where t_1 and N_1 refer to the time and cycles at one strain range, t_2 and N_2 refer to the data at a second strain range, and t_f and N_f refer to the failure time and cycles to failure corresponding to tests at a given strain range, leads to conservative results since the Table I data indicate that the cyclic fatigue life actually remaining in a material is greater than that calculated.

Typical load vs time and strain vs time plots obtained in the test of specimen 67-7 are presented in Fig. 1. Particularly noteworthy in the load-time plot is the strain-hardening which is indicated at 2 pct strain range and the strain softening which is noted at the 1 pct strain range.

Another interesting plot obtained in the test of specimen 67-7 is shown in Fig. 2. A definite hysteresis loop is indicated for each strain range and the transfer from one loop to another is also highlighted. Arrows are shown to identify the hysteresis loops for the first and last cycles in the sequence and these clearly indicate the cyclic hardening and softening mentioned in the discussion of Fig. 1. It is important to emphasize that in this evaluation the specimen was tested in axial strain control with zero mean strain.

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Gas Solubility Measurements and the Derivation of Inherent Thermodynamic Information

KLAUS W. LANGE AND HERMANN SCHENCK

More information can be derived from gas solubility measurements than just the knowledge of solubility values. If the gas solubility in mixed solvents is small the solubility data give quantitative information about the thermodynamic behavior of the components of the mixed solvent. If these thermodynamic data are known from other independent measurements, the thermodynamics of the mixed solvent derived from gas solubility measurements can be used to check the thermodynamic consistency between the two sets of data.

During measurements of the hydrogen solubility in binary nickel alloys[1-5] it was found that, at constant

KLAUS W. LANGE is Privatdozent, Institut fur Eisenhüttenkunde der Rheinisch-Westfälischen Technischen Hochschulle Aachen, Aachen, West Germany. HERMANN SCHENCK, formerly Director, Institut für Eisenhüttenkunde der Rheinisch-Westfälischen Technischen Hochschule Aachen, is Professor Emeritus and Director, Forschungsstelle für technisch-wirtschaftliche Unternehmensstrukturen der Stahlindustrien, Aachen, West Germany.

temperature and partial pressure of the gas, $\log f_{H_{Ni}}^{Co}$ (and/or $\log f_{H_{Co}}^{Ni}$) varies linearly with the mole fraction X_{Co} (and/or X_{Ni}). It was shown[1,6] that this linear concentration dependence occurs if the mixed solvent forms an ideal solution. Considered on an atom fraction scale the nitrogen solubility in Ni-Co-alloys is even smaller, and one would expect the same linear dependence of $\log N_{Ni-Co}$ on X_{Co}. Of the two measurements[7,8] known from the literature only one[8] covers the whole system with five points, Fig. 1. Since the linear dependence is not clearly established, the nitrogen solubility measurements were repeated. Ni-Co-alloys were equilibrated with nitrogen gas at 1600°C, quenched* and analyzed for nitrogen. The re-

sults are given in Fig. 1. The logarithms of the nitrogen solubility in the Ni-Co-alloys and cobalt lie close to a straight line. The experimental value for pure nickel is lower. In view of the analytical difficulties at these low nitrogen values this value is omitted in establishing the regression line through the other experimental points. From this regression line the nitrogen solubility in pure nickel is estimated
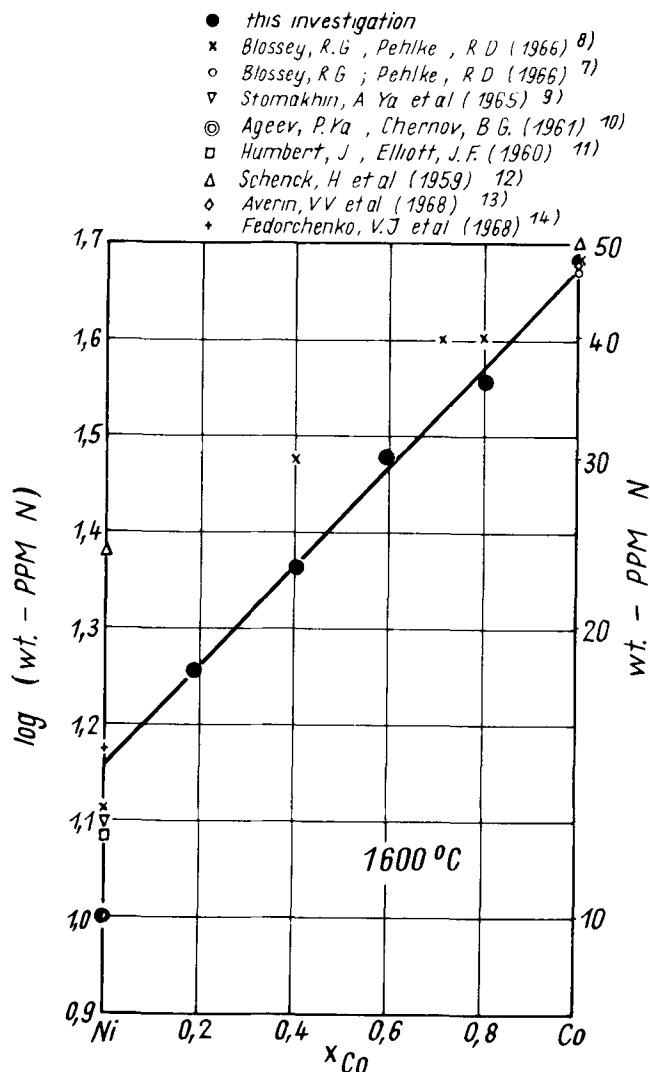

