

A Segregation in Modified P20 Steel Ingots

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Online Ingot Mold Design & Solidification and Segregation Analysis

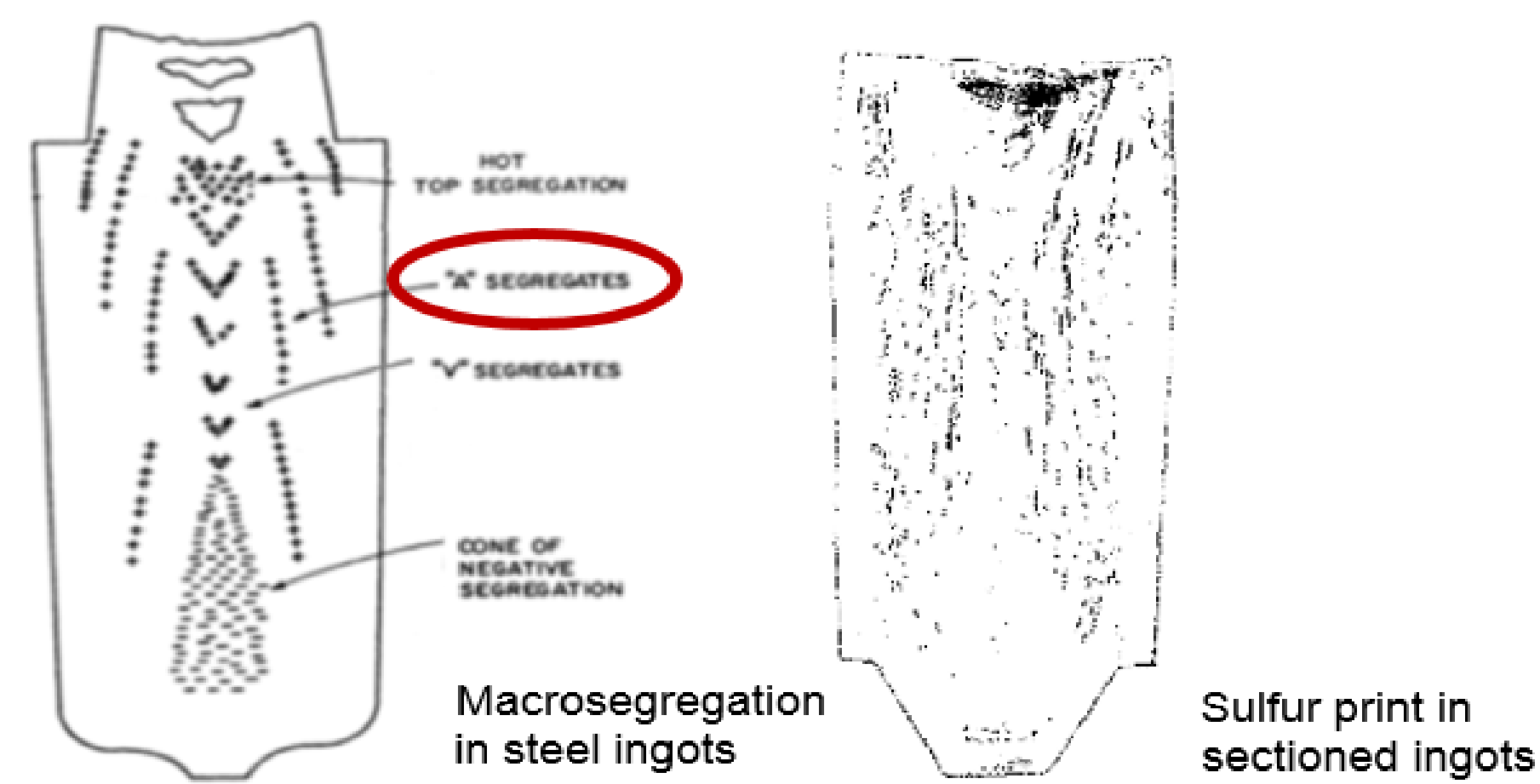
ABSTRACT

Macrosegregation in forging ingots has adverse effects on the quality of final product and is one of the reasons why the ingot manufacturer has to choose the right steel to get a cost effective product, save time, energy and improve the durability of the forged part.

The goal of this work was to assess the segregation level in several modified P20 steels having in view just the chemical composition of these steels.

INTRODUCTION

The internal defects that can affect the quality of steel ingots, as shown in the figures 1 and 2, include primary and secondary pipe, positive segregation, negative segregation, V-segregation and A-segregation. From all these types of defects, in our analysis, we are focused on A-segregation.

