Ni – Pb (Nickel – Lead)

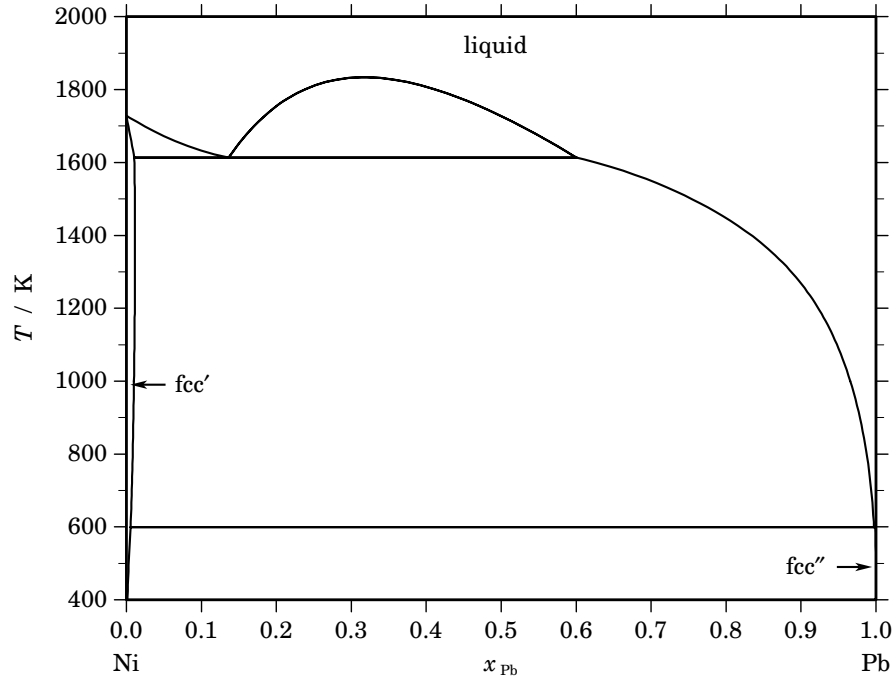

Fig. 1. Calculated phase diagram for the system Ni-Pb.

Alloys based on Ni-Pb or Cu-Ni-Pb are used as bearings in heavy-duty diesel engines. The literature on the Ni-Pb system has been reviewed in [1991Nas, 1999Gho, 2000Wan] and optimised thermodynamic datasets have been reported in [1999Gho, 2000Wan]. The Ni-Pb system has been been investigated repeatedly with various techniques. The liquidus has been determined by thermal analysis [1907Por, 1908Vos], chemical analysis [1955Pel, 1958Ald, 1959Fle, 1961Dav], and EMF measurements [1964Cav, 1981Tas]. The temperatures given in [1908Vos] had to be corrected due to a deviation in the melting point of pure Ni [1991Nas]. The activities of Ni in Pb-rich melts have been determined in EMF experiments [1964Cav] and activities of Pb in Ni-rich melts have been obtained by an isopiestic technique [1986Pom]. The location of the consolute point on the miscibility gap in the liquid has been estimated by [1960Mil] by extrapolating data from the Fe-Ni-Pb system. Both assessments [1999Gho, 2000Wan] provide good descriptions of the experimental data and they may be considered to be equivalent. The present tables and diagrams have been calculated with the data of [2000Wan] but that does not mean that those of [1999Gho] have been rejected.

Table I. Phases, structures and models.

Phase	Struktur-bericht	Prototype	Pearson symbol	Space group	SGTE name	Model
liquid					LIQUID	$(Ni,Pb)_1$
fcc	$A1$	Cu	$cF4$	$Fm\overline{3}m$	FCC_A1	$(Ni,Pb)_1$

Table II. Invariant reactions.

