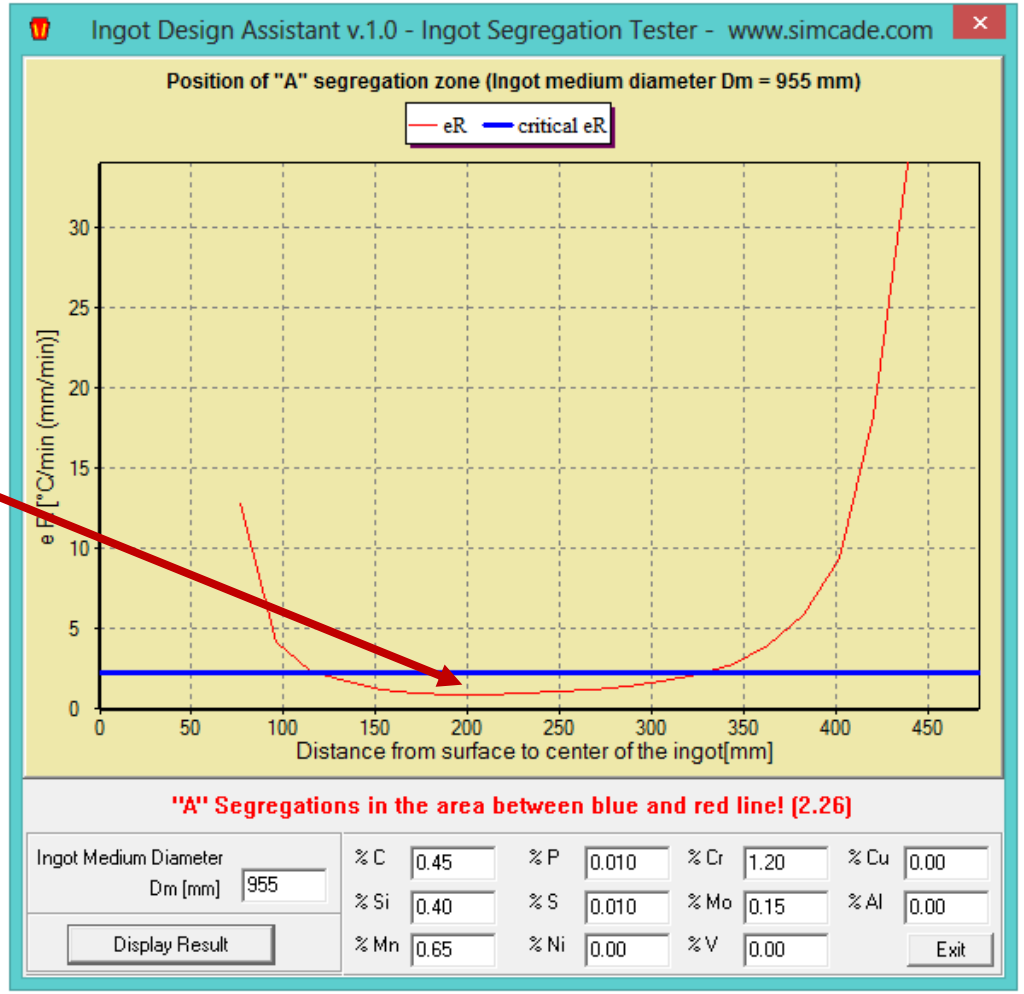


A Segregation Assessment Indicators

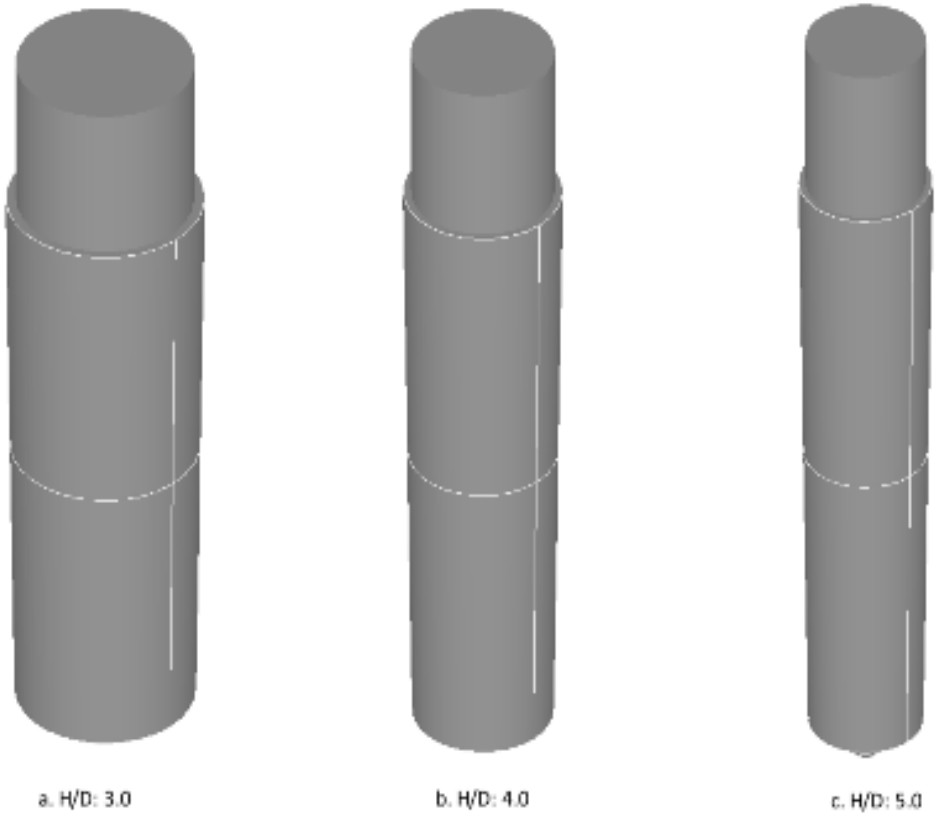


Segregation intensity

Segregation area ratio



Optimization of Ingot Geometry



a. H/D: 3.0 b. H/D: 4.0 c. H/D: 5.0

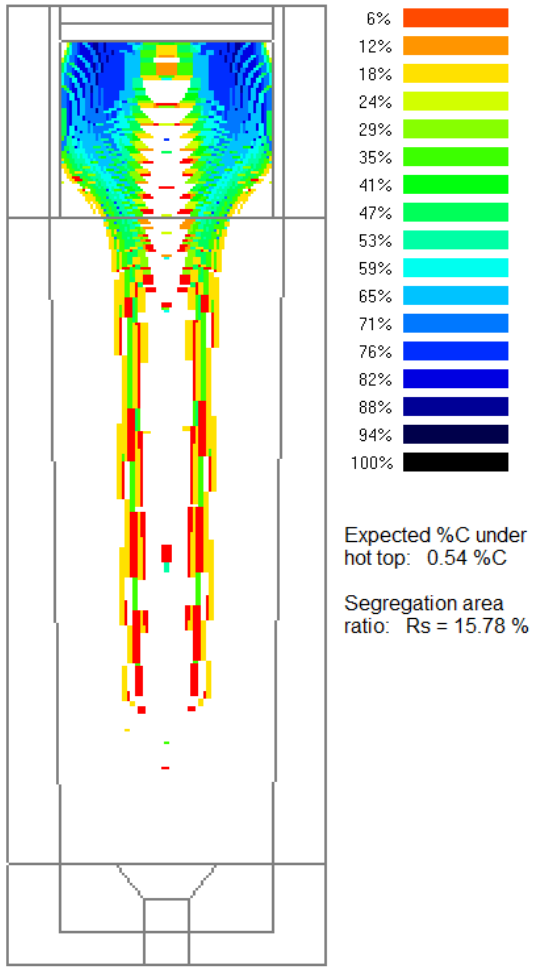
	C	Si	Mn	P	S	Cr	Mo
42CrMo4	0.41	0.30	0.70	0.01	0.01	0.80	0.20