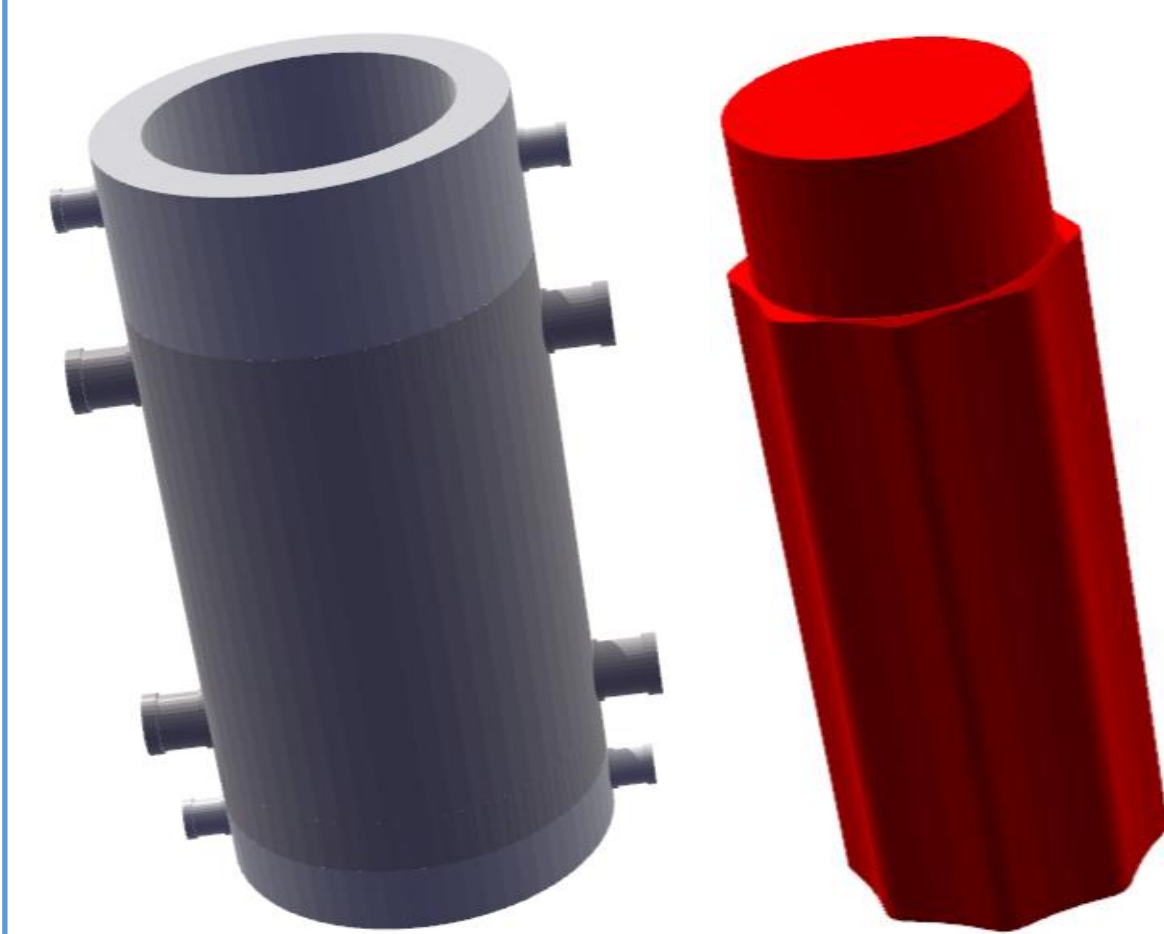


ANALYSIS TOOLS

Both, the online tools Ingot Mold Design and Solidification and Segregation Analysis available at simcade.com have been used to evaluate the segregation area size and its intensity in following modified P20 steels: AISI P20, P20 MODIFIED, P20 MOLD QUALITY, P20 PREMIUM, DIN 1.2311, DIN 1.2312, JIS PX5, HIGH HARD P20 and #3 STEEL.

To assess comparatively the analyzed steels we have defined two quantitative parameters: the A-segregation ratio Rs (ratio between longitudinal section area affected by segregation and longitudinal area of ingot body) and segregation intensity Is (difference between minimum value of cooling and solidification rate and the A-segregation critical value).

INGOT SIZE and STEEL GRADE

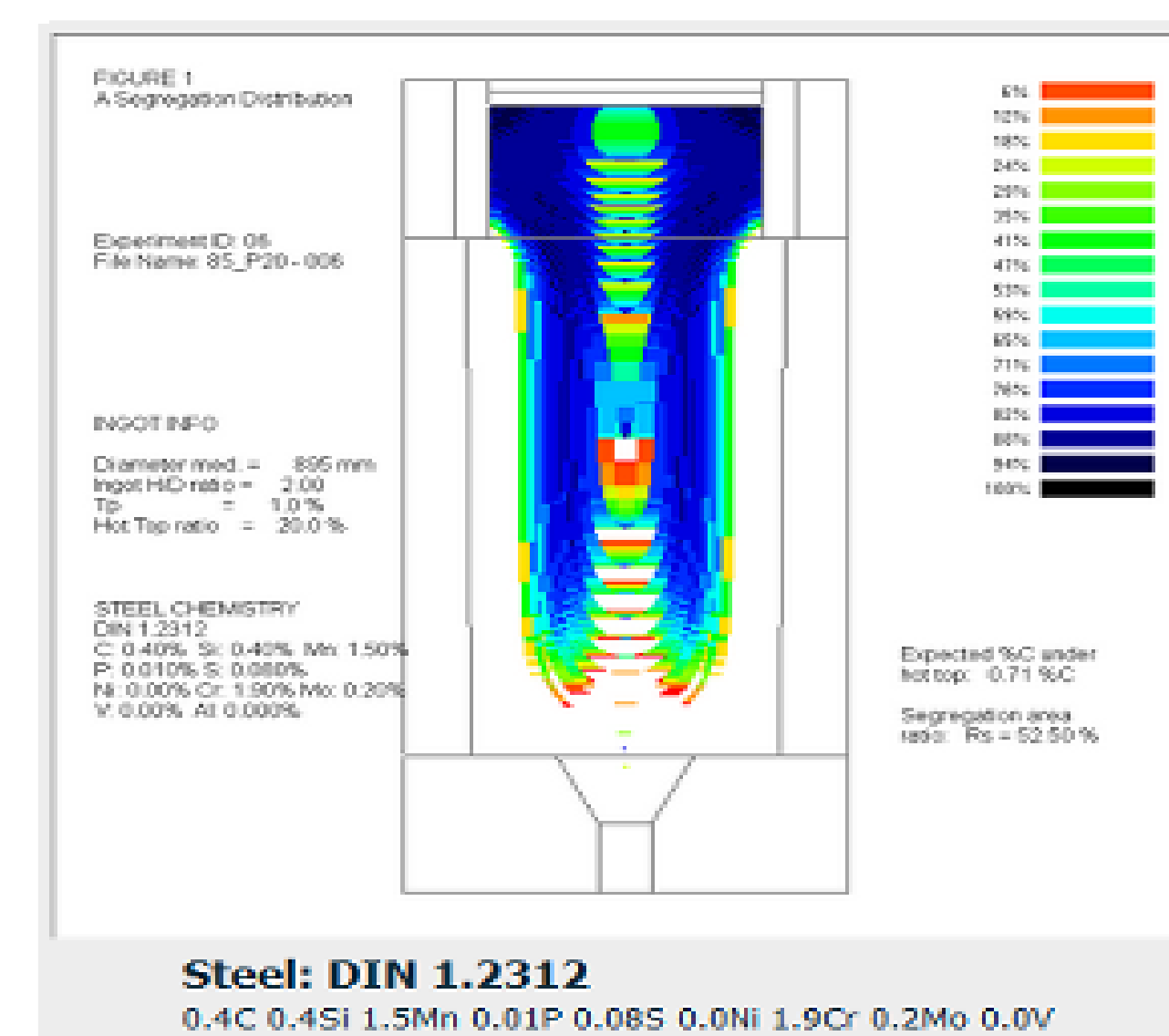


Ingot weight: 10 T
H/D ratio: 2.0

GRADE	C	Si	Mn	S	Cr	Mo	Ni	V
AISI P20	0.350	0.450	0.850	0.035	1.800	0.500		
P20 MODIFIED	0.400	0.300	1.400	0.003	2.000	0.200		
P20 MOLD QUALITY	0.310	0.400	0.750	0.008	1.200	0.410		
P20 PREMIUM	0.400	0.300	1.400	0.003	2.000	0.200	1.000	
DIN 1.2311	0.400	0.300	1.450	0.035	1.950	0.200		
DIN 1.2312	0.400	0.400	1.500	0.080	1.900	0.200		
JIS PX5	0.200	0.200	1.250	0.050	2.000	0.400		0.100
HIGH HARD P20	0.400	0.300	1.500	0.010	2.000	0.200	1.000	
#3 STEEL	0.300	0.250	0.500	0.000	0.950	0.200		

