Segregation Effects in Continuous Casting

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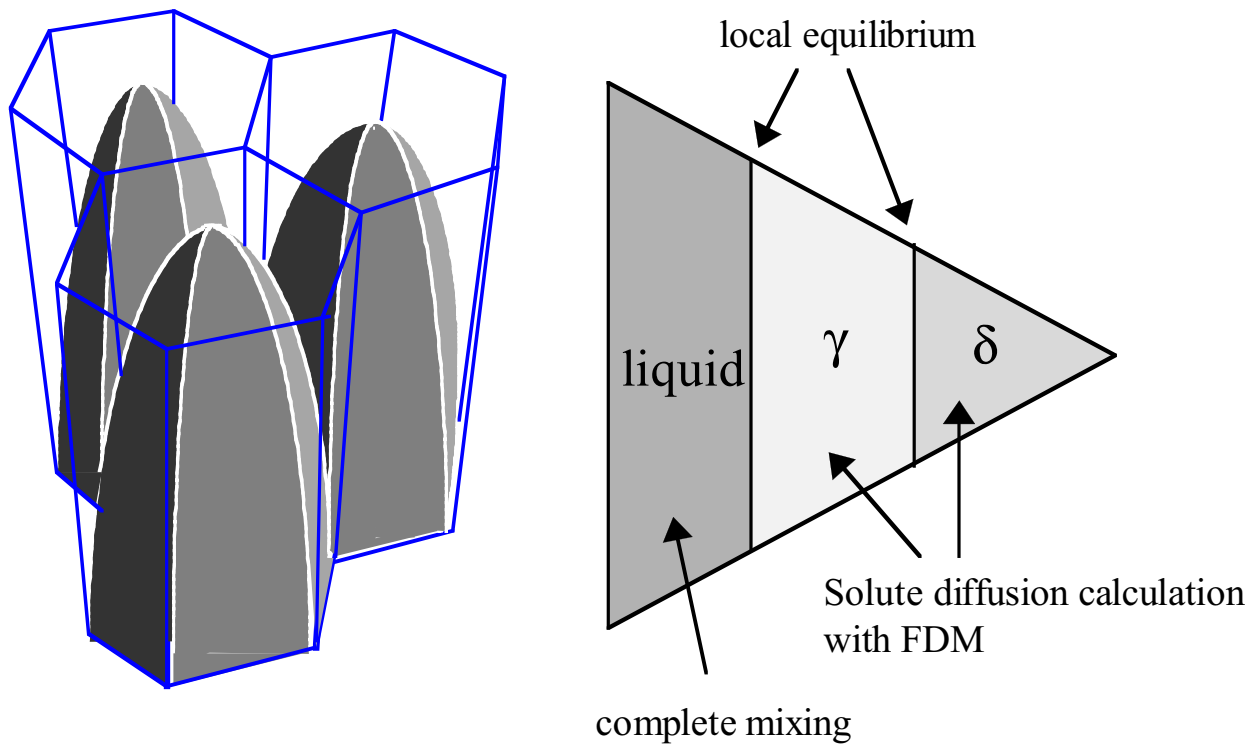
Calculation Domain of Microsegregation



- **Moving speed of L/S and δ/γ interface**

$$T_L = 1536 - 78(\%C) - 7.6(\%Si) - 4.9(\%Mn) - 34.4(\%P) - 38(\%S)$$

$$T_{Ar4} = 1392 + 1122(\%C) - 60(\%Si) + 12(\%Mn) - 140(\%P) - 160(\%S)$$

Equilibrium Distribution and Diffusion Coefficient of Solute Elements

Element	$k^{\delta/L}$	$k^{\gamma/L}$	$k^{\delta/\gamma}$	D^{δ} (10^{-4} m^2/s)	D^{γ} (10^{-4} m^2/s)
C	0.19	0.34	1.79	0.0127exp(-81379/RT)	0.0761exp(-143511/RT)
Si	0.77	0.52	0.68	8.0exp(-248948/RT)	0.3exp(-251458/RT)
Mn	0.76	0.78	1.03	0.76exp(-224430/RT)	0.055exp(-249366/RT)
P	0.23	0.13	0.57	2.9exp(-230120/RT)	0.01exp(-182841/RT)
S	0.05	0.035	0.70	4.56exp(-214639/RT)	2.4exp(-223425/RT)