Table 1. Chemical composition of analyzed steel

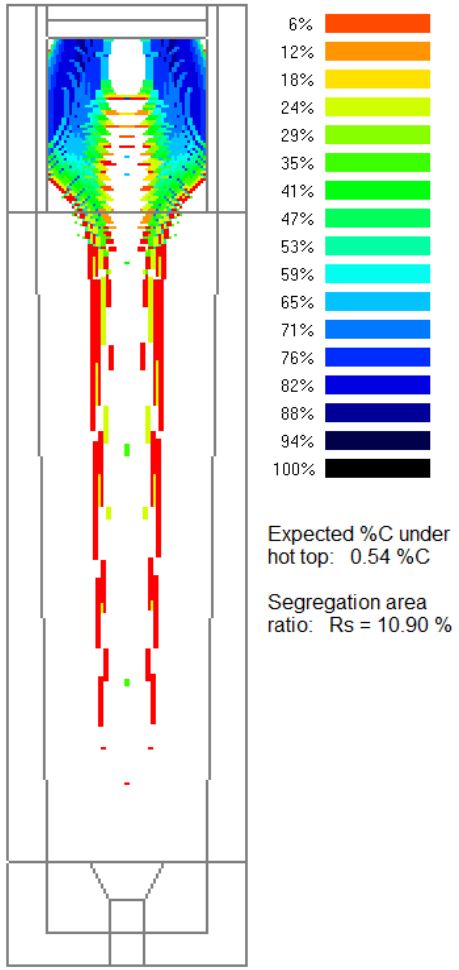
Ingot ID	Ingot Weight	Body Weight	Hot Top	Ingot H/D
a	20T	16T	20.0%	3.0
b	20T	16T	20.0%	4.0
c	20T	16T	20.0%	5.0

Table 2. Size of the ingots analyzed

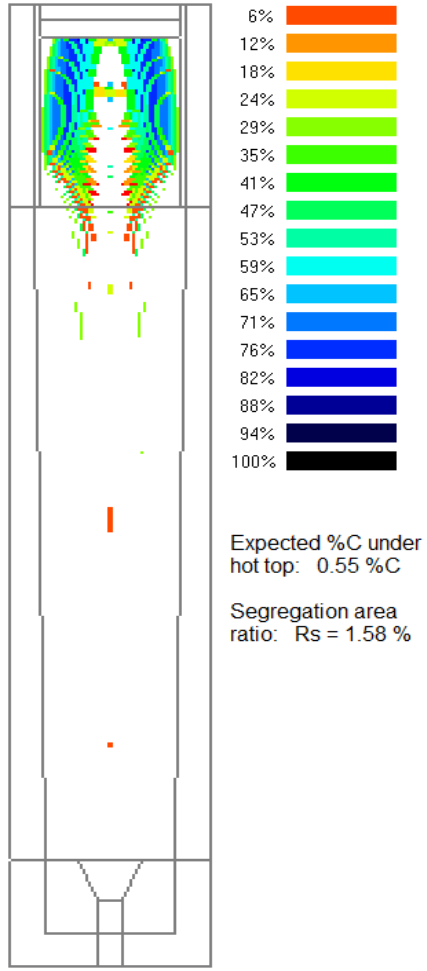
A Segregation function by H/D ingot ratio