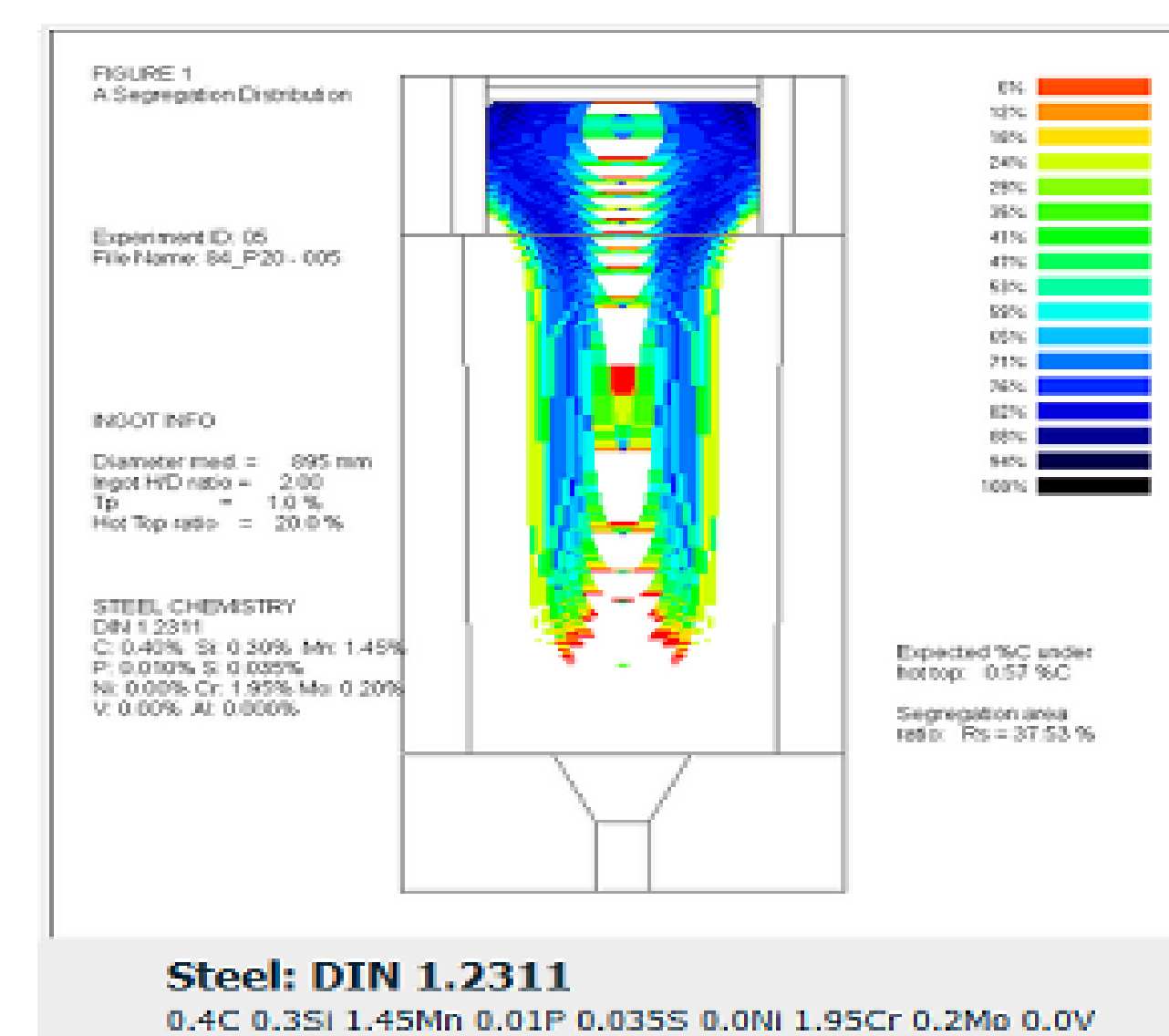
Analyzed steels

RESULTS



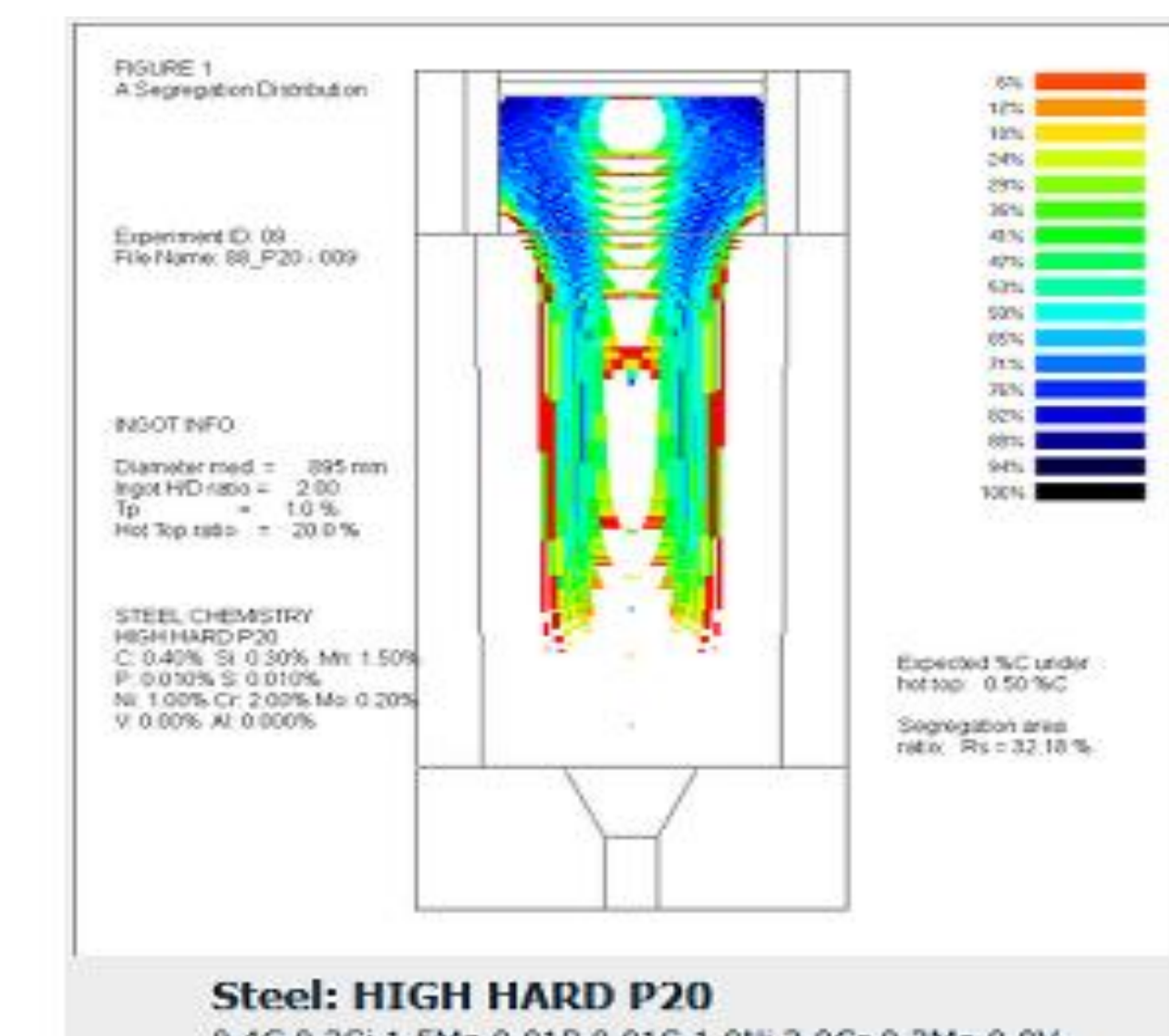
Rs: 53.0 %
Is: 82.0 %

DIN 12312 - Heavy segregation



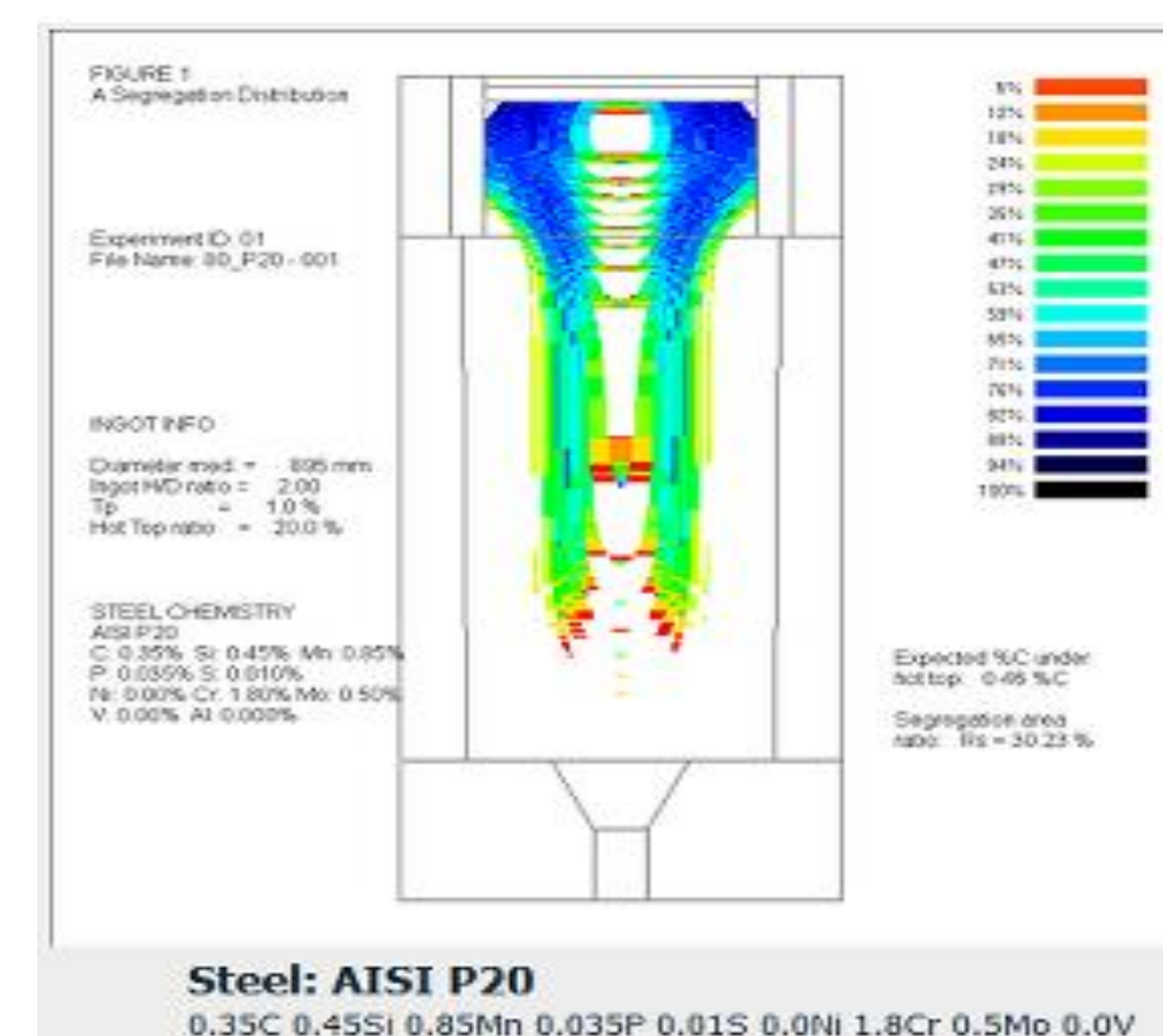
Rs: 38.0 %
Is: 65.0 %

DIN 12311 - Medium segregation



