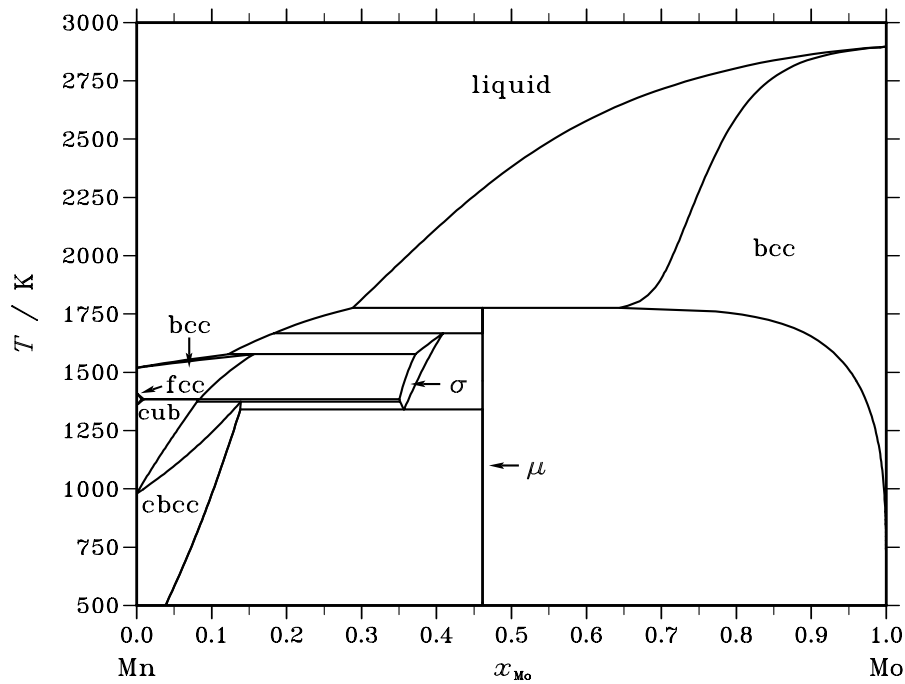


**Mn – Mo** (Manganese – Molybdenum)**Fig. 1.** Calculated phase diagram for the system Mn-Mo.

Mn and Mo are both important alloying elements in steel but usually in small amounts. The phase diagram shows rather high solubility of Mo in the Mn phases and two intermetallic phases,  $\sigma$  and  $\mu$ , both with narrow stoichiometry ranges and the  $\sigma$  is stable only at high temperature. The solubility of Mn in Mo is small except at very high temperatures. A thermodynamic assessment of the Mn-Mo system has been done by Lee [95Lee].

**Table I.** Phases, structures and models.

Phase	Struktur-bericht	Prototype	Pearson symbol	Space group	SGTE name	Model
liquid					LIQUID	(Mn,Mo) <sub>1</sub>
fcc	A1	Cu	<i>cF4</i>	<i>Fm<math>\bar{3}m</math></i>	FCC_A1	(Mn,Mo) <sub>1</sub>
bcc	A2	W	<i>cI2</i>	<i>Im<math>\bar{3}m</math></i>	BCC_A2	(Mn,Mo) <sub>1</sub>
cbcc	A12	$\alpha$ Mn	<i>cI58</i>	<i>I<math>\bar{4}3m</math></i>	CBCC_A12	(Mn,Mo) <sub>1</sub>
cub	A13	$\beta$ Mn	<i>cP20</i>	<i>P4<sub>1</sub>32</i>	CUB_A13	(Mn,Mo) <sub>1</sub>
$\sigma$	D8 <sub>b</sub>	$\sigma$ CrFe	<i>tP30</i>	<i>P4<sub>2</sub>/mnm</i>	D8B_SIGMA	Mn <sub>10</sub> Mo <sub>4</sub> (Mn,Mo) <sub>16</sub>
$\mu$	D8 <sub>5</sub>	Fe <sub>7</sub> W <sub>6</sub>	<i>hR13</i>	<i>R<math>\bar{3}m</math></i>	D85_MN7MO6	Mn <sub>7</sub> Mo <sub>2</sub> Mo <sub>4</sub>

**Table II.** Invariant reactions.

Reaction	Type	$T / \text{K}$	Compositions / $x_{\text{Mo}}$			$\Delta_f H / (\text{J/mol})$
liquid + bcc $\rightleftharpoons \mu$	peritectic	1776.4	0.288	0.644	0.462	−17511
liquid + $\mu \rightleftharpoons \sigma$	peritectic	1667.7	0.183	0.462	0.409	−1685
liquid + $\sigma \rightleftharpoons \text{bcc}$	peritectic	1578.1	0.123	0.372	0.156	−7973
bcc $\rightleftharpoons \text{cub}$	congruent	1386.6	0.050	0.050		−4788
bcc $\rightleftharpoons \text{cub} + \sigma$	eutectoid	1385.1	0.084	0.081	0.350	−5299
bcc $\rightleftharpoons \text{fcc} + \text{cub}$	eutectoid	1384.3	0.009	0.006	0.010	−3965
cub + $\sigma \rightleftharpoons \text{cbcc}$	peritectoid	1373.8	0.080	0.351	0.139	−1563
$\sigma \rightleftharpoons \text{cbcc} + \mu$	eutectoid	1340.2	0.357	0.138	0.462	−2380