Fig. 1—Nitrogen solubility in liquid Ni-Co alloys at 1 atm N partial pressure.

Fig. 2—Activity coefficients of nickel and molybdenum derived from hydrogen solubility measurements.
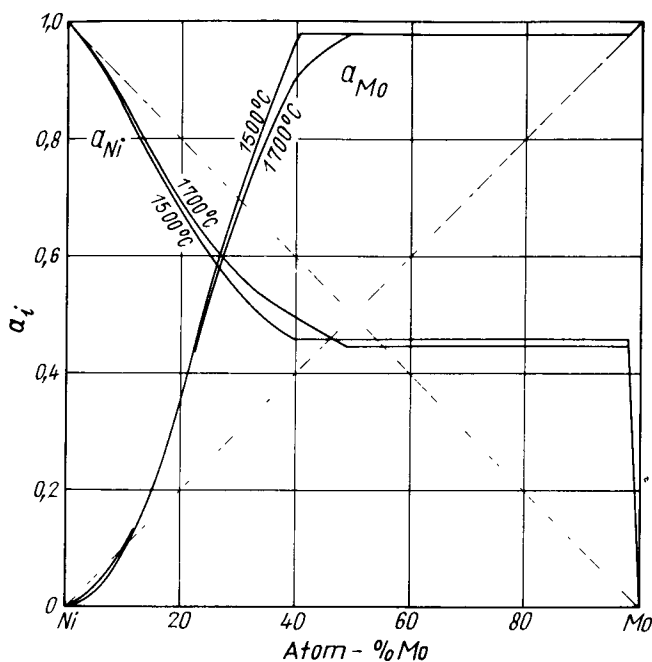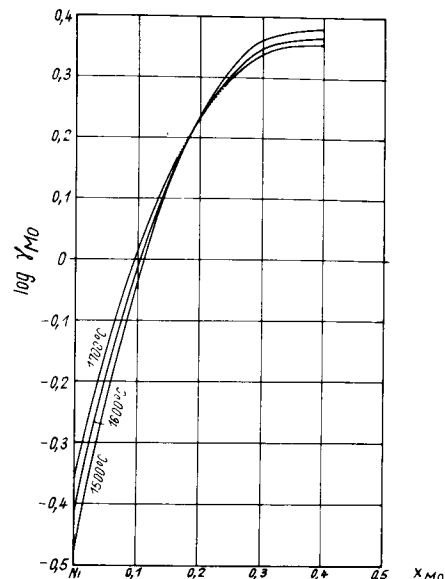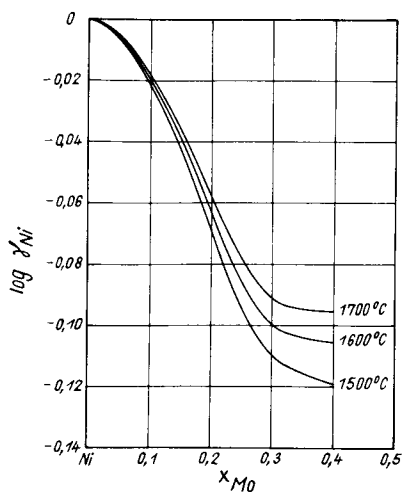

Fig. 3—Raoult's activity of the components in the system Ni-Mo, derived from hydrogen solubility measurements (standard states: liquid nickel, solid molybdenum).

to be 14.4 ppm at 1 atm partial pressure of nitrogen.

It was shown[1,6] that qualitative relationships exist between the concentration dependence of $\log f^3_{gas_1}$ and the activities of the components 1 and 3 of the mixed solvent 1-3. If the $\log f^3_{gas_1}$ values remain smaller than the connecting straight line through the $\log f^3_{gas_1}$ values of the pure components 1 and 3, then the activities of the components 1 and 3 show positive deviations from Raoult's law. If the $\log f^3_{gas_1}$ values exceed this connecting straight line, then the activities of the components 1 and 3 show negative deviations from Raoult's law.