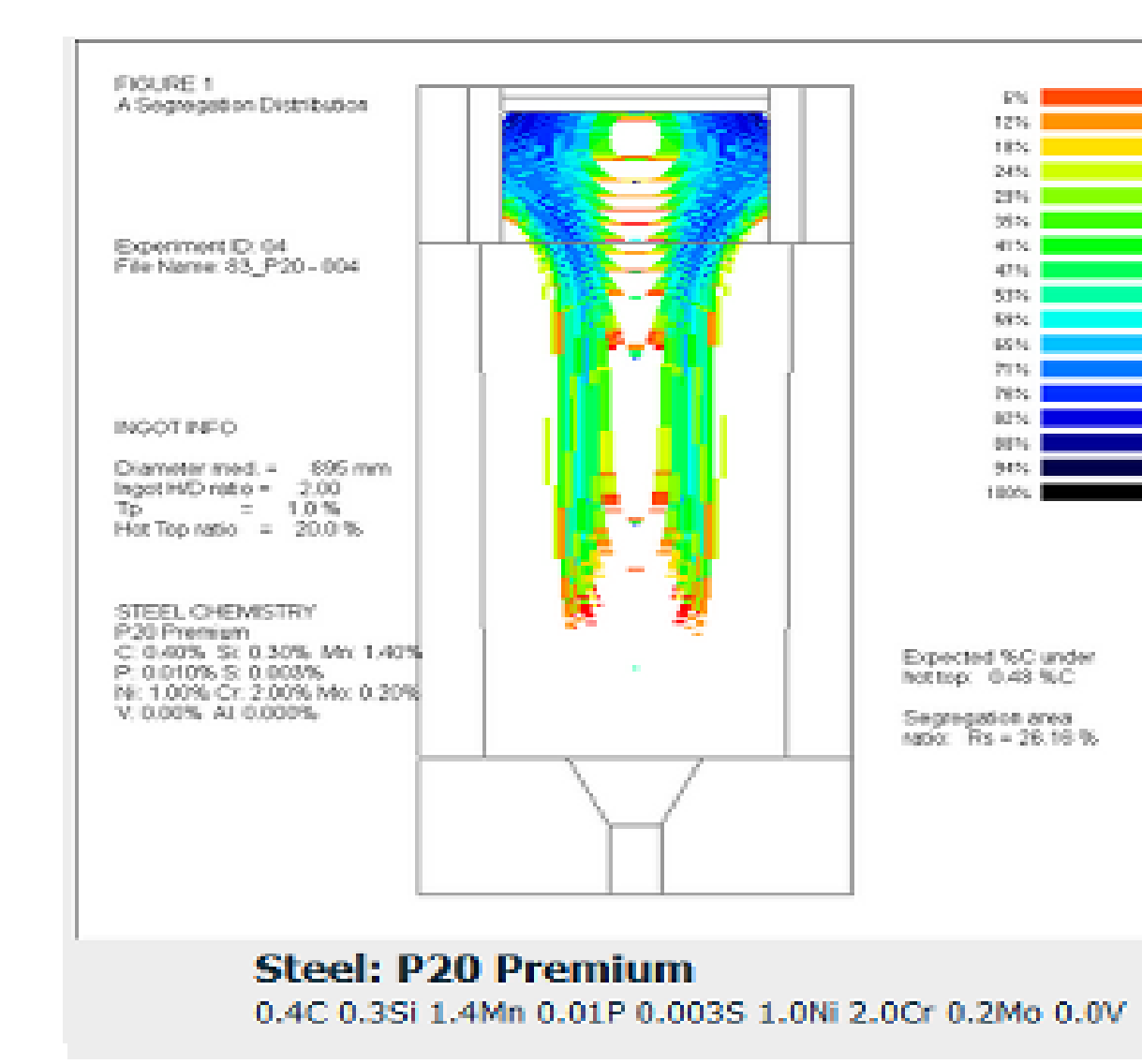
Rs: 32.0 %
Is: 50.0 %

HIGH HARD P20 - Medium segregation



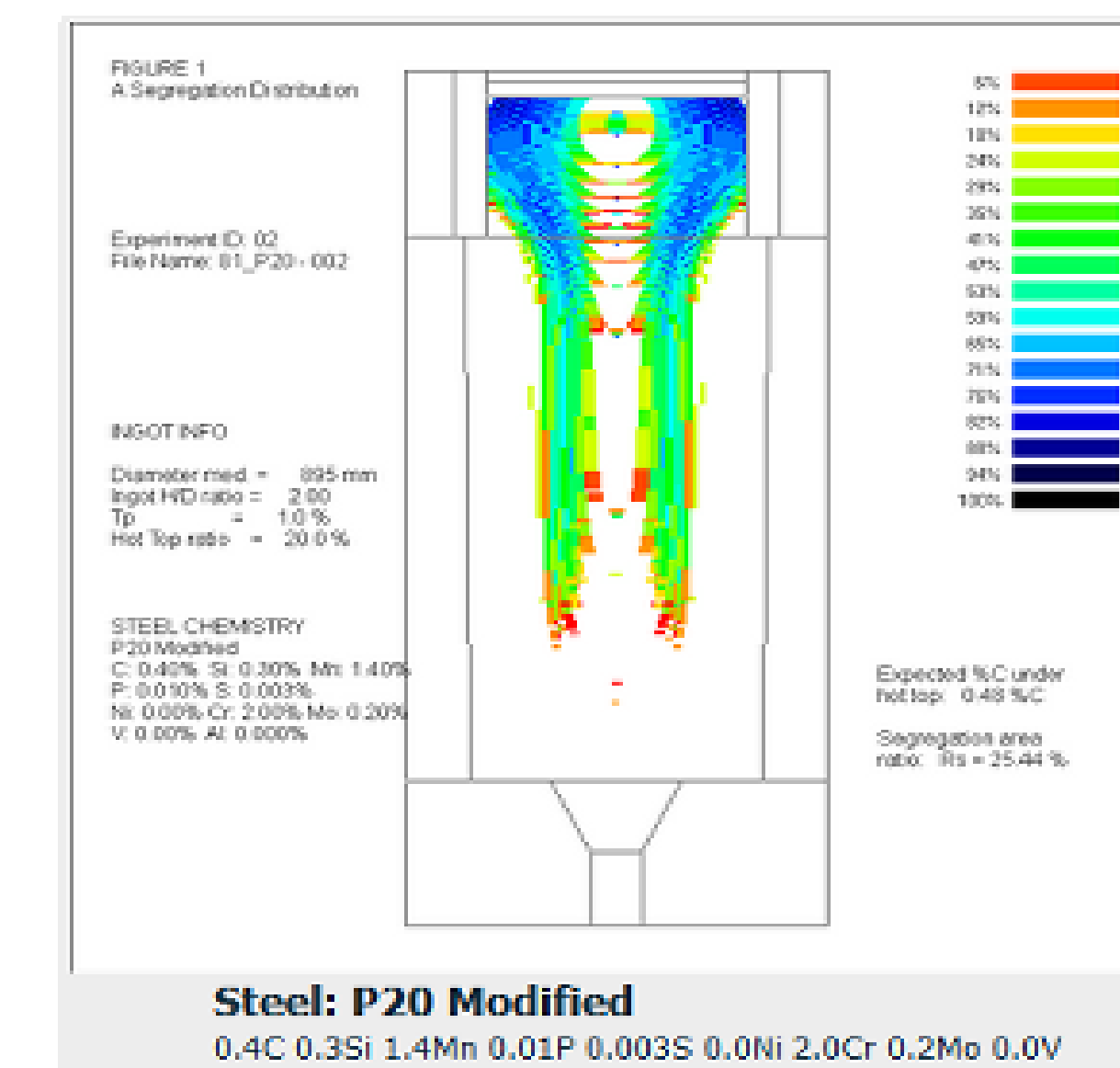
Rs: 30.0 %
Is: 50.0 %

AISI P20 - Moderate segregation



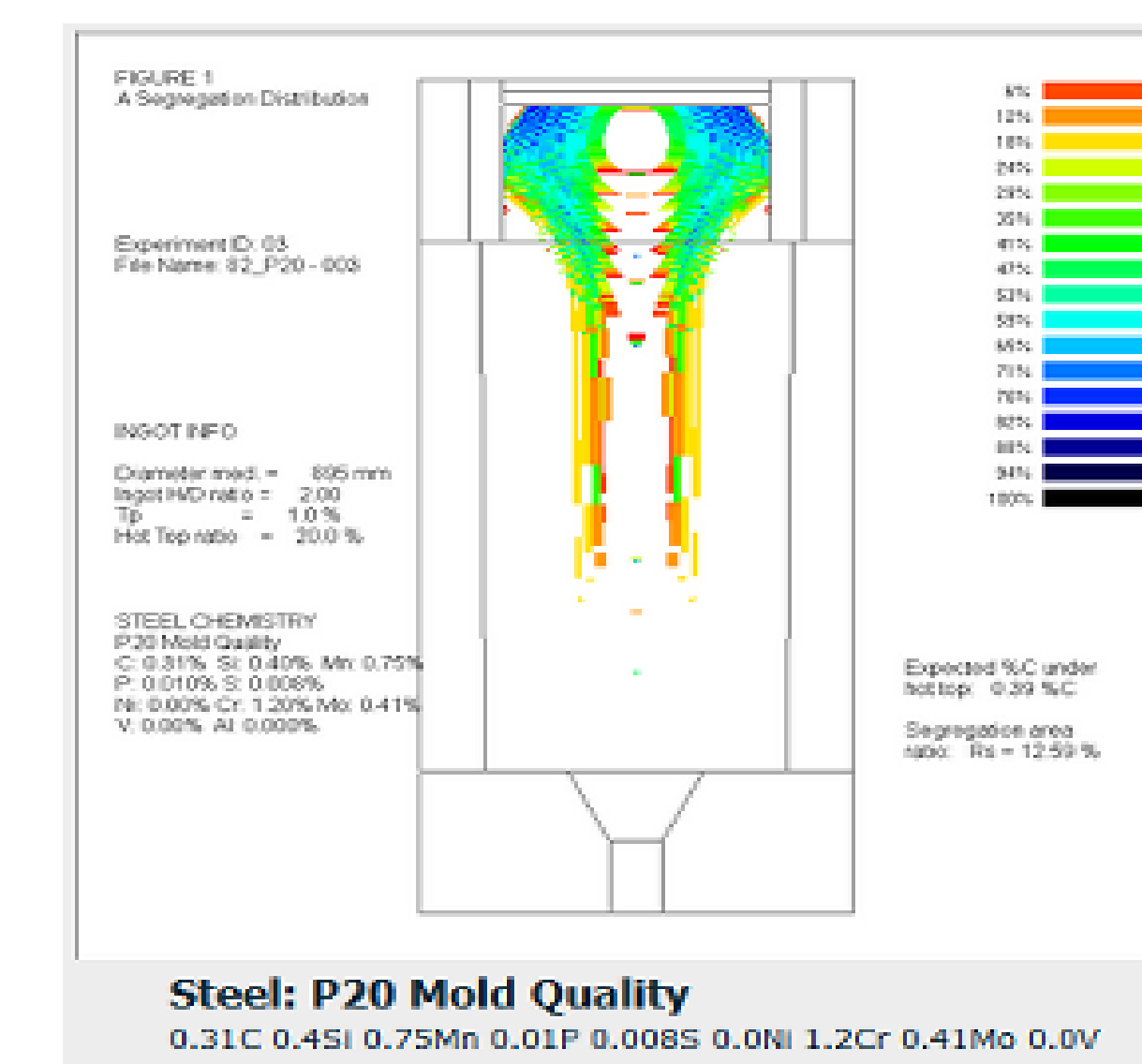
Rs: 26.0 %
Is: 50.0 %

