669.18.954.8: 669.18.046.548.4: 669.3: 669.64

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ALLOYING EFFECT ON EVAPORATION RATES OF COPPER AND TIN FROM IRON MELTS.

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INTRODUCTION: Elimination of Sn and Cu from steel scrap by conventional metal-slag reactions is extremely difficult because of their low reactivity under iron and steelmaking conditions. For this reason evaporation processess are considered to be more suitable for this purpose. Up to now there have been many reports on kinetics of evaporation of Cu and Sn from iron melts under vacuum. This communication reports experimental findings for Cu and Sn evaporation from iron base ternary and quaternary systems under atmospheric pressure in order to study alloying effects on the phenomena and to establish a process for Sn evaporation which might be fast enough to avoid vacuum processess.

PROCEDURE: The samples weighing 0.8±0.01g were levitated and melted at 1800 °C by using a 15Kw-300KHz generator under a stream of 250 cm^3/min of helium. The studied systems were: Fe-C-Cu, Fe-C-Sn, Fe-Si-Cu, Fe-S-Sn and Fe-Si-S-Sn. The initial contents of Cu and Sn were around 1% for all alloys. The contents of carbon were 1.5, 2.5, and 4,5% for the first two systems. The contents of silicon were 2.5,5.8,10.7 and 16.7% for the third system and 0.72, 2.82, 4.8 and 7.3% for the last system. Contents of initial sulfur varied from 0.1 to 0.46% for the fourth and the fifth systems.

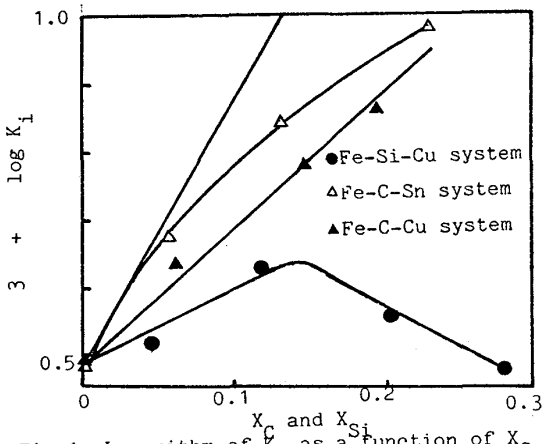

Fig.1. Logarithm of K_i as a function of X_C and X_{Si}

RESULTS AND DISCUSSION. Evaporation of Cu and Sn obeyed quiet well the first order equation. Fig. 1 shows the variation of the logarithm of rate constant for evaporation K_i (g-cm^{-2}-sec^{-1}) against fraction mol of carbon. The two plots on the ordinate are for the Fe-Cu and Fe-Sn binary systems.

From the slopes of those two lines, interaction coefficients ε^C_{Cu} and ε^C_{Sn} were estimated as 0.093 and 0.181 respectively assuming that the rate is proportional to the vapor pressure of each element. The system Fe-Si-Cu behaved similarly up to 6% Si approximately but at higher contents log K_i decreased. This phenomena was interpreted on the basis of the theory of solution thermodynamics for ternary systems, and from this $\gamma^{\circ}_{Cu(Si-Cu)}$ was estimated as 0.23. From the data of this system, the interaction coefficient ε^{Si}_{Cu} was estimated as 0.035. Schenck and Spieker[1] obtained values of 0.084, 0.192 and 0.027 for ε^C_{Cu}, ε^C_{Sn} and ε^{Si}_{Cu} respectively which are in good agreement with the present values estimated from kinetic data.

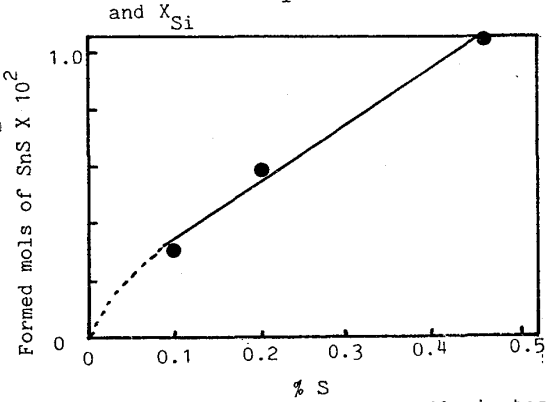

Fig.2. Quantity of SnS formed in 10 minutes as a function of initial % of sulfur.

As for the Fe-S-Sn system, the slight formation of SnS was noticed indirectly. Sulfur evaporation followed a second order equation and that of Sn a first order one. The higher the initial content of sulfur in the melt, the more SnS formation was observed (Fig.2).

Finaly the system Fe-Si-S-Sn was found to be the most suitable for the fast evaporation of Sn due to the Si influence on S and Sn activities[2]. The formation of SnS is plausible as well as that of Sn. Both, S and Sn followed a second order equation with a very high rate of evaporation. The final contents of sulfur and tin after 10 minutes varied from 0.01-0.007 and 0.02-0.009 respectively regardless of the initial silicon content. As an example the rate of evaporation of Sn for the alloy with 7.3% initial Si was around 10 times bigger than the rate for the binary Fe-Sn. This suggests the possibility for the fast evaporation of S and Sn even under atmospheric pressure conditions.

BIBLIOGRAPHY: (1) H. Schenck and W. Spieker: Arch. Eissenhüttenw., 1959, Vol11, pp 641-48. (2) R. Morales D. N. Sano and Y. Matsushita: Proceedings of The 2nd Japan-Sweden Symp. on Ferrous Met. Tokyo-Japan, 1978.