（＊掲載記事題目及び掲載頁は変更になる場合があります。）

Fundamentals of High Temperature Processes

Aluminum deoxidation equilibrium in liquid Fe–36%Ni alloy

S.-B.LEE et al.

For thermodynamic prediction, the deoxidation equilibrium of aluminum in Fe–36%Ni alloy was investigated by employing a cold crucible under an Ar gas atmosphere at 1 773 K. The interaction parameters between aluminum and oxygen by taking liquid Fe–36%Ni alloy as the basis (*i.e.*, solvent) are evaluated as follows:

$$e_O^{Al}=-3.8,\ r_O^{Al}=0.9,\ e_{Al}^{O}=-6.4,$$
$$r_{Al}^{O}=700,\ r_{Al}^{Al,O}=3.1,\ r_O^{Al,O}=833$$

within the composition range of [Al]<1 mass%.

The equilibrium constant for reaction $2\underline{Al}_{(in\ Fe\text{-}36\%Ni)}+3O_{(in\ Fe\text{-}36\%Ni)}=Al_2O_{3(s)}$ was obtained in the temperature range of 1 773 to 1 973 K by using data from the present study and from previous works reported:

$$\log K_{AO}=0.58-24\,460/T$$

The deoxidation equilibrium of aluminum in Fe–36%Ni can thus be thermodynamically described in the range of [Al]<1 mass% using both the first and second order interaction parameters as well as the equilibrium constant determined in this study.

(cf. *ISIJ Int.*, **42** (2002), 679)

Behavior of magnesium in the desulfurization process of molten iron with magnesium vapor produced *in-situ* by aluminothermic reduction of magnesium oxide

J.YANG et al.

The behavior of magnesium in the desulfurization process of molten iron with magnesium vapor produced *in-situ* by the aluminothermic reduction of magnesium oxide has been investigated.

The magnesium concentration first increased rapidly, reaching the maximum, and then decreased gradually to a very low level. The magnesium concentration of the molten iron was mainly that of the dissolved magnesium and the following decrease in the magnesium concentration was due to the evaporation from the melt surface and the mass transfer of the dissolved magnesium to the bubble surface. Under the present experimental conditions, the magnesium concentration increased with increasing temperature, pellet mass, carrier gas flow rate and decreasing initial sulfur concentration.

Decreasing the pellet mass and increasing initial sulfur concentration made the desulfurization efficiency higher and decreased the amounts of magnesium dissolving into the melt and leaving the melt. The equilibrium relation between [ppmMg] and [ppmS] did not conflict with the present experimental results at temperatures from 1 553 to 1 673 K.

A mathematical model for analyzing the behavior of magnesium in the present desulfurization process has been developed. The calculated magnesium and sulfur concentrations are well consistent with the experimental results. The calculated results demonstrate that the existence of the peak of magnesium concentration is reasonable. The present mathematical model can also explain the effects of pellet mass and initial sulfur concentration on the behavior of magnesium injected into the melt.

(cf. *ISIJ Int.*, **42** (2002), 685)

Ironmaking

Sloshing of melts in a bath smelting process having an elliptic cross section

J.-L.LIOW

Recently, the use of the elliptic cross section cylinder for bath smelting operations was adopted by the AusIron process. The high gas flow rates used have been found to generate wave motion in the bath that can enhance refractory wear. The standing wave modes were found for the bath. Two distinct sets of eigenvalues were obtained, one in the major axis and the other in the minor axis. The two sets converged when the ellipticity of the cylinder is zero, which is the shape of a circle. The calculated wave frequency was found to agree well with experimental data. A complete set of eigenvalues have been calculated for elliptic cylinders and fitted to Chebyshev polynomials, enabling quick estimation of the standing wave frequencies. The study showed that the ellipticity of the vessel for the AusIron process needs to be carefully chosen as the standing wave modes that can be generated may result in beat frequencies that can interact with the natural frequencies of the vessel support and auxilliary equipment.

(cf. *ISIJ Int.*, **42** (2002), 694)

Casting and Solidification

Microstructure simulation of aluminum alloy using parallel computing technique

W.FENG et al.

The formation and evolution of the microstructure of casting are important research areas in the field of material science and engineering. The solidified microstructure of aluminum alloy was simulated by combining the CA (Cellular Automaton) model with macro heat transfer. A modified CA (MCA) model, which uses a more similar shape to the actual dendrite to describe the growth grain, was proposed and studied. Because of the huge computational capacity to simulate the microstructure of casting, a relevant parallel computing technique based on the serial arithmetic was developed, which can greatly improve the computing scale and efficiency and can also ensure the computing accuracy as well. The simulation results are compared with the experimental results and agreed quite well.

(cf. *ISIJ Int.*, **42** (2002), 702)

Compression test to reveal surface crack sensitivity between 700 and 1 100°C of Nb-bearing and high Ni continuous casting slabs

S.S.XIE et al.

In this study, the surface crack sensitivities in samples of a Nb-bearing steel and a high Ni grade steel from continuous casting slabs have been examined by simple compression tests at various temperatures between 700–1 100°C using a metallography method to evaluate the severity of surface cracks, and corresponding microstructure in the two grades of steel has been investigated. The results show that most specimen have cracks on the hoop surface after 50% compression in height in the temperature range of interest, and the critical hoop strain obtained from the metallography examination gives a clear cracking tendency for the two grades of steel. Microstructure observation revealed that the static precipitation of TiNb(CN) before deformation and thin ferrite film along grain boundaries are important for controlling surface crack sensitivity for the Nb-bearing steel, while coarse grains with flat boundaries, and grain-boundary precipitation of Cu_2S and flake-like Ti(CN) at lower temperature, is responsible for the high crack sensitivity in high Ni steel between 700–1 100°C, which implies Cu, S, Ti and N content should be kept as low as possible in this grade of steel, and surface temperatures of continuous casting slabs at the straightening point should be above 970°C for Nb-bearing steel while 980°C for high Ni steel to avoid transverse cracking.

(cf. *ISIJ Int.*, **42** (2002), 708)

Collision and coalescence of alumina particles in the vertical bending continuous caster

H.LEE et al.

The three-dimensional fluid flow in a vertical bending continuous caster was numerically studied. Three dimensionless collision numbers were introduced to analyze the inclusion collision mechanism. The analysis showed that turbulent collisions were the major factor causing inclusions to collide with each other in the continuous caster. Stokes collisions had a minor effect and Brownian collisions were negligible. A mathematical model was then developed to study the inclusion collisions in the continuous caster. The mathematical model considered the inclusion mass transfer and expressed the radius and population of new inclusions after coalescence relative to the mass and population conservation. Since the motion of cluster-shaped inclusions differs from that of spherical inclusions, the inclusion physical parameters were modified. The results showed that the inclusions congregated approximately one fourth of the face width from the slab edge so that the characteristic radius distribution of the inclusions had a 'W' shape, while the inclusion concentration and number density had an inverse 'W' shape in the longitudinal direction. More inclusions were trapped near the inner arc and they had larger characteristic radii than those near the outer arc. The concentration and inclusion number density decreased with the distance from the free surface, but the inclusion radius increased.

(cf. *ISIJ Int.*, **42** (2002), 717)

Forming Processing and Thermomechanical Treatment

Prediction of the surface profile and area of the exit cross section of workpiece in round–oval–round pass sequence

Y.LEE

In this paper, the model[9] that predicts the surface