P20 Premium - Moderate segregation



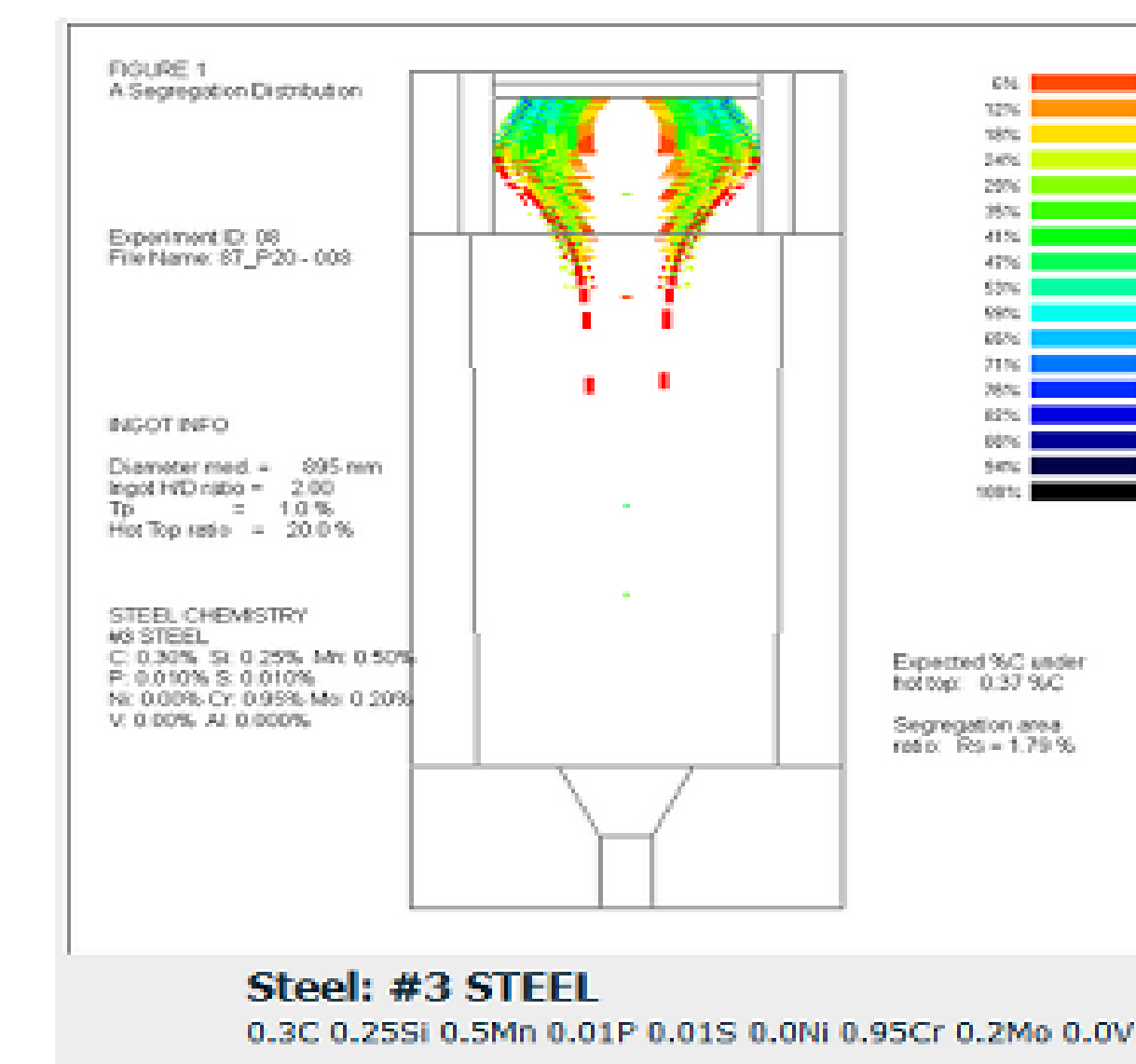
Rs: 25.0 %
Is: 50.0 %

P20 Modified - Moderate segregation



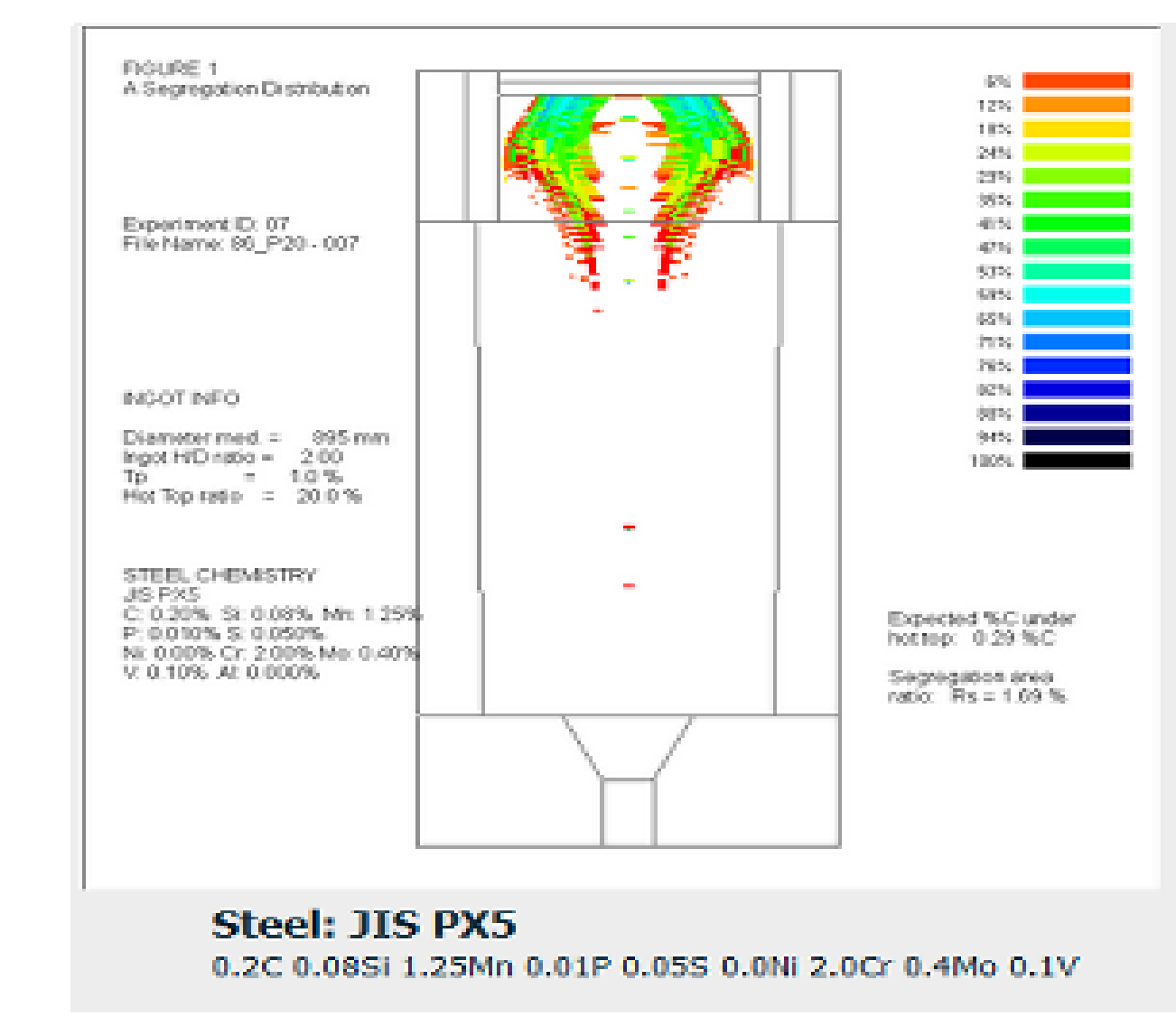
Rs: 13.0 %
Is: 18.0 %

P20 Mold Quality - Low segregation



Rs: 1.8 %