H/D: 3.0

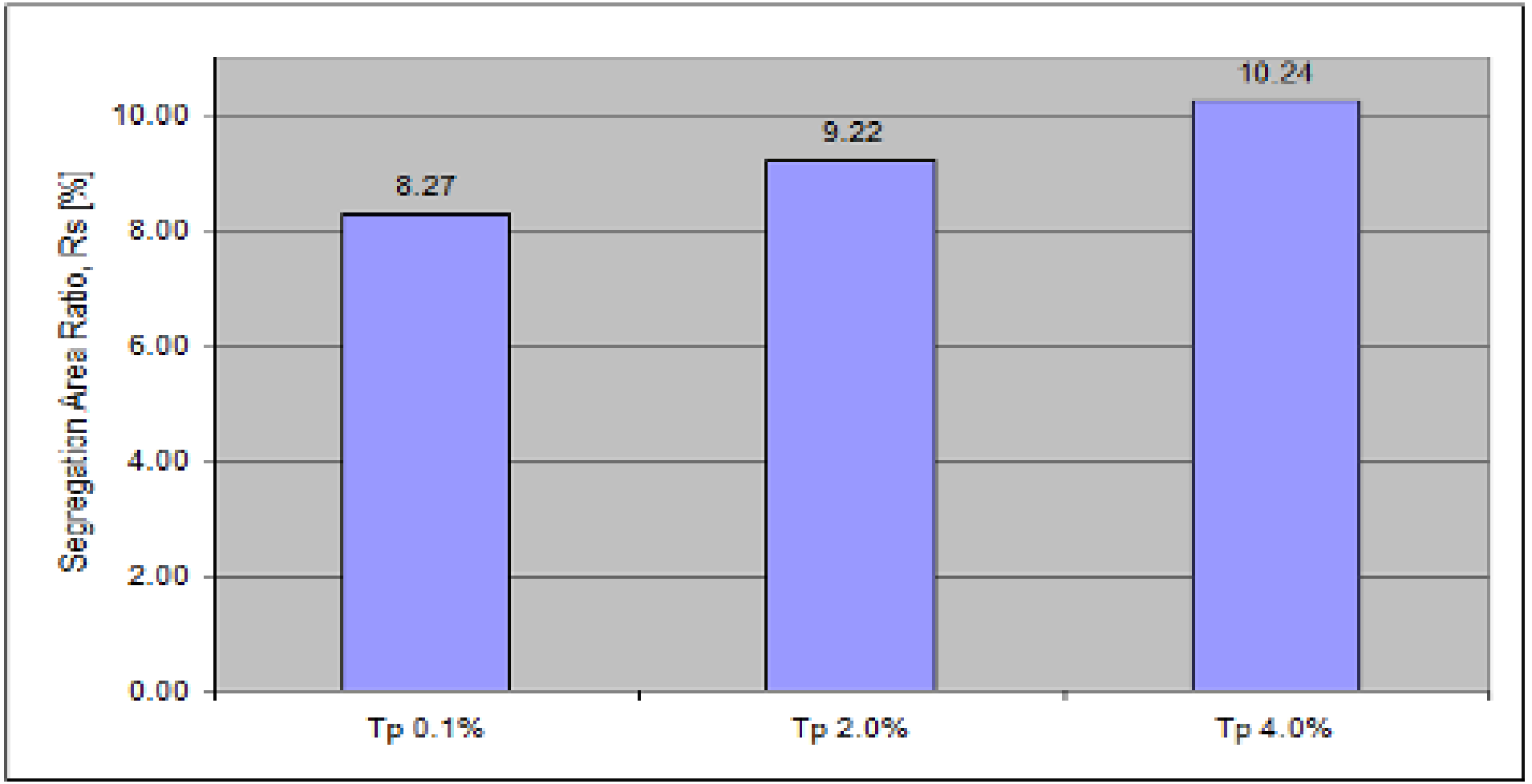


H/D: 4.0

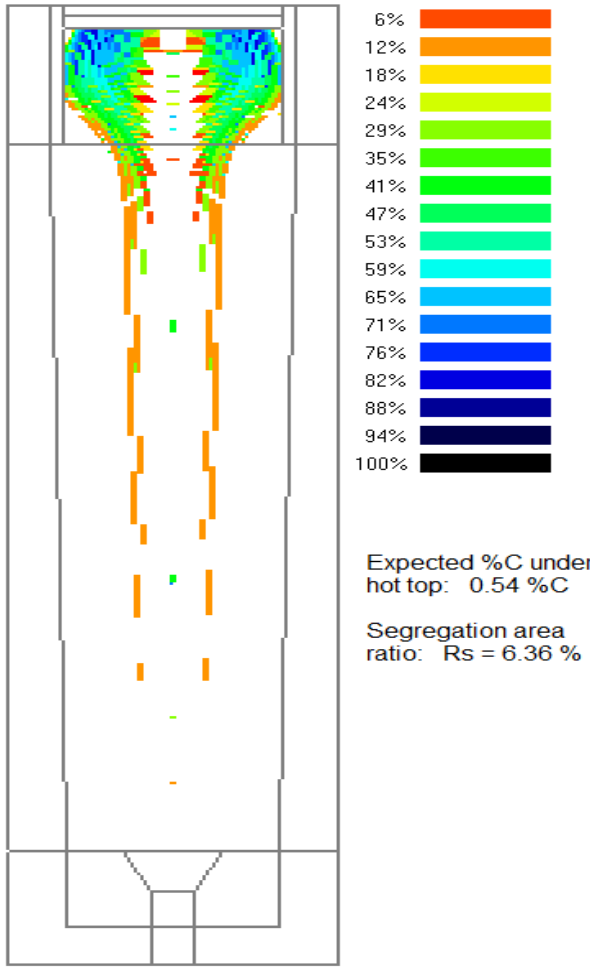


H/D: 5.0

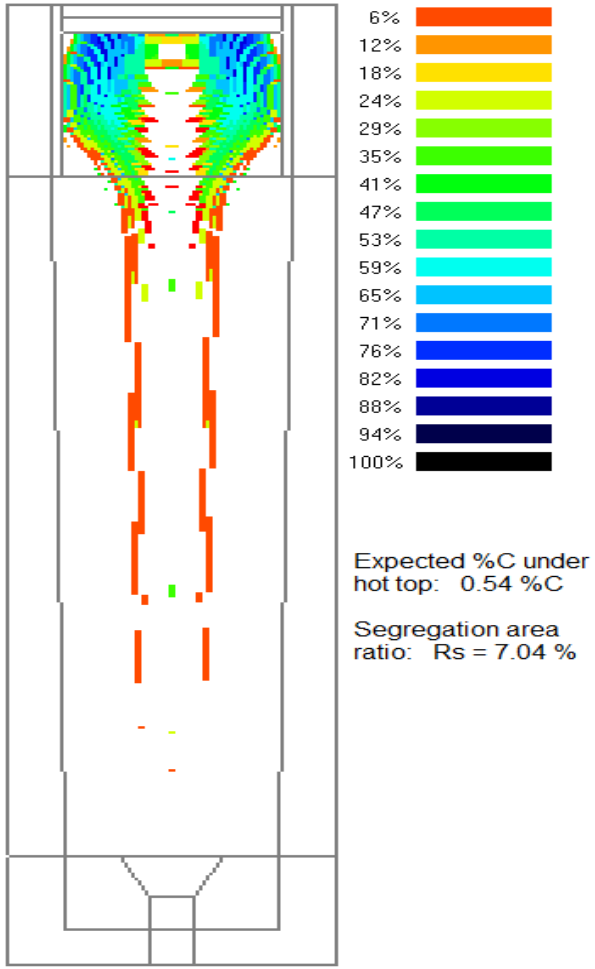
A Segregation function by Ingot Taper



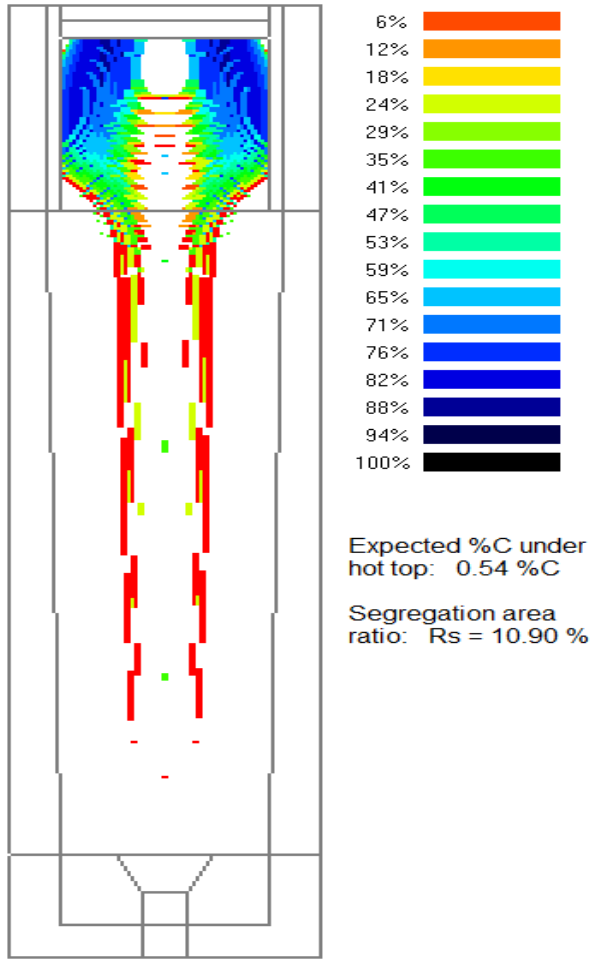
A Segregation function by Hot Top Size



Hot top 13.5%

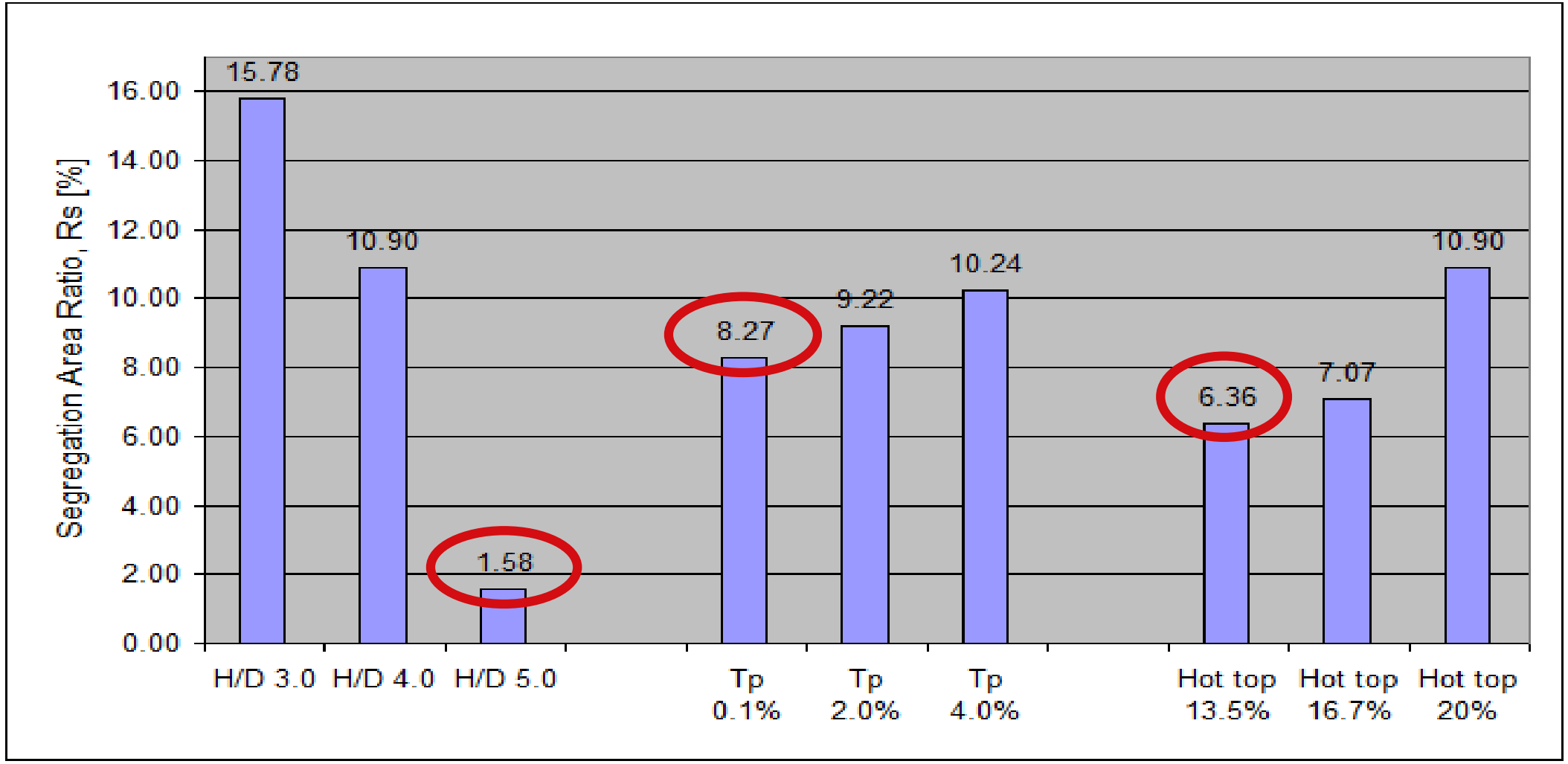


Hot top 16.7%

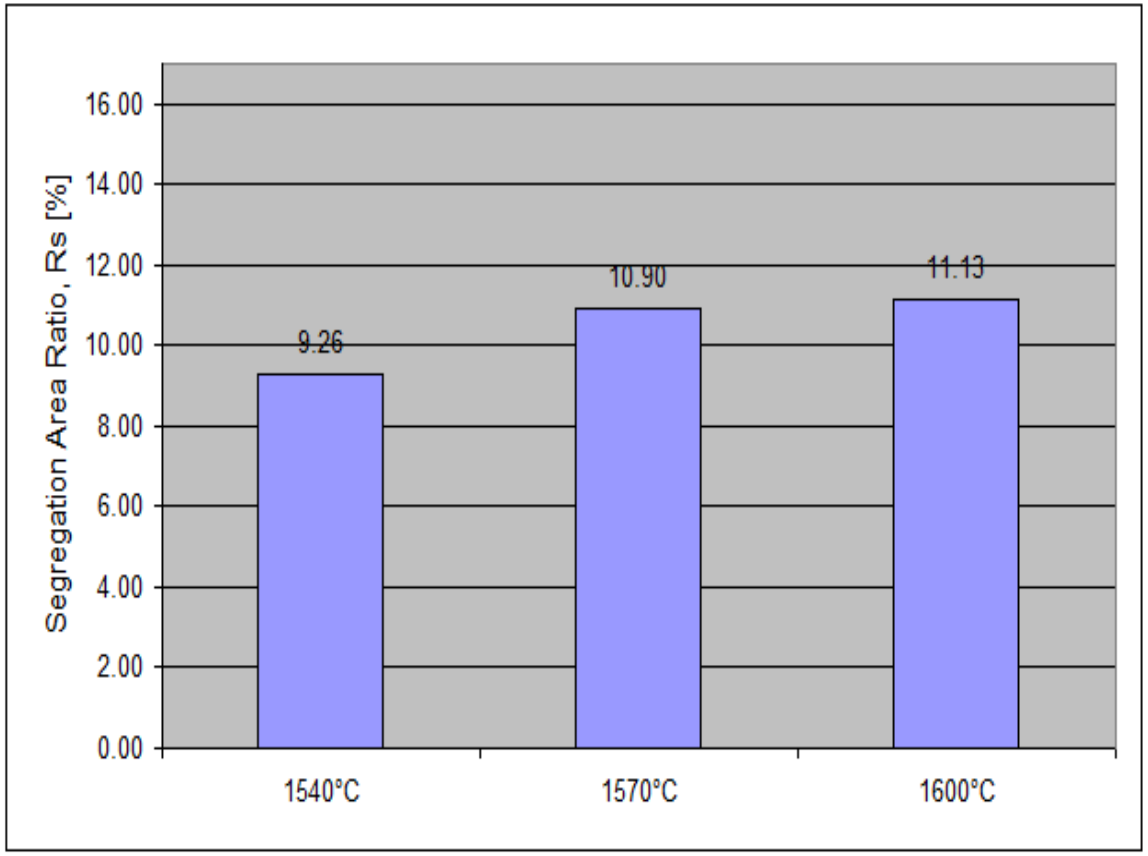