- Relationship between primary dendrite arm spacing and cooling rate by the best fitting of the measured dendrite arm spacings

$$\lambda = 319.427 \cdot \dot{T}^{-0.377723}$$

Assumption for Microsegregation Model

1. The transverse cross section of dendrites is approximated by a regular hexagon.

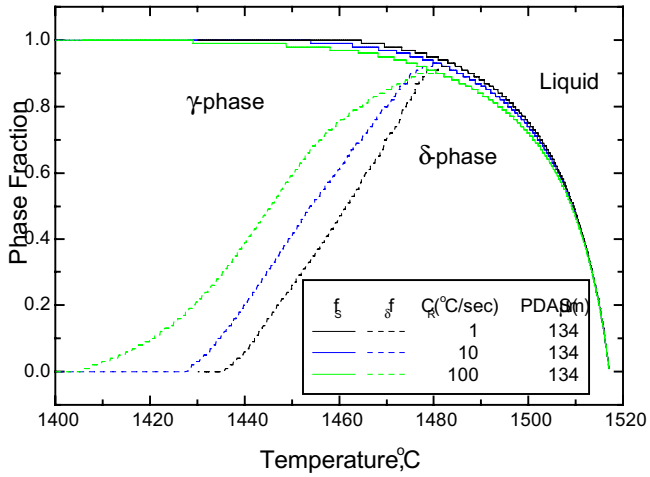
2. The complete mixing of solute elements in liquid phase.

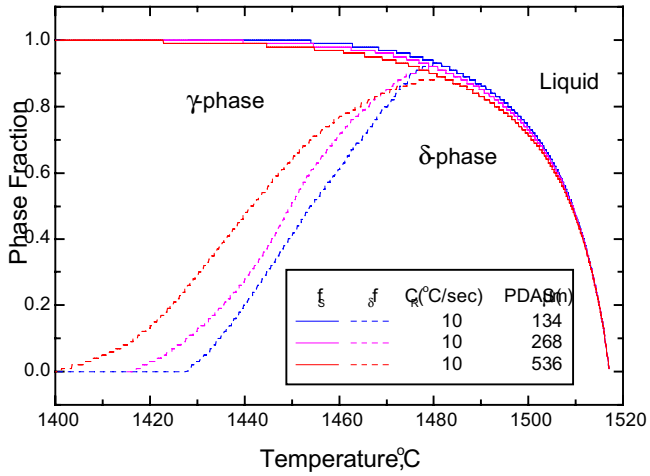
3. The diffusion of solute in solid and liquid phases in the axial direction of dendrite is neglected.

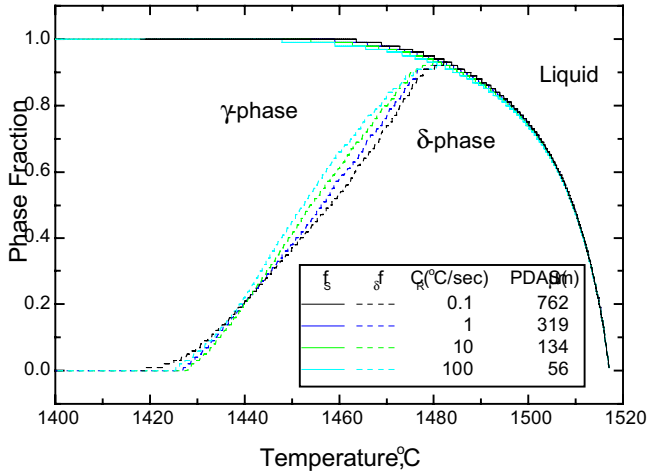
4. The local equilibrium at liquid/δ, liquid/γ and δ/γ interfaces is assumed.

Effect of PDAS and Cooling Rate

(0.1C-1.52Mn-0.32Si-0.012P-0.015S)