Is: 6.0 %

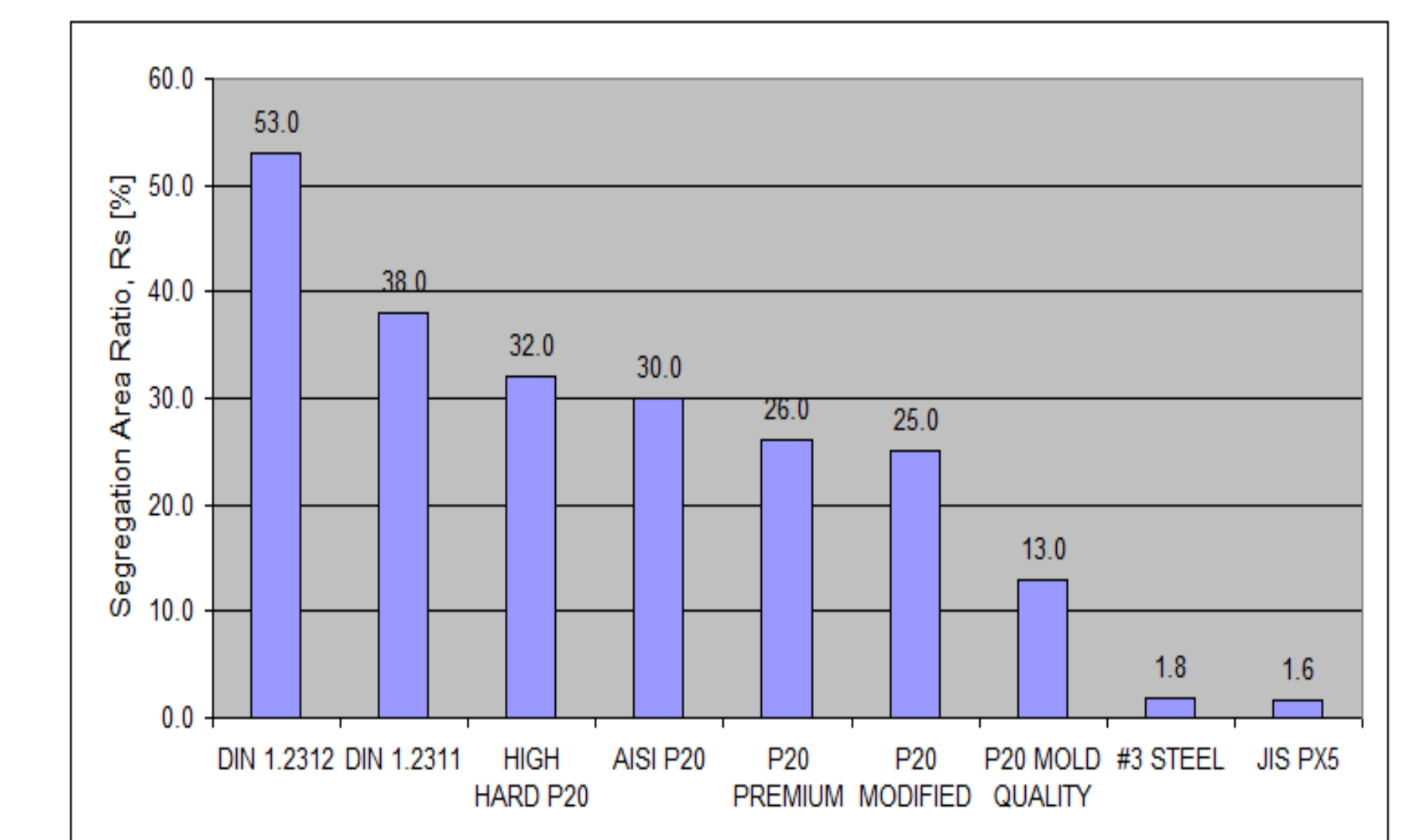
#3 Steel - NO segregation



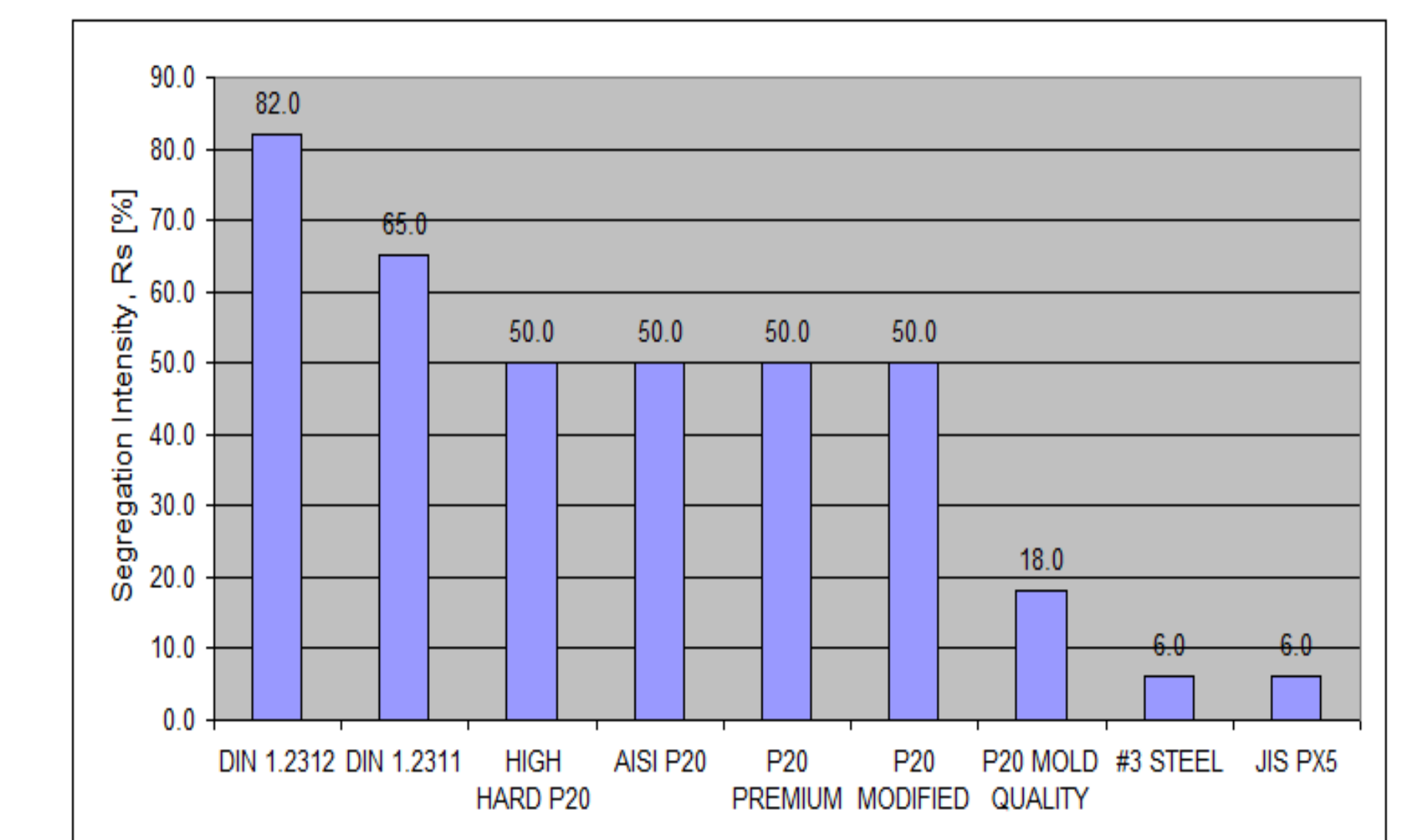
Rs: 1.6 %
Is: 6.0 %

JIS PX5 - NO segregation

CONCLUSION



Segregation Area Ratio function by steel type



Segregation Intensity function by steel type

REFERENCES

1. Optimization of ingot geometry, casting technology and chemical composition of a 20 tones 42CrMo4 ingot to minimize A-segregation and increase material homogeneity, ICRF2018 Conference, Stockholm, Sweden, October, 2018
2. What You Should Consider When Purchasing P20 Steel, Moldmaking Technology Magazine, November 2004
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3. Mold steel - P20 or not P20?, Canadian Metalworking Magazine, 2013
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