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SVMMARIVM — Auctor experimentis probare voluit theoricam curvam, quae indicat quomodo in ferri fusione, quae per zonas fiat, impuritates nonnullae (ut Ni, Mn, C, S e C) separentur: quoties zonae fusae celeritas haud magna sit, curva satis confirmatur experimentis, si tamen ratio habeatur solutorum, quae in finitimam zonam solidam effunduntur.

This is a short note to explain briefly the result obtained by TAKAYUKI OOKA, HIROSHI MIMURA, SEINOSUKE YANO, and SEIICHI SOEDA of our Institute (Tokyo Research Institute of Yawata).

In recent years, several studies have been published on zone refining of iron [1] [6]. Efficiency of the zone refining has been expressed by the distribution coefficient k. The experiment of OOKA, MIMURA, YANO and SOEDA was carried out to see, if the refining efficiency for Ni, Mn, C, S and O can be explained by the existing theory. The floating zone melting method was employed to avoid contamination from the crucible. It was found that the solute distribution for Ni is well explained by the available theoretical expression including only the effect of segregation. However, in order to explain the solute distri-

bution for Mn, C, S and O, it has been found necessary to take account of the evaporation of the solute. There still remains some disagreement as to the solute distribution of C and S at slow travelling rates, and that of O at any rate. OOKA, MIMURA, YANO and SOEDA suggested that the diffusion in the solid phase just adjacent to the molten zone is responsible for this disagreement. The theoretical expression of the solute distribution taking into account all the effects mentioned above is obtained as

$$C_n (x, k, k_v, \alpha) = C_n (x, k, k_v) + k (1-\alpha)/\{1 - (k + k_v)\} \cdot$$

$$(\text{I}) \quad \cdot \sum_{m=1}^{n} \frac{C_{n-m}^{*} (o, k, k_v, \alpha)}{C_o} \left\{ \frac{k + k_v}{k} C_m (x, k, k_v) - C_{m-1} (x, k, k_v) \right\}$$

where

$$C_n (x. k. k_v) = \left(\frac{k}{k + k_v} \right)^n C_n (x. k + k_v)$$

$$C_m^{*} (o. k. h_v \cdot \alpha) = \frac{1}{l} \int_{o}^{l} C_m (x. k. k_v \cdot \alpha) \, dx$$

and I is the zone length.

The above expression is derived on the assumption that the initial concentration of the zone increases by factor α due to the diffusion in the solid phase and the solute decreases due to vaporization in proportion to the concentration of the solute [7] with proportional constant k_v.

Putting k_v to zero and α to unity, $C_n (x.k.k_v. \alpha)$ is reduced to $C_n (x.k)$ which expresses the solute distribution including only the effect of segregation.

For example, distribution of carbon after zone refining is shown in Fig. 1. The theoretical curve is drawn using equation (1). The agreement between the theoretical and experimental values is good.

2

In order to show that the diffusion in the solid phase increases the concentration of the zone at the starting end, the molten zone was kept stationary. As time passes the concentration of the solute in the molten zone increases while that of the solid zone adjacent to the molten zone decreases. The full account of this work will be published by them in Nippon Kinzoku Gakkaishi in Japanese.

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3

TABLE I

Change of the concentration in the stationary melting

Element		Original	1			6			28			60		
			A	B	C	A	B	C	A	B	C	A	B	C
S	%	0.142	0.120	0.138	0.140	0.134	0.140	0.132	—	—	—	0.108	0.170	0.128
C	%	0.067	—	—	—	0.062	0.065	0.049	0.059	0.097	0.063	0.045	0.095	0.046
O	%	0.072	0.050	0.116	0.052	0.063	0.140	0.074	0.051	0.108	0.023	—	—	—

(Melting time (min))
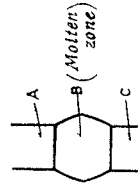
A: upper solid zone adjacent to the molten zone.
B: molten zone.
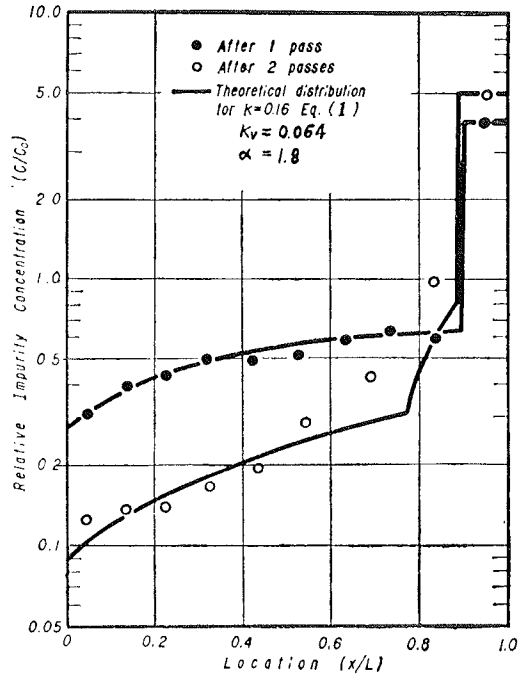C: lower solid zone adjacent to the molten zone.

4

FIG. 1 — Distribution of carbon in iron after zone refining at the constant traveling rate, 0.1 mm/min.