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Figure 1

Figure 1: Figure 1

Abstract

Full Text

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SOLUBILITY OF NITROGEN IN LIQUID MANGANESE

The solubility of nitrogen in liquid manganese has been studied previously ([1–4]). However, the results of determinations by different investigators are contradictory. Thus, the solubility of nitrogen in liquid manganese at 1300–1400 (1450) °C was determined to be 0.10–0.13% ([1]); 3.7% ([2]); 1.0% ([3]); 1.58–1.95% ([4]). The use of the "hot-volume" method in determining the solubility of nitrogen in liquid manganese is undesirable because of the high vapor pressure of liquid manganese. The interaction of the condensate with gaseous nitrogen, accompanied by the formation of Mn_4N, leads to substantial errors.

We chose the method of dynamic equilibrium between liquid manganese and a gas phase consisting of nitrogen or a mixture of nitrogen and hydrogen. The partial pressure of nitrogen in the gas phase at the moment equilibrium is reached determines the activity of nitrogen in the metal. In a sample of solid, rapidly cooled metal, the nitrogen content corresponding to the equilibrium state was then determined. The method and apparatus for studying the solubility of nitrogen in metallic melts have been described previously ([5]).

Fig. 1. Kinetic curves: nitriding of liquid Mn (a), denitriding of liquid Mn containing 3.3% N (b), denitriding of liquid Mn containing 6.0% N (c).

For heating the metal we used an LG-60 tube high-frequency generator. As starting materials we used electrolytic manganese that had been remelted beforehand and nitrided electrolytic manganese. The content of individual elements in the manganese is given in Table 1.

In the first series of heats, the metal was held for 120–180 min at the specified temperature and at hydrogen and nitrogen flow rates (40 and 1100 ml/min.,

Table 1

Fig. 2. Effect of temperature on the solubility of N in liquid Mn. a —Mn, b —nitrided Mn

Figure 2: Fig. 2. Effect of temperature on the solubility of N in liquid Mn. a —Mn, b —nitrided Mn

Manganese	Content, %	Content, %	Content, %	Content, %	Content, %	Content, %
	C	Fe	Si	S	P	N
Electrolytic, remelted	0.06—0.08	0.05—0.06	0.04	0.05—0.06	0.003	—
Electrolytic, nitrided	0.06—0.08	0.05—0.06	0.05	0.05—0.06	0.003	3.3 and 6.0

respectively), samples of the metal were taken and quenched almost instantaneously (less than 1 sec.). In series II the melt was held under the same conditions, and samples were taken after 30, 60, 90, and 120 min.

In the first and second series, in order to purify the manganese from oxygen, the liquid melt was held for 60 min in a stream of purified hydrogen (400 ml/min), after which the current was switched off. The solidified metal was remelted and held at the specified temperature and at hydrogen and nitrogen flow rates of 40 and 1100 ml/min, respectively. In the third series of melts, manganese containing 3.3 and 6.0% N was held under the same conditions, without preliminary purification in hydrogen, for 60—120 min.

The nitrogen content in manganese was determined by a chemical method ([6]).

As was noted, at one and the same temperature equilibrium was reached both in saturating liquid manganese with nitrogen and in denitriding nitrogen-containing manganese. It was established (Fig. 1) that a one-hour holding of the metal in the gas stream is quite sufficient for attaining equilibrium.

Fig. 2. Effect of temperature on the solubility of N in liquid Mn. *a* —Mn, *b* —nitrided Mn

With increasing temperature, the solubility of nitrogen in liquid manganese decreases (Fig. 2). This dependence may be represented by the equations

$$\tfrac{1}{2}N_{2(\mathrm{g})} \rightleftarrows [\%N], \quad K = \frac{a_N}{P_{N_2}^{1/2}} = \frac{f_N[\%N]}{P_{N_2}^{1/2}}. \tag{1}$$

The standard state is taken to be a manganese melt in equilibrium with nitrogen whose pressure is 1 atm. On the basis of the experimental data, at $P_{N_2} = 1$ atm and $f_N = 1$,

$$\lg K = \lg[\%N] = \frac{3010}{T} - 1.457; \quad (2)$$

$$\Delta F^0 = -13780 + 6.65T. \quad (3)$$

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References

[1] R. Ochsenfeld, Ann. Phys., **12**, 353 (1932).
[2] U. Zwicker, Zs. Metallkunde, **42**, 274 (1951).
[3] T. Saito, Sci. Repts. Res. Inst. Tôhoku Univ., Ser. A., **1**, No. 4, 419 (1949).
[4] V. P. Perepelkin, V. A. Bogolyubov, *Stal'*, No. 9, 813 (1960).
[5] A. M. Samarin, V. P. Fedotov, Proceedings of the IV Conference on the Physicochemical Foundations of Steel Production, Publishing House of the Academy of Sciences of the USSR, 1960, p. 144.
[6] V. P. Fedotov, Proceedings of the Conference on Experimental Technique and Methods of High-Temperature Investigations, Publishing House of the Academy of Sciences of the USSR, 1956, p. 454.

Note: Figure translations are in progress. See original paper for figures.