V – W (Vanadium – Tungsten)

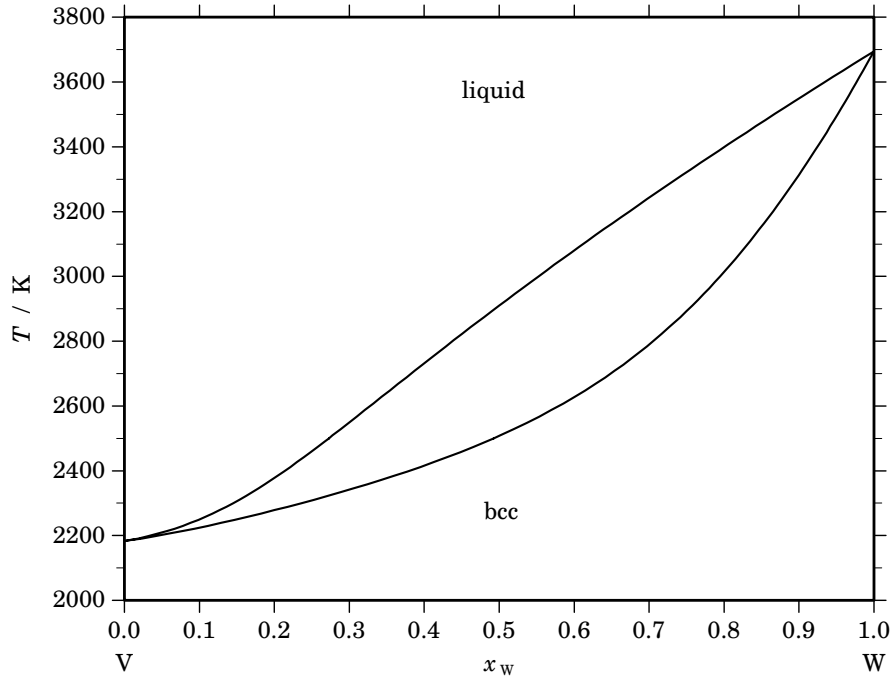

Fig. 1. Calculated phase diagram for the system V-W.

The literature on the V-W system has been reviewed in [1991Nag] and thermodynamic datasets have been optimised by [2005Bra, 2005Hua]. The phase diagram consists only of the liquid and the bcc phases with continuous solubility for the components. The phase diagram has been investigated several times with some conflicting results especially in the V-rich part where older investigations found a minimum in the solidus line. Later investigations [1969Rud, 1975Kol] found that the solidus increases monotonically when W is added to vanadium alloys. Therefore, the previous minimum was attributed to higher levels of impurity in the samples of the older investigations. No data on the thermodynamics of mixing have been available. For the optimisation of the thermodynamic dataset [2005Bra] have selected the solidus data of [1969Rud] and the liquidus data of [1960Bar] for samples with more than 30 at.% W. The evaluation of [2005Bra] is preferred here over that of [2005Hua] because the latter authors propose excess entropies for the liquid and bcc phases which are quite high. The dataset of [2005Bra] predicts a miscibility gap in the bcc phase below 1070 K, however, no experimental evidence is available.

Table I. Phases, structures and models.

Phase	Struktur-bericht	Prototype	Pearson symbol	Space group	SGTE name	Model
liquid					LIQUID	$(V,W)_1$
bcc	$A2$	W	$cI2$	$Im\overline{3}m$	BCC_A2	$(V,W)_1$

Table IIa. Integral quantities for the liquid phase at 3700 K.

x_{W}	ΔG_{m} [J/mol]	ΔH_{m} [J/mol]	ΔS_{m} [J/(mol·K)]	$G_{\mathrm{m}}^{\mathrm{E}}$ [J/mol]	$S_{\mathrm{m}}^{\mathrm{E}}$ [J/(mol·K)]	ΔC_P [J/(mol·K)]
0.000	0	0	0.000	0	0.000	0.000
0.100	−10001	0	2.703	0	0.000	0.000
0.200	−15394	0	4.161	0	0.000	0.000
0.300	−18792	0	5.079	0	0.000	0.000
0.400	−20704	0	5.596	0	0.000	0.000
0.500	−21324	0	5.763	0	0.000	0.000
0.600	−20704	0	5.596	0	0.000	0.000
0.700	−18792	0	5.079	0	0.000	0.000
0.800	−15394	0	4.161	0	0.000	0.000
0.900	−10001	0	2.703	0	0.000	0.000
1.000	0	0	0.000	0	0.000	0.000

Reference states: V(liquid), W(liquid)

Table IIb. Partial quantities for V in the liquid phase at 3700 K.

