

South Dakota School of Mines and Technology
Department of Materials and Metallurgical Engineering

Met 426/526
MI 220

HQ 1
1 Hour

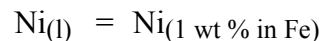
Feb 28, 2011
2:00 – 2:50 PM

Open Book and Notes; Calculators and Laptops Allowed

1. Describe briefly with a sketch and some labels each of the following processes: **(25)**
 - a) BF (Blast Furnace)
 - b) BOF (Basic Oxygen Furnace)
 - c) EAF (Electric Arc Furnace)

2. Describe/answer each of the following in a sentence or two: **(25)**
 - a) What does the term *Coke Rate* mean?
 - b) What is the difference between topochemical and diffuse reduction?
 - c) How has USA iron production changed over the last 50 years and why?
 - d) What is the economic impact of *stoves* in the operation of a BF?
 - e) Why was oxygen introduced from the top of the BOF compared to the historical way air was introduced into the Bessemer converter?
 - f) What is continuous casting?

3. Find ΔG° at 1873 K for the change in standard state for the reaction. **(20)**



4. What CO to CO₂ ratio would be required to achieve an equilibrium wt% C of 0.4 at 1000 °C? **(20)**
 - a) Assume that $f_C = 1$
 - b) How does the computation change if f_C is not assumed to be unity but rather the real solution behavior is used? (Be quantitative but only recalculate if time permits.)

5. Refer to Figure 2 below. **(10)**
 - a) Do the data for the Fe-Ni system at 1873 K conform to Darken's quadratic formalism? Why or why not?
 - b) What is the mathematical relationship between the slope (say b) on a Darken Plot at infinite dilution and the interaction coefficient e_i^i ?

Table 1. Solution Thermodynamic Properties of the Liquid Fe-Ni System at 1873 K. (ref: Hultgren, Desai, Hawkins, Glines, and Kelly, **Selected Values of the Thermodynamic Properties of Binary Alloys**, ASM, Metals Park, Ohio, 1973, p.852.)

x_{Ni}	a_{Fe}	γ_{Fe}	a_{Ni}	γ_{Ni}
0.0	1.000	1.000	0.000	0.617
0.1	0.897	0.996	0.068	0.675
0.2	0.794	0.992	0.138	0.692
0.3	0.693	0.990	0.209	0.697
0.4	0.587	0.978	0.285	0.721
0.5	0.470	0.941	0.373	0.745
0.6	0.343	0.858	0.481	0.802
0.7	0.218	0.726	0.614	0.877
0.8	0.116	0.581	0.756	0.945
0.9	0.045	0.454	0.888	0.987
1.0	0.000	0.355	1.000	1.000

Table 2. Molecular Weights

Element	MW
Ni	58.70
Fe	55.85

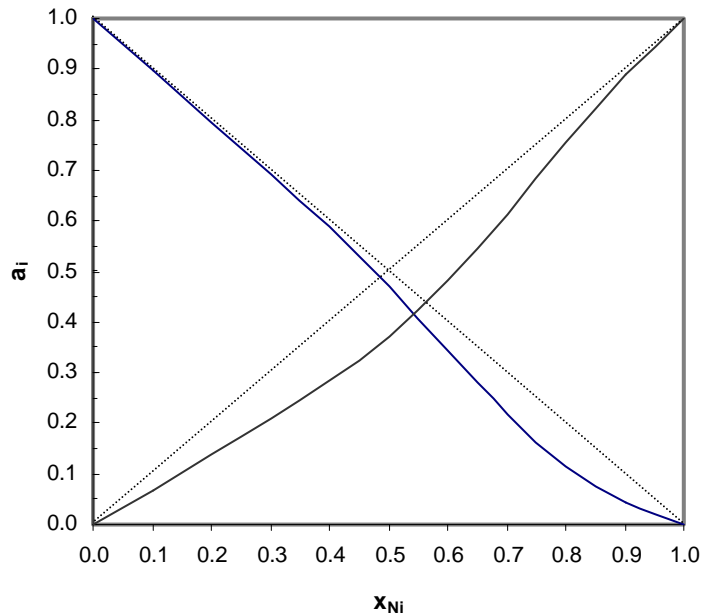


Figure 1. Activities in the Liquid Fe-Ni System at 1873 K.

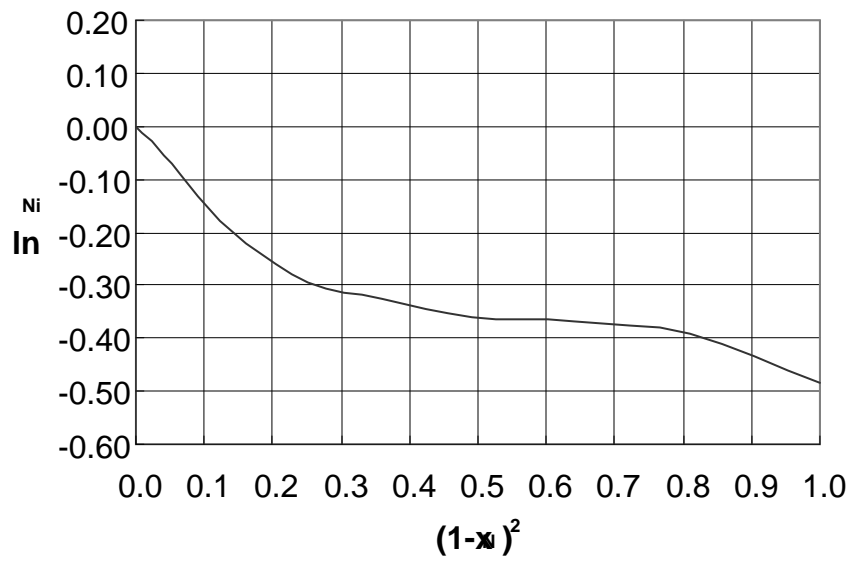


Figure 2. Darken Plot for the Liquid Fe-Ni System at 1873 K.