

Cs – Na (Caesium – Sodium)

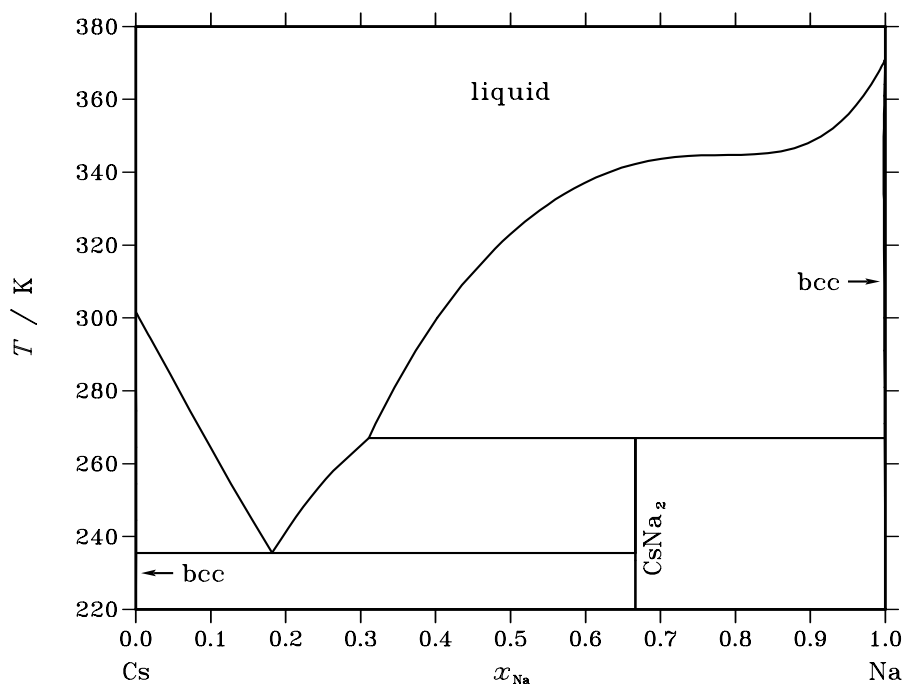


Fig. 1. Calculated phase diagram for the system Cs-Na.

The phase diagram for the Cs-Na system exhibits complete mixing between the pure elements in the liquid phase, negligible mutual solubility of the crystalline elements and the existence of an intermetallic compound phase CsNa_2 which melts peritectically at about 265.4 K. The flatness of the liquidus for Na rich compositions indicates a tendency to form a miscibility gap in the liquid phase at lower temperatures. The dataset adopted by SGTE were derived by Potter and Rand [85Pot] and is in very good agreement with the experimental data for the system. The phase diagram has been studied by Ott *et al.* [71Ott], Gorla [35Gor] and Rinck [36Rin]. Thermodynamic properties in the liquid phase were measured by Ichikawa *et al.* [74Ich], Oriani [59Ori] and Yokokawa and Kleppa [64Yok]. The assessment by Rand and Potter was based on these data coupled to the experimental phase diagram information. More recently the thermodynamic properties of the liquid phase have been studied further [88Kag, 89Der, 90Erm]. The system has also been reviewed by Bale [82Bal].

Table I. Phases, structures and models.

Phase	Strukturbericht	Prototype	Pearson symbol	Space group	SGTE name	Model
liquid					LIQUID	$(\text{Cs},\text{Na})_1$
bcc	A2	W	<i>cI2</i>	$Im\bar{3}m$	BCC_A2	$(\text{Cs},\text{Na})_1$
CsNa_2	C14	MgZn_2	<i>hP12</i>	$P6_3/mmc$	CSNA_S	Cs_1Na_2

Table II. Invariant reactions.

Reaction	Type	T / K	Compositions / x_{Na}			$\Delta_r H / (\text{J/mol})$
$\text{liquid} + \text{bcc} \rightleftharpoons \text{CsNa}_2$	peritectic	267.1	0.311	0.999	0.667	−3562
$\text{liquid} \rightleftharpoons \text{bcc} + \text{CsNa}_2$	eutectic	235.5	0.182	0.000	0.667	−3011

Table IIIa. Integral quantities for the liquid phase at 385 K.

x_{Na}	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)]
0.000	0	0	0.000	0	0.000	0.000
0.100	−928	150	2.799	113	0.096	0.181
0.200	−1302	287	4.125	300	−0.035	0.321
0.300	−1446	454	4.935	510	−0.144	0.422
0.400	−1448	641	5.428	706	−0.168	0.482
0.500	−1353	805	5.607	865	−0.156	0.502
0.600	−1188	890	5.398	966	−0.198	0.482
0.700	−975	846	4.729	981	−0.350	0.422
0.800	−732	654	3.600	870	−0.561	0.321
0.900	−468	340	2.099	573	−0.604	0.181
1.000	0	0	0.000	0	0.000	0.000