x_{V}	ΔG_{V} [J/mol]	ΔH_{V} [J/mol]	ΔS_{V} [J/(mol·K)]	$G_{\mathrm{V}}^{\mathrm{E}}$ [J/mol]	$S_{\mathrm{V}}^{\mathrm{E}}$ [J/(mol·K)]	a_{V}	γ_{V}
1.000	0	0	0.000	0	0.000	1.000	1.000
0.900	−3241	0	0.876	0	0.000	0.900	1.000
0.800	−6865	0	1.855	0	0.000	0.800	1.000
0.700	−10973	0	2.966	0	0.000	0.700	1.000
0.600	−15715	0	4.247	0	0.000	0.600	1.000
0.500	−21324	0	5.763	0	0.000	0.500	1.000
0.400	−28189	0	7.619	0	0.000	0.400	1.000
0.300	−37039	0	10.010	0	0.000	0.300	1.000
0.200	−49512	0	13.382	0	0.000	0.200	1.000
0.100	−70836	0	19.145	0	0.000	0.100	1.000
0.000	$-\infty$	0	∞	0	0.000	0.000	1.000

Reference state: V(liquid)

Table IIc. Partial quantities for W in the liquid phase at 3700 K.

x_{W}	ΔG_{W} [J/mol]	ΔH_{W} [J/mol]	ΔS_{W} [J/(mol·K)]	$G_{\mathrm{W}}^{\mathrm{E}}$ [J/mol]	$S_{\mathrm{W}}^{\mathrm{E}}$ [J/(mol·K)]	a_{W}	γ_{W}
0.000	$-\infty$	0	∞	0	0.000	0.000	1.000
0.100	−70836	0	19.145	0	0.000	0.100	1.000
0.200	−49512	0	13.382	0	0.000	0.200	1.000
0.300	−37039	0	10.010	0	0.000	0.300	1.000
0.400	−28189	0	7.619	0	0.000	0.400	1.000
0.500	−21324	0	5.763	0	0.000	0.500	1.000
0.600	−15715	0	4.247	0	0.000	0.600	1.000
0.700	−10973	0	2.966	0	0.000	0.700	1.000
0.800	−6865	0	1.855	0	0.000	0.800	1.000
0.900	−3241	0	0.876	0	0.000	0.900	1.000
1.000	0	0	0.000	0	0.000	1.000	1.000

Reference state: W(liquid)

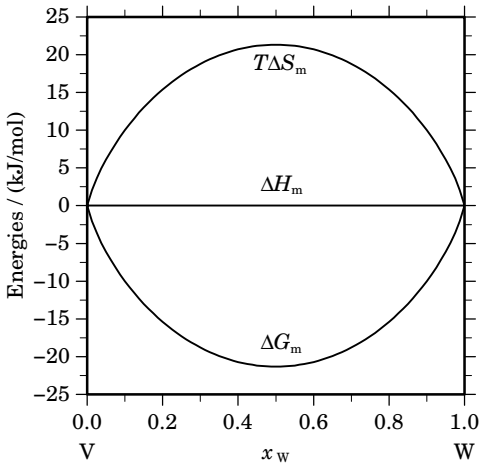

Fig. 2. Integral quantities of the liquid phase at T=3700 K.

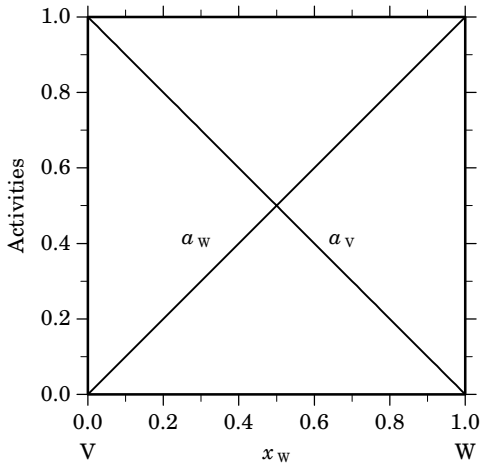

Fig. 3. Activities in the liquid phase at T=3700 K.

Table IIIa. Integral quantities for the stable phases at 2000 K.