Hot top 20.0%

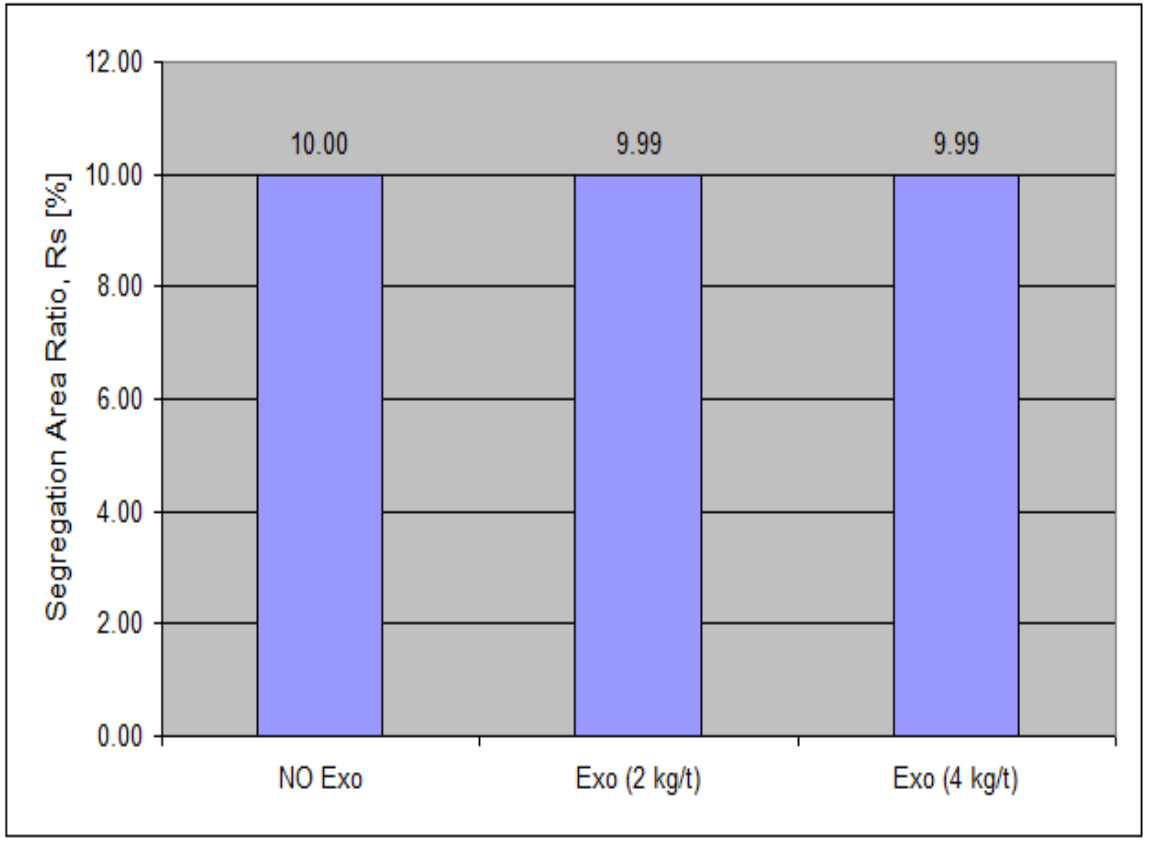
Choosing the ingot geometry to minimize A segregation



A Segregation function by Pouring Temperature and Exothermic Material



A Segregation area function by pouring temperature

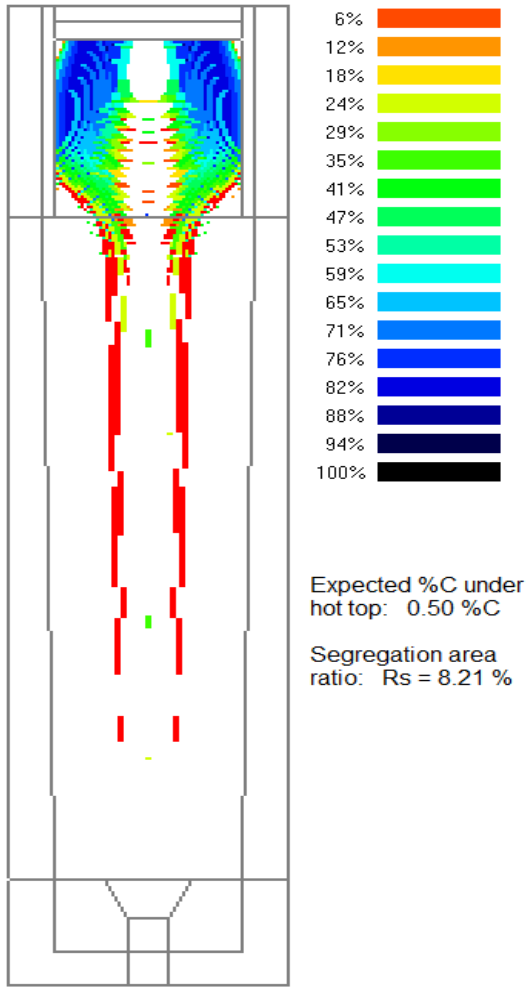


A Segregation area function by exothermic material

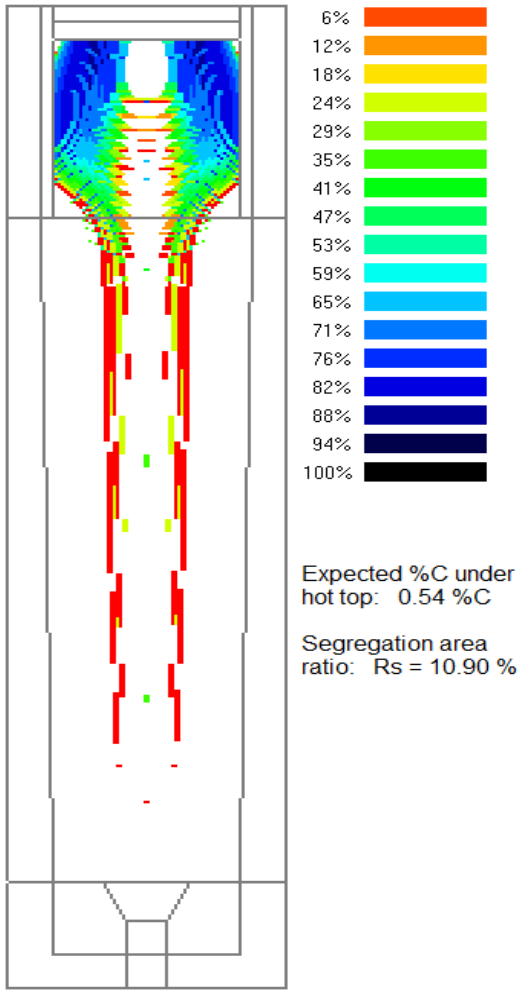
Optimization of chemical composition

	C	Si	Mn	Cr	Mo
Reference	0.41	0.30	0.70	1.05	0.20
Carbon	0.38	0.30	0.70	1.05	0.20
Carbon	0.45	0.30	0.70	1.05	0.20
Silicon	0.41	0.15	0.70	1.05	0.20
Silicon	0.41	0.40	0.70	1.05	0.20
Manganese	0.41	0.30	0.65	1.05	0.20
Manganese	0.41	0.30	0.90	1.05	0.20
Chromium	0.41	0.30	0.70	0.90	0.20
Chromium	0.41	0.30	0.70	1.20	0.20
Molybdenum	0.41	0.30	0.70	1.05	0.15
Molybdenum	0.41	0.30	0.70	1.05	0.30