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Conditions for Calculation

-Steel composition: 0.1C - 1.52Mn - 0.34Si - 0.012P - 0.015S

-CON1D INPUT

Casting speed : 1.524 m/min

Slab dimension : 960 mm * 132.1 mm

Working mold length : 1096 mm

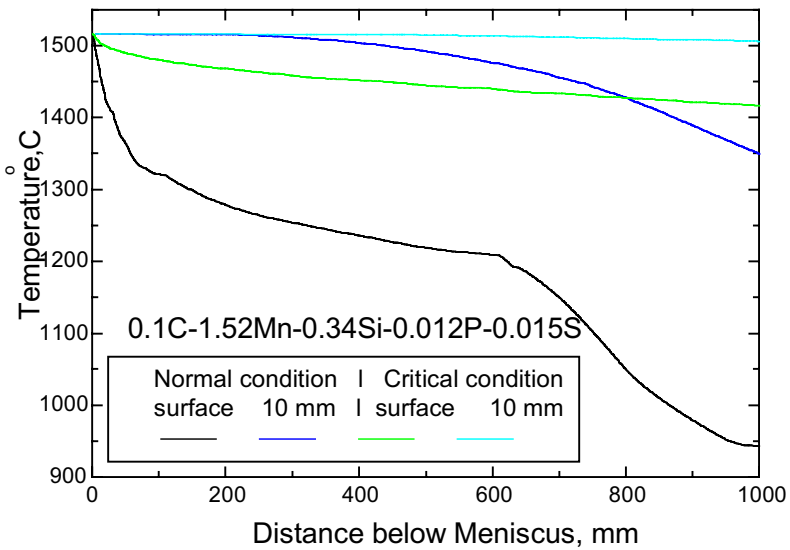
T_{liq} : 1516 °C

T_{sol} : 1460 °C

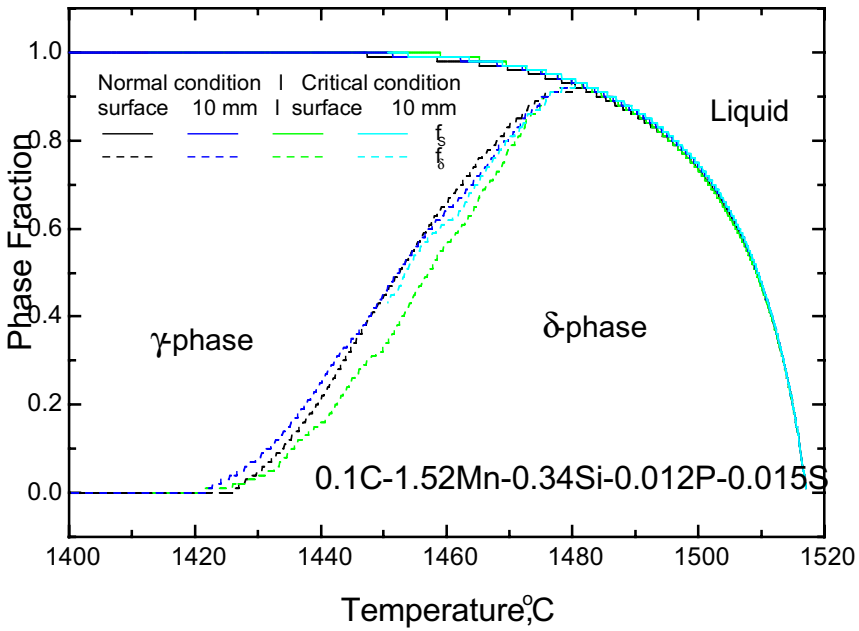
-Cooling rate (°C/sec) = $(T_{liq} - T_{sol}) / t_f$

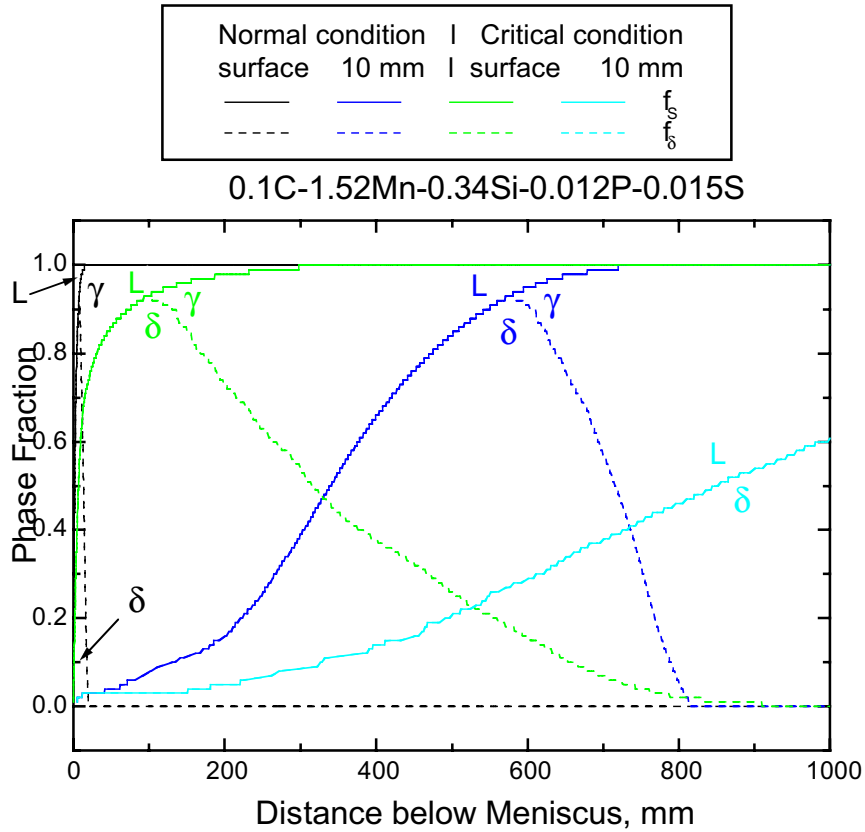
	Normal Condition		Critical Condition	
	Surface	10 mm	Surface	10 mm
t_f (sec)	0.472	21.142	11.417	64.409
C_R (°C/sec)	118.5	2.649	4.905	0.869
PDAS(μm)	53	221	175	337

-CON1D OUTPUT : ****.shl



Results of Phase Fraction





Future Works

- Optimization of the relationship between primary and secondary dendrite arm spacing and cooling rate.

- Consideration of the others solute element, such as Ni, Cr, Mo, W, V etc.

  => To predict the microsegregation of Stainless Steel