Phase	x_W	ΔG_m [J/mol]	ΔH_m [J/mol]	ΔS_m [J/(mol·K)]	G_m^E [J/mol]	S_m^E [J/(mol·K)]	ΔC_P [J/(mol·K)]
bcc	0.000	0	0	0.000	0	0.000	0.000
	0.100	−3801	1605	2.703	1605	0.000	0.000
	0.200	−5469	2852	4.161	2852	0.000	0.000
	0.300	−6414	3744	5.079	3744	0.000	0.000
	0.400	−6913	4279	5.596	4279	0.000	0.000
	0.500	−7069	4457	5.763	4457	0.000	0.000
	0.600	−6913	4279	5.596	4279	0.000	0.000
	0.700	−6414	3744	5.079	3744	0.000	0.000
	0.800	−5469	2852	4.161	2852	0.000	0.000
	0.900	−3801	1605	2.703	1605	0.000	0.000
	1.000	0	0	0.000	0	0.000	0.000

Reference states: V(bcc), W(bcc)

Table IIIb. Partial quantities for V in the stable phases at 2000 K.

Phase	x_V	ΔG_V [J/mol]	ΔH_V [J/mol]	ΔS_V [J/(mol·K)]	G_V^E [J/mol]	S_V^E [J/(mol·K)]	a_V	γ_V
bcc	1.000	0	0	0.000	0	0.000	1.000	1.000
	0.900	−1574	178	0.876	178	0.000	0.910	1.011
	0.800	−2998	713	1.855	713	0.000	0.835	1.044
	0.700	−4327	1605	2.966	1605	0.000	0.771	1.101
	0.600	−5642	2852	4.247	2852	0.000	0.712	1.187
	0.500	−7069	4457	5.763	4457	0.000	0.654	1.307
	0.400	−8819	6418	7.619	6418	0.000	0.588	1.471
	0.300	−11285	8736	10.010	8736	0.000	0.507	1.691
	0.200	−15354	11410	13.382	11410	0.000	0.397	1.986
	0.100	−23849	14441	19.145	14441	0.000	0.238	2.383
	0.000	$-\infty$	17828	∞	17828	0.000	0.000	2.922

Reference state: V(bcc)

Table IIIc. Partial quantities for W in the stable phases at 2000 K.

Phase	x_W	ΔG_W [J/mol]	ΔH_W [J/mol]	ΔS_W [J/(mol·K)]	G_W^E [J/mol]	S_W^E [J/(mol·K)]	a_W	γ_W
bcc	0.000	$-\infty$	17828	∞	17828	0.000	0.000	2.922
	0.100	−23849	14441	19.145	14441	0.000	0.238	2.383
	0.200	−15353	11410	13.382	11410	0.000	0.397	1.986
	0.300	−11285	8736	10.010	8736	0.000	0.507	1.691
	0.400	−8819	6418	7.619	6418	0.000	0.588	1.471
	0.500	−7069	4457	5.763	4457	0.000	0.654	1.307
	0.600	−5642	2852	4.247	2852	0.000	0.712	1.187
	0.700	−4327	1605	2.966	1605	0.000	0.771	1.101
	0.800	−2998	713	1.855	713	0.000	0.835	1.044
	0.900	−1574	178	0.876	178	0.000	0.910	1.011
	1.000	0	0	0.000	0	0.000	1.000	1.000

Reference state: W(bcc)

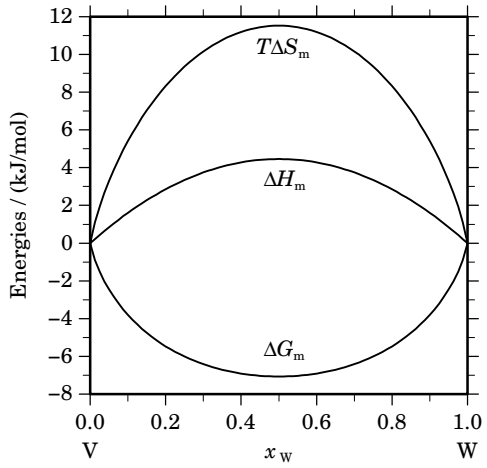

Fig. 4. Integral quantities of the stable phases at T=2000 K.

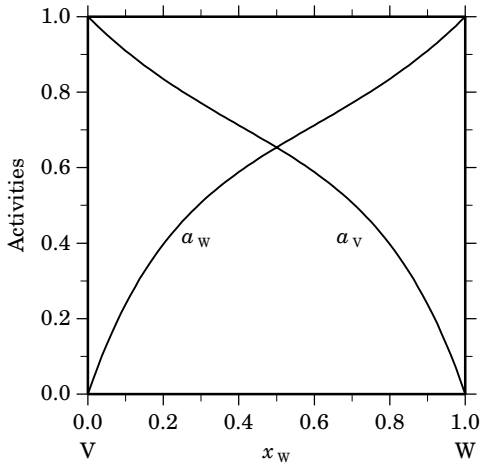

Fig. 5. Activities in the stable phases at T=2000 K.

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