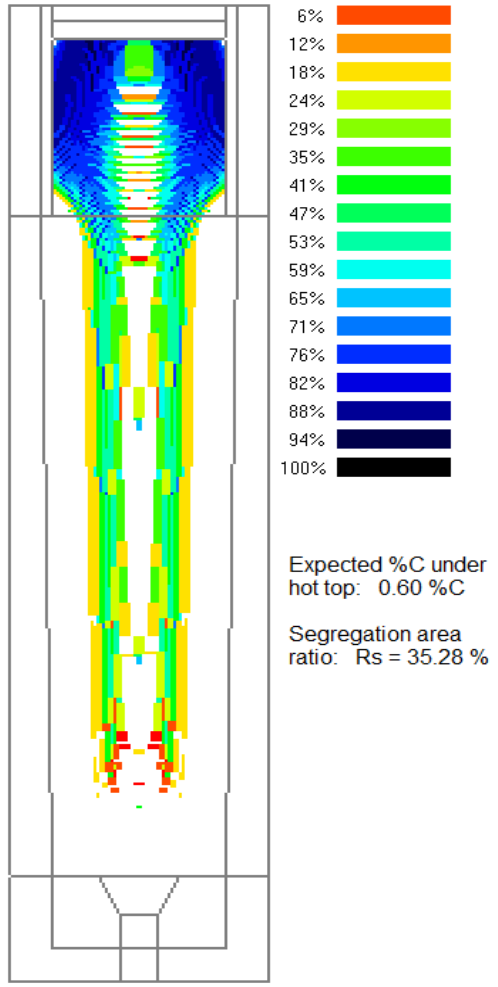
A Segregation function by Carbon content



Carbon: 0.38%

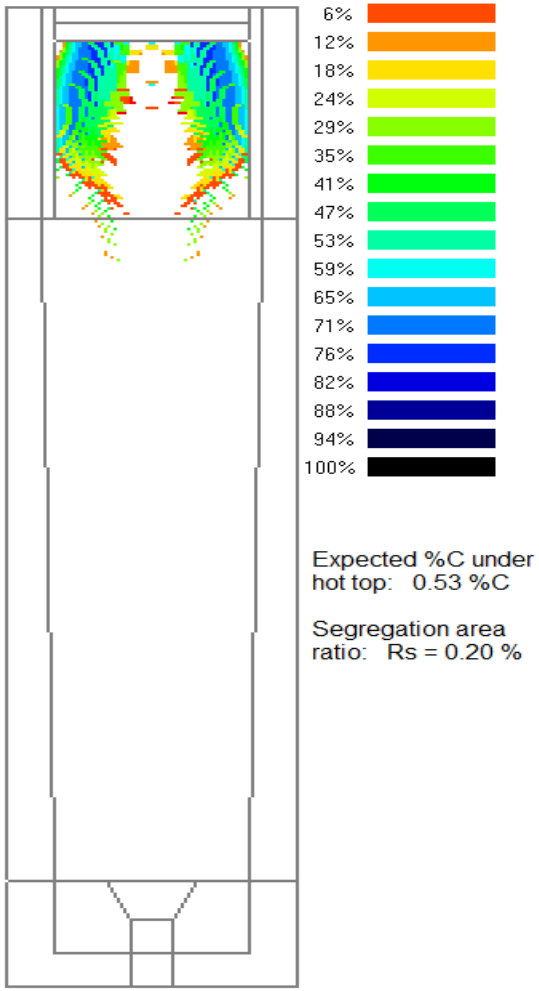


Carbon: 0.41%

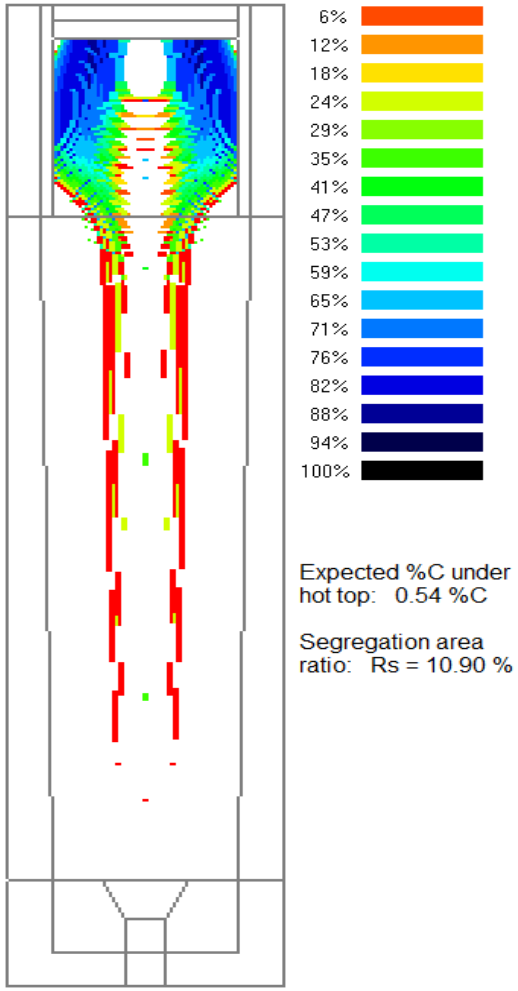


Carbon: 0.45%

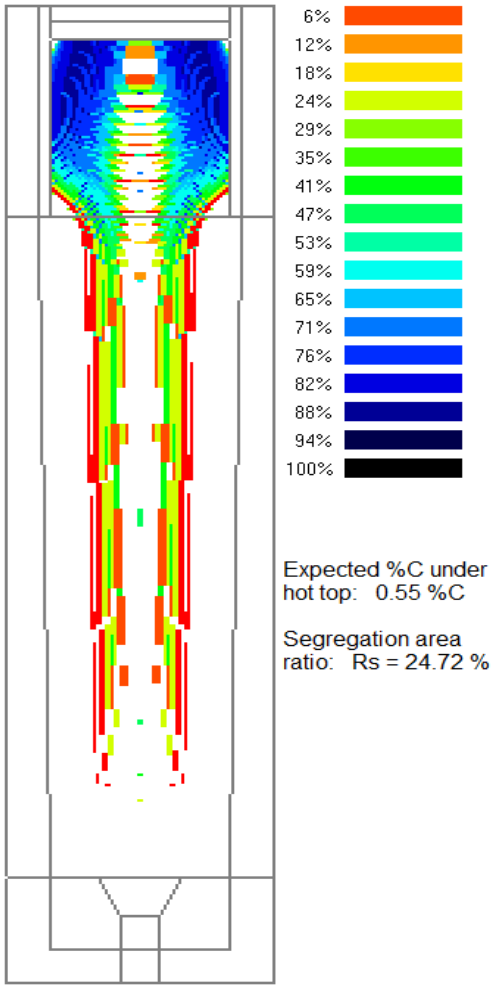
A Segregation function by Silicon content



