# (245) Thermodynamics of Nitrogen Solubility in $CaO-CaF_2$ Slags

The University of Tokyo °E.Martinez and N.Sano

Introduction:Removal of nitrogen by slag treatment during iron and steelmaking operations requires fundamental knowledge of the solubility of nitrogen in liquid slags . At the same time this knowledge will enable the continuous casting process to protect the steel from nitrogen absorption by using appropriate slags . With this purpose experiments were conducted using a $CaO-CaF_2$ slag mainly at 14.5 % CaO . A wide range of oxygen partial pressure was used,from $3.1 \times 10^{-6}$ atm to $1.23 \times 10^{-13}$ atm with $CO-CO_2-N_2$ gas mixtures and from $3.1 \times 10^{-17}$ atm to $7.5 \times 10^{-20}$ atm with $CO-Ar-N_2$ gas mixtures . The influence of nitrogen partial pressure,temperature,lime content and oxygen partial pressure on nitrogen solubility was used in this work

Experimental:A $CaO-CaF_2$ slag was put in a platinum,nickel,molybdenum or graphite crucible depending mainly on the oxygen potential of the experiment and placed in an electric resistance furnace for equilibration for 5 to 24 hrs.,under a $CO-CO_2-N_2$ atmosphere or $CO-Ar-N_2$ atmosphere. Nitrogen-free $CaO-CaF_2$ slags were used in a range from $10^{-6}$ atm to $10^{-11}$ atm of oxygen partial pressure and nitrogen presaturated slags were used in a range from $10^{-11}$atm to $10^{-13}$ atm of oxygen partial pressure and at carbon saturation . The main temperature used in this work was 1375°C .

Results and Discussion:Fig. 1 shows nitrogen content(as $N^{3-}$) dependence on oxygen partial pressure . The results indicate that from $10^{-6}$ atm to $10^{-11}$ atm of oxygen partial pressure there is no significant change in nitrogen content . If the oxygen partial pressure is lower than $10^{-11}$ atm, nitrogen content follows the direction of a straight line with a slope of -0.58 which is close to the estimation (-3/4) from the following equation :

$$1/2\ N_2 + 3/2\ O^{2-} = N^{3-} + 3/4\ O_2$$

In Fig. 2 nitrogen partial pressure dependence is shown for different oxygen partial pressures . For all of those there is agreement with the expected slope for the line,1/2 . Temperature dependence is shown in Fig 3,according to which with higher temperatures nitrogen content increases . The enthalpy change involving the heat of nitrogen dissolution into a slag is estimated from these results as $\Delta H^{\circ}$ = 17,800 cal/mole .

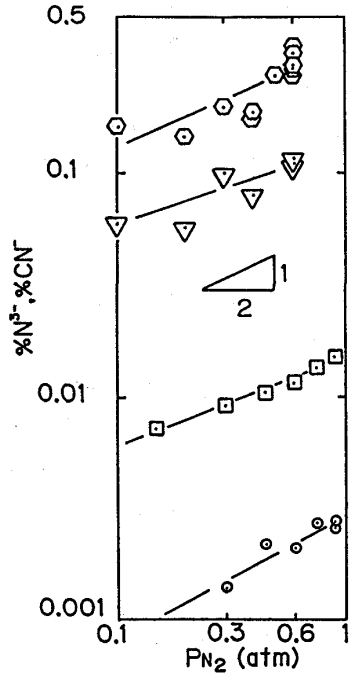


FIG2RELATIONSHIP BETWEEN NITROGEN PARTIAL PRESSURE AND NITRIDE AND CYANIDE CONTENTS IN A CaO-CaF2 SLAG AT 1375°C.( ○ )$N^{3-}$ $Po_2$=4.9X10⁻⁹atm ,( □ )$N^{3-}$ $Po_2$=3.08X10⁻¹²atm,(◯)$N^{3-}$ $Po_2$=9.8X10⁻¹⁰atm,(▽)$CN^-$ $Po_2$=9.8X10⁻¹⁰atm

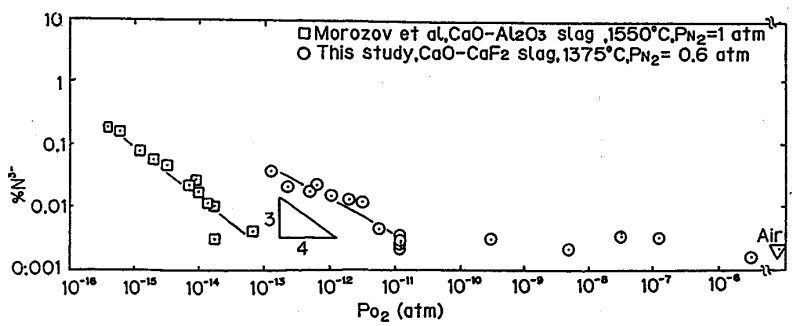


FIG1 NITRIDE CONTENT AS A FUNCTION OF OXYGEN PARTIAL PRESSURE IN A CaO-CaF2 SLAG AT 1375°C

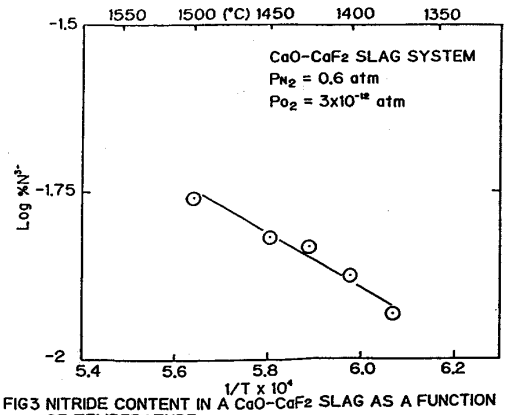


FIG3 NITRIDE CONTENT IN A CaO-CaF2 SLAG AS A FUNCTION OF TEMPERATURE