**Table IIIa.** Integral quantities for the stable phases at 1800 K.

Phase	$x_{\text{Mo}}$	$\Delta G_{\text{m}}$ [J/mol]	$\Delta H_{\text{m}}$ [J/mol]	$\Delta S_{\text{m}}$ [J/(mol·K)]	$G_{\text{m}}^{\text{E}}$ [J/mol]	$S_{\text{m}}^{\text{E}}$ [J/(mol·K)]	$\Delta C_P$ [J/(mol·K)]
liquid	0.000	0	0	0.000	0	0.000	0.000
	0.100	−2818	3855	3.707	2048	1.004	−0.061
	0.200	−3640	7027	5.926	3850	1.765	−0.121
	0.296	−3696	9694	7.439	5396	2.388	−0.180
bcc	0.668	−2824	7220	5.580	6693	0.293	−0.106
	0.700	−2745	7122	5.482	6397	0.403	−0.096
	0.800	−2452	6034	4.714	5037	0.554	−0.064
	0.900	−1931	3689	3.122	2934	0.419	−0.032
	1.000	0	0	0.000	0	0.000	0.000

Reference states: Mn(liquid), Mo(bcc)

**Table IIIb.** Partial quantities for Mn in the stable phases at 1800 K.

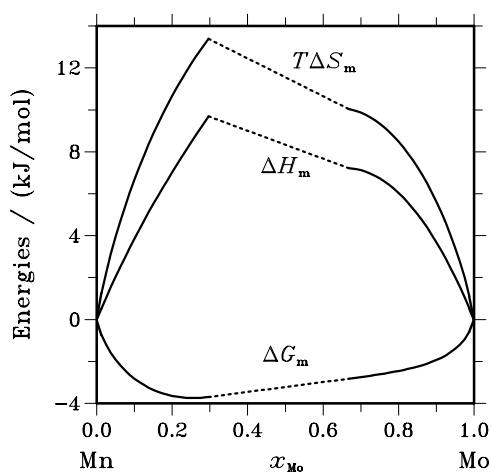
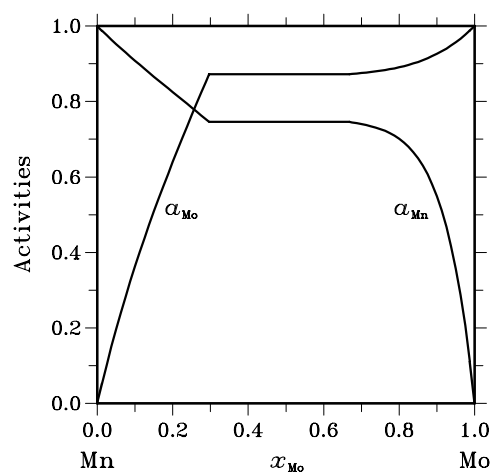
Phase	$x_{\text{Mn}}$	$\Delta G_{\text{Mn}}$ [J/mol]	$\Delta H_{\text{Mn}}$ [J/mol]	$\Delta S_{\text{Mn}}$ [J/(mol·K)]	$G_{\text{Mn}}^{\text{E}}$ [J/mol]	$S_{\text{Mn}}^{\text{E}}$ [J/(mol·K)]	$a_{\text{Mn}}$	$\gamma_{\text{Mn}}$
liquid	1.000	0	0	0.000	0	0.000	1.000	1.000
	0.900	−1446	388	1.019	131	0.143	0.908	1.009
	0.800	−2882	1177	2.255	458	0.400	0.825	1.031
	0.704	−4391	1788	3.433	863	0.514	0.746	1.059
bcc	0.332	−4391	7981	6.873	12091	−2.283	0.746	2.243
	0.300	−4503	10545	8.360	13516	−1.651	0.740	2.467
	0.200	−5314	19651	13.869	18773	0.488	0.701	3.506
	0.100	−8990	30711	22.056	25471	2.911	0.548	5.484
	0.000	−∞	43899	∞	33783	5.620	0.000	9.557

Reference state: Mn(liquid)

**Table IIIc.** Partial quantities for Mo in the stable phases at 1800 K.

Phase	$x_{\text{Mo}}$	$\Delta G_{\text{Mo}}$ [J/mol]	$\Delta H_{\text{Mo}}$ [J/mol]	$\Delta S_{\text{Mo}}$ [J/(mol·K)]	$G_{\text{Mo}}^{\text{E}}$ [J/mol]	$S_{\text{Mo}}^{\text{E}}$ [J/(mol·K)]	$a_{\text{Mo}}$	$\gamma_{\text{Mo}}$
liquid	0.000	$-\infty$	42900	$\infty$	21868	11.684	0.000	4.311
	0.100	-15165	35054	27.899	19296	8.754	0.363	3.630
	0.200	-6670	30427	20.610	17417	7.228	0.640	3.202
	0.296	-2044	28492	16.964	16172	6.844	0.872	2.946
bcc	0.668	-2044	6841	4.936	4005	1.576	0.872	1.307
	0.700	-1992	5655	4.249	3346	1.283	0.875	1.251
	0.800	-1736	2630	2.426	1603	0.570	0.890	1.113
	0.900	-1147	686	1.019	430	0.143	0.926	1.029
	1.000	0	0	0.000	0	0.000	1.000	1.000

Reference state: Mo(bcc)

**Fig. 2.** Integral quantities of the stable phases at  $T=1800$  K.**Fig. 3.** Activities in the stable phases at  $T=1800$  K.**Table IV.** Standard reaction quantities at 298.15 K for the compounds per mole of atoms.

Compound	$x_{\text{Mo}}$	$\Delta_f G^\circ$ / (J/mol)	$\Delta_f H^\circ$ / (J/mol)	$\Delta_f S^\circ$ / (J/(mol·K))	$\Delta_f C_P^\circ$ / (J/(mol·K))
$\mu$	0.462	632	2035	4.707	0.138

## References

[95Lee] B.-J. Lee: unpublished research, 1995.