Silicon: 0.15%

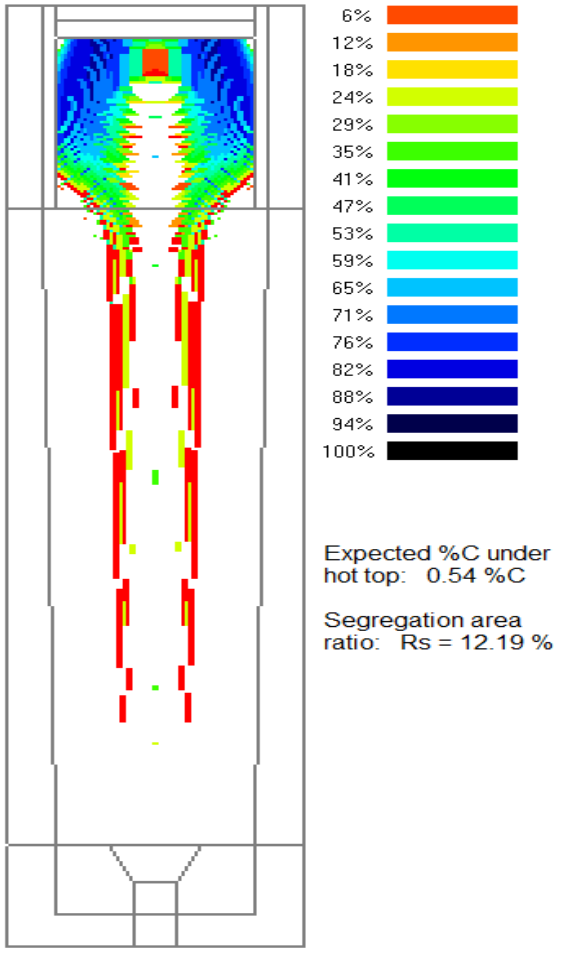


Silicon: 0.30%

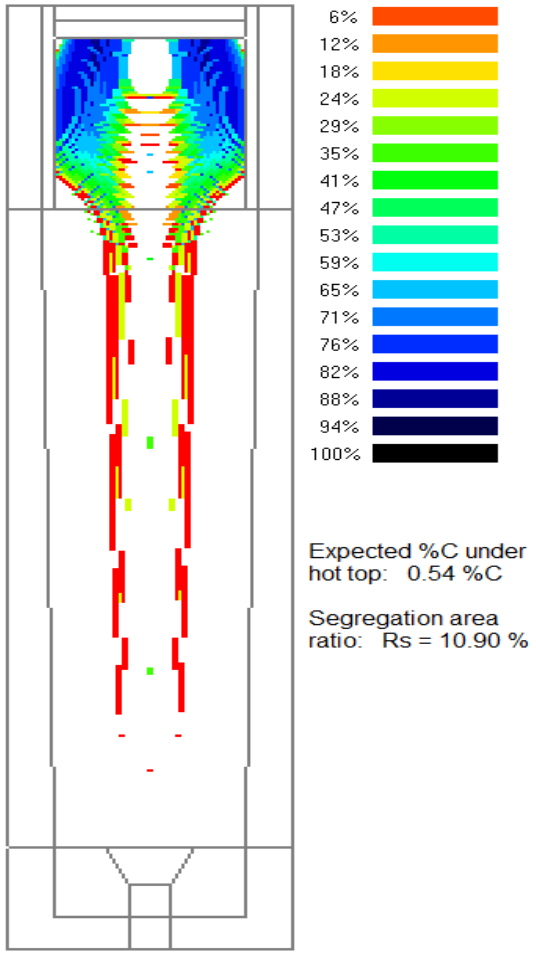


Silicon: 0.40%

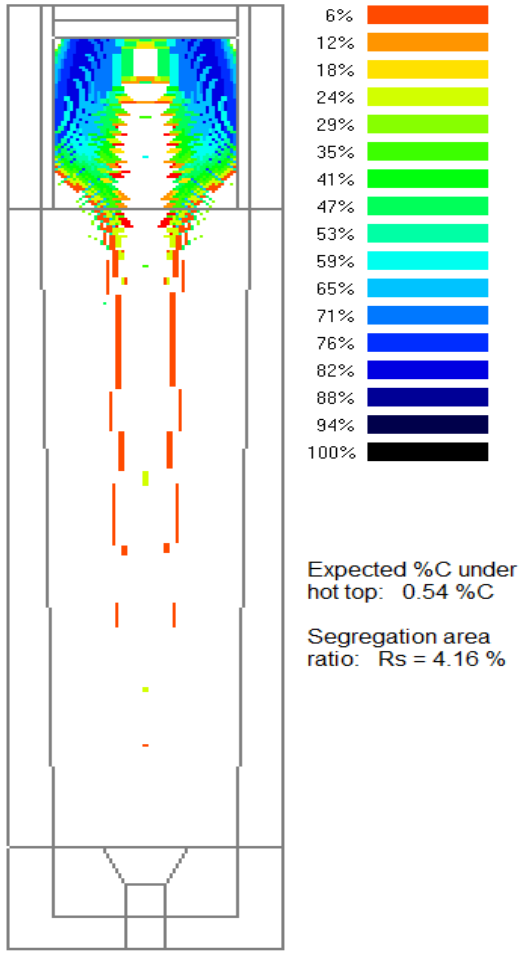
A Segregation function by Molybdenum content