These qualitative relationships would be of more value if they could be made to yield quantitative information. This was done[6,15] by expressing the isothermal concentration dependence of the gas solubility in the form of potential series[16] and processing the data in the manner of Wagner[17] and Darken.[18] This treatment

is not restricted either to gas solubility measurements covering the whole concentration range of a solvent system or to binary solvents. Figs. 2 and 3 illustrate, as an example, the results of such a treatment of hydrogen-solubility data[4] in liquid Ni-Mo-alloys. Since the solubility of nickel in solid molybdenum is very small,[19] Raoult's law is assumed to be valid in this region. The saturation solubility of molybdenum in nickel is taken from Casselton and Hume-Rothery.[19] The activities of nickel and molybdenum show negative deviations from Raoult's law in nitrogen-rich alloys. There are no known activity measurements in the literature, only indications of short range orders,[20-22] while the phase diagram[23,24] shows compounds. Both phenomena are usually indicative of negative deviations.

As an example of checking the consistency of solubility data the system Fe-H-V is considered. There exist five[25-29] determinations of the hydrogen solubility in liquid Fe-V alloys. To calculate the activity of iron and/or vanadium only those hydrogen solubility measurements are used[26-29] which cover an extended concentration range. The results are given in Fig. 4 and they are contradictory even when limited to one publication.

There exist two independent determinations[30,31] of the activities of iron and vanadium in solid Fe-V alloys. Both activities show negative deviations from Raoult's law. The available activity data of Myles and Aldred[31] are given in Fig. 4. There is a reasonably good agreement between the results of the vapor pressure measurements and the hydrogen-solubility measurements of Ban-ya et al.[28] at 1548°C, especially if one takes into account the temperature difference. In the light of this knowledge the other hydrogen solubility measurements in liquid Fe-V alloys cannot be considered as giving very reliable information on the exact concentration dependence of the gas solubility. The proposed treatment of solubility measurements of gases scarcely soluble in mixed solvents provides thus a sensitive means of testing the reliability of gas solubility data. Where the isothermal concentration dependence is based on extremely accurate solubility data, it is possible to derive valuable knowledge on
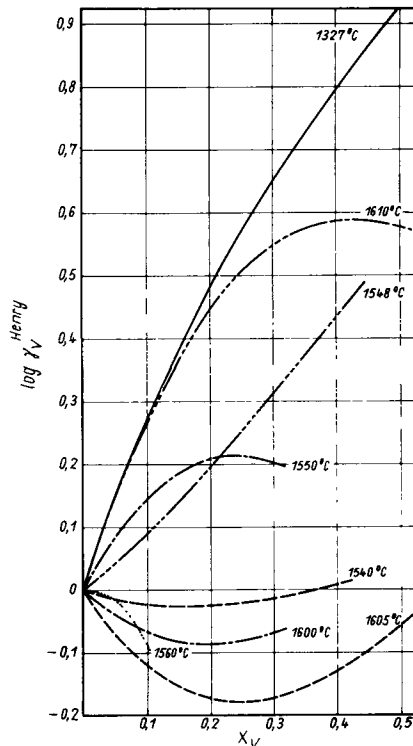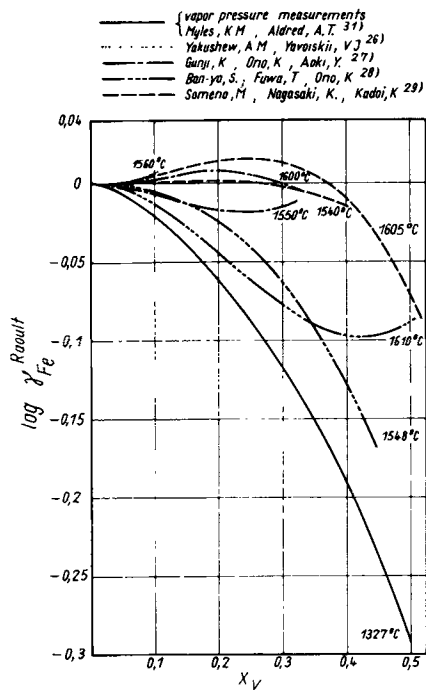
Fig. 4—Comparison between activity co-efficients of iron and vanadium in Fe-V alloys derived from vapor pressure measurements and hydrogen solubility data.

the activity of the components of the mixed solvent.[6,15] With measurements of similar accuracy at different temperatures it is even possible to extend the treatment in such a way[32] as to gain quantitative information concerning the heat and entropy of mixing of the mixed solvent system.

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Delamination in Banded Steels

ERIC A. ALMOND

THE high energy values and the impressive amount of delamination, see Fig. 1, often observed in impact tests on banded steels and similar structures[1,2] often causes speculation about the possible application of these structures for their crack arresting properties. However, apart from semiquantitative analyses[3,4] of the role of the plastic zone at the crack tip in producing delamination there has been no detailed examination of the stress conditions that cause this type of

ERIC A. ALMOND, formerly Post-Doctoral Teaching Fellow, Department of Metallurgy, McMaster University, Hamilton, Ontario, Canada, is at the National Physical Laboratory, Teddington, Middlesex, England.