Reference states: Cs(liquid), Na(liquid)

Table IIIb. Partial quantities for Cs in the liquid phase at 385 K.

x_{Cs}	ΔG_{Cs} [J/mol]	ΔH_{Cs} [J/mol]	ΔS_{Cs} [J/(mol·K)]	G_{Cs}^{E} [J/mol]	S_{Cs}^{E} [J/(mol·K)]	a_{Cs}	γ_{Cs}
1.000	0	0	0.000	0	0.000	1.000	1.000
0.900	−385	19	1.050	−48	0.174	0.887	0.985
0.800	−825	−14	2.107	−111	0.252	0.773	0.966
0.700	−1255	−93	3.017	−113	0.051	0.676	0.965
0.600	−1655	−97	4.048	−20	−0.199	0.596	0.994
0.500	−2022	137	5.609	197	−0.154	0.532	1.063
0.400	−2346	728	7.982	588	0.364	0.481	1.201
0.300	−2595	1669	11.075	1259	1.065	0.445	1.482
0.200	−2749	2753	14.291	2403	0.910	0.424	2.119
0.100	−3041	3487	16.956	4330	−2.189	0.387	3.867
0.000	−∞	3011	∞	7496	−11.651	0.000	10.400

Reference state: Cs(liquid)

Table IIIc. Partial quantities for Na in the liquid phase at 385 K.

x_{Na}	ΔG_{Na} [J/mol]	ΔH_{Na} [J/mol]	ΔS_{Na} [J/(mol·K)]	G_{Na}^{E} [J/mol]	S_{Na}^{E} [J/(mol·K)]	a_{Na}	γ_{Na}
0.000	−∞	1873	∞	515	3.525	0.000	1.175
0.100	−5811	1327	18.538	1560	−0.607	0.163	1.628
0.200	−3208	1488	12.199	1944	−1.183	0.367	1.835
0.300	−1892	1731	9.410	1962	−0.600	0.554	1.846
0.400	−1138	1748	7.497	1795	−0.121	0.701	1.752
0.500	−685	1473	5.604	1534	−0.159	0.807	1.615
0.600	−417	998	3.674	1218	−0.573	0.878	1.463
0.700	−280	494	2.010	862	−0.956	0.916	1.309
0.800	−227	129	0.927	487	−0.929	0.931	1.164
0.900	−182	−9	0.448	156	−0.428	0.945	1.050
1.000	0	0	0.000	0	0.000	1.000	1.000

Reference state: Na(liquid)

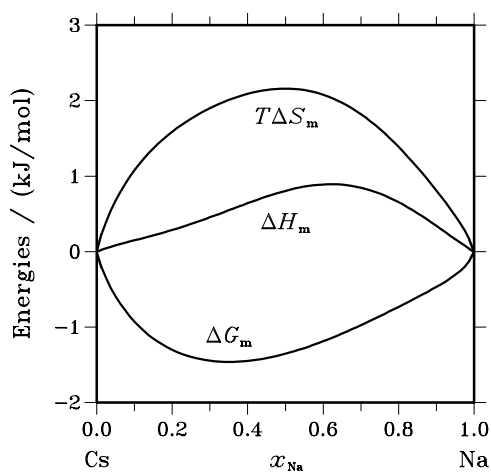
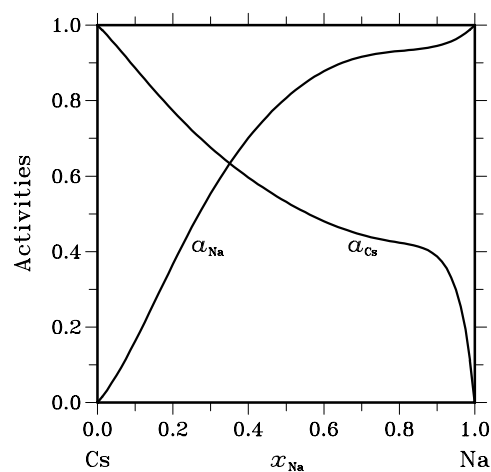
Fig. 2. Integral quantities of the liquid phase at $T=385$ K.Fig. 3. Activities in the liquid phase at $T=385$ K.

Table IV. Standard reaction quantities at 298.15 K for the compounds per mole of atoms.

Compound	x_{Na}	$\Delta_f G^\circ / (\text{J/mol})$	$\Delta_f H^\circ / (\text{J/mol})$	$\Delta_f S^\circ / (\text{J}/(\text{mol}\cdot\text{K}))$	$\Delta_f C_P^\circ / (\text{J}/(\text{mol}\cdot\text{K}))$
Cs_1Na_2	0.667	3	-2267	-7.615	0.000

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