Molybdenum: 0.15%

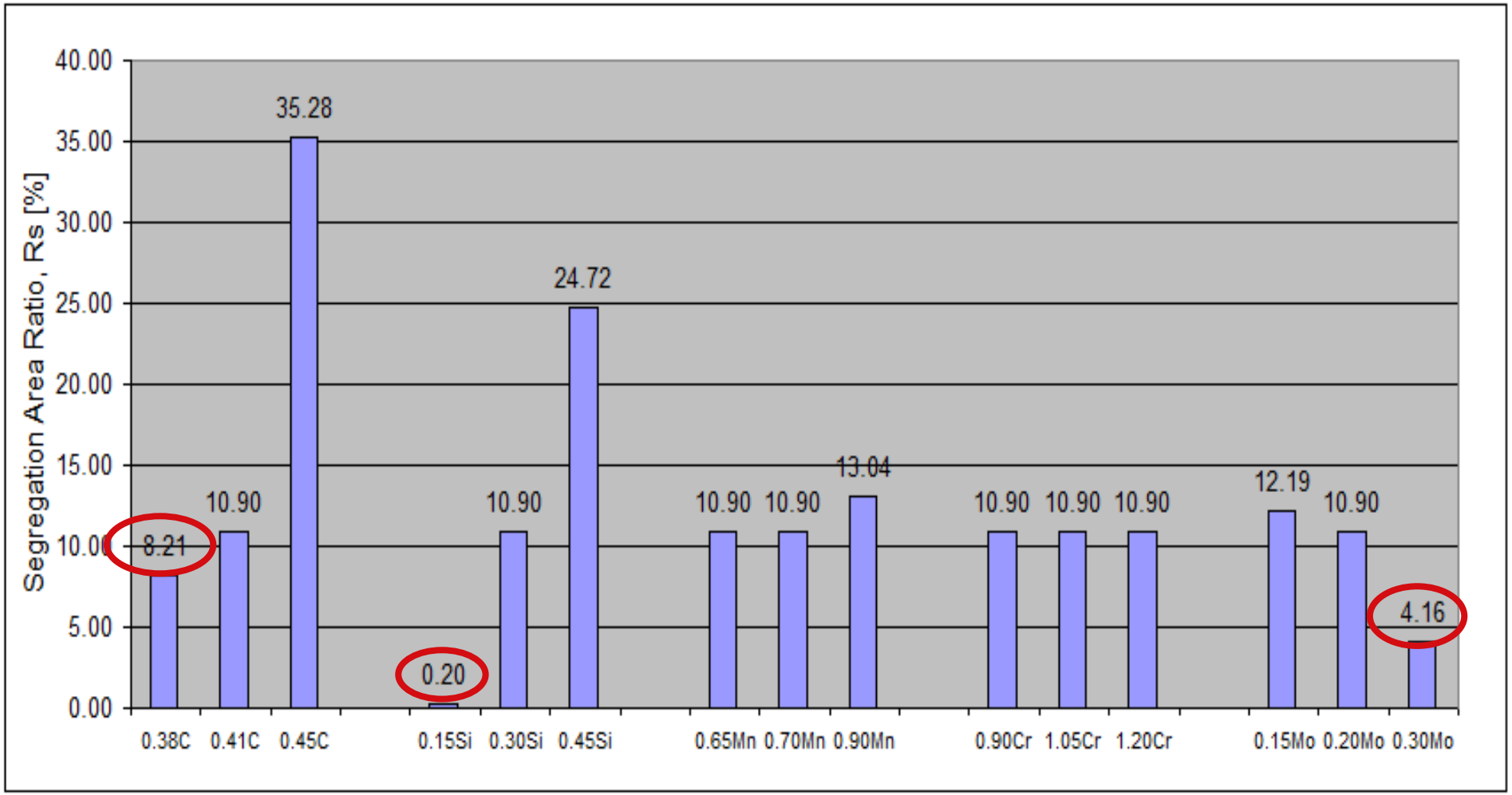


Molybdenum: 0.20%



Molybdenum: 0.30%

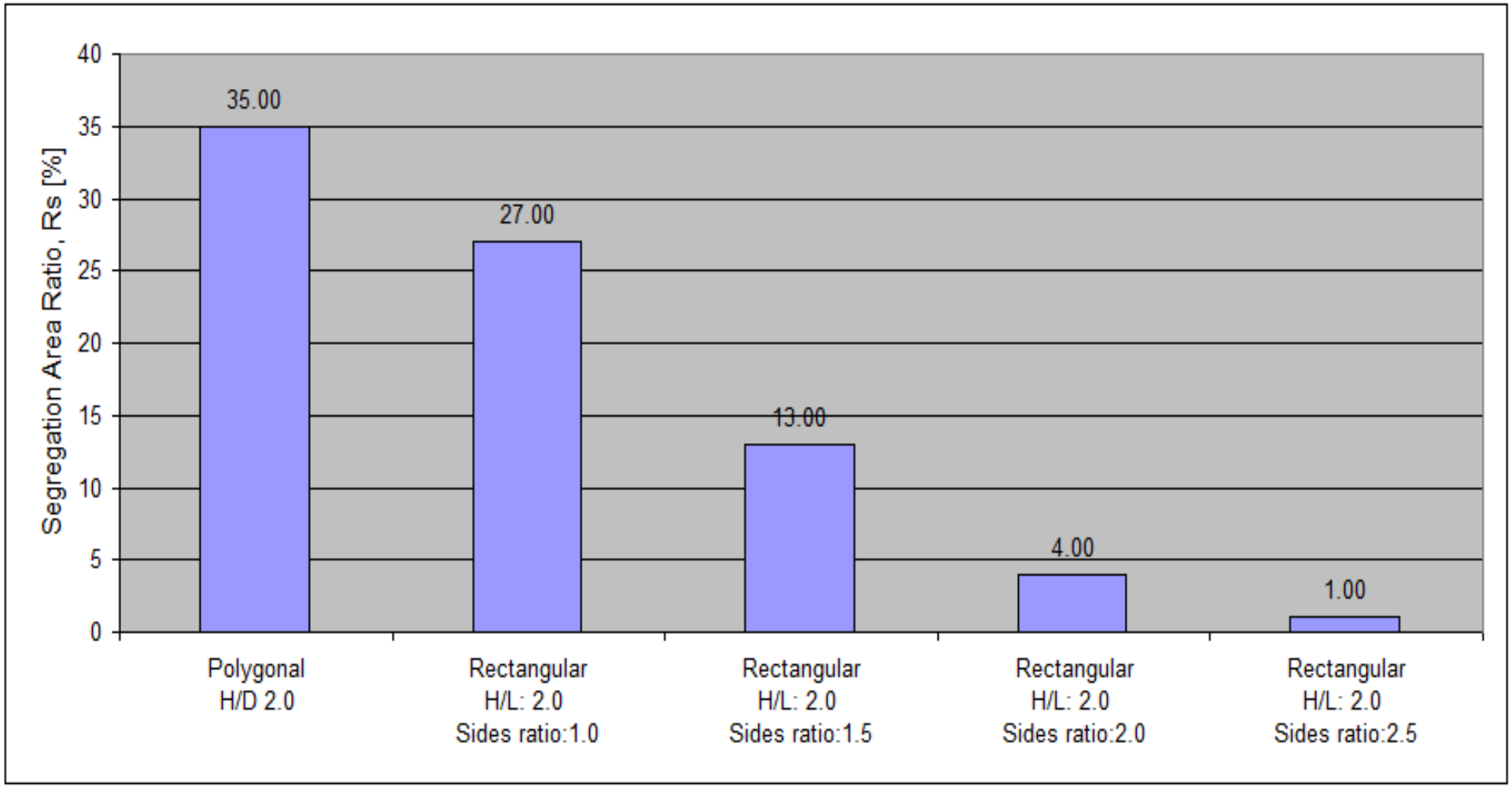
A Segregation function by Chemical Element



Ingots for Forged Plates

Ingots for Forged Plates

Ingots for Forged Plates



Conclusions

Having in view the results of experiments and solidification analysis, we can conclude the following:

- to minimize A segregation in a forged bar we need an ingot with a high H/D ratio, small hot top and a steel with low C and Si and high Mo content;
- to minimize A segregation in a forged plate we need a rectangular ingot with high sides ratio;
- pouring temperature, ingot taper and Mn content have low influence on A segregation;
- exothermic material and Cr content does not have influence on A segregation.

Mold Design and A Segregation Analysis are easy to use tools available online with a PC, MAC, tablet or smart phone to design molds, analyze segregation and choose the mold function by steel grade and forged shape.

Contact

OVIDIU BOGDAN, Industrial Soft, Canada
Phone: 1-514-3425833
http://demo.simcade.com
bogdan@castingsnet.com