Reaction	Type	T / K	Compositions / x_{Pb}			$\Delta_{\mathrm{r}}H$ / (J/mol)
liquid $\rightleftharpoons$ liquid′ + liquid″	critical	1832.1	0.318	0.318	0.318	0
liquid′ $\rightleftharpoons$ fcc′ + liquid″	monotectic	1613.3	0.136	0.010	0.601	−15523
liquid″ $\rightleftharpoons$ fcc′ + fcc″	eutectic	599.5	0.997	0.005	0.999	−4799

Table IIIa. Integral quantities for the liquid phase at 1900 K.

x_{Pb}	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	−2242	2790	2.648	2894	−0.055	0.000
0.200	−2944	5291	4.334	4961	0.174	0.000
0.300	−3428	7083	5.532	6222	0.453	0.000
0.400	−3863	7958	6.222	6769	0.626	0.000
0.500	−4219	7883	6.369	6731	0.606	0.000
0.600	−4397	6968	5.981	6235	0.386	0.000
0.700	−4282	5426	5.110	5368	0.031	0.000
0.800	−3769	3541	3.847	4136	−0.314	0.000
0.900	−2701	1627	2.278	2434	−0.425	0.000
1.000	0	0	0.000	0	0.000	0.000

Reference states: Ni(liquid), Pb(liquid)

Table IIIb. Partial quantities for Ni in the liquid phase at 1900 K.

x_{Ni}	ΔG_{Ni} [J/mol]	ΔH_{Ni} [J/mol]	ΔS_{Ni} [J/(mol·K)]	$G_{\mathrm{Ni}}^{\mathrm{E}}$ [J/mol]	$S_{\mathrm{Ni}}^{\mathrm{E}}$ [J/(mol·K)]	a_{Ni}	γ_{Ni}
1.000	0	0	0.000	0	0.000	1.000	1.000
0.900	−1256	55	0.690	409	−0.186	0.924	1.026
0.800	−1870	895	1.455	1655	−0.400	0.888	1.110
0.700	−2065	3026	2.680	3570	−0.286	0.877	1.254
0.600	−2230	6388	4.536	5840	0.289	0.868	1.447
0.500	−2790	10498	6.994	8160	1.231	0.838	1.676
0.400	−4094	14594	9.836	10381	2.218	0.772	1.929
0.300	−6355	17780	12.702	12665	2.692	0.669	2.229
0.200	−9790	19165	15.240	15635	1.858	0.538	2.690
0.100	−15851	18012	17.823	20525	−1.322	0.367	3.666
0.000	$-\infty$	13878	∞	29332	−8.134	0.000	6.403

Reference state: Ni(liquid)

Table IIIc. Partial quantities for Pb in the liquid phase at 1900 K.

x_{Pb}	ΔG_{Pb} [J/mol]	ΔH_{Pb} [J/mol]	ΔS_{Pb} [J/(mol·K)]	$G_{\mathrm{Pb}}^{\mathrm{E}}$ [J/mol]	$S_{\mathrm{Pb}}^{\mathrm{E}}$ [J/(mol·K)]	a_{Pb}	γ_{Pb}
0.000	$-\infty$	27333	∞	32881	−2.920	0.000	8.015
0.100	−11114	27405	20.273	25261	1.128	0.495	4.948
0.200	−7239	22875	15.849	18187	2.467	0.632	3.162
0.300	−6610	16549	12.189	12410	2.178	0.658	2.194
0.400	−6313	10312	8.750	8162	1.132	0.671	1.676
0.500	−5647	5268	5.745	5303	−0.018	0.699	1.399
0.600	−4598	1884	3.411	3472	−0.836	0.747	1.246
0.700	−3394	132	1.856	2240	−1.110	0.807	1.152
0.800	−2263	−366	0.999	1262	−0.857	0.867	1.083
0.900	−1240	−193	0.551	424	−0.325	0.924	1.027
1.000	0	0	0.000	0	0.000	1.000	1.000

Reference state: Pb(liquid)

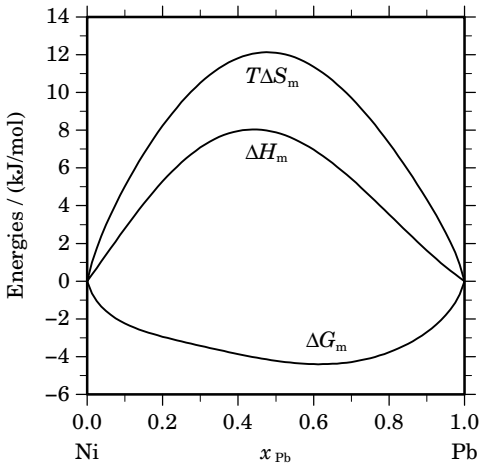

Fig. 2. Integral quantities of the liquid phase at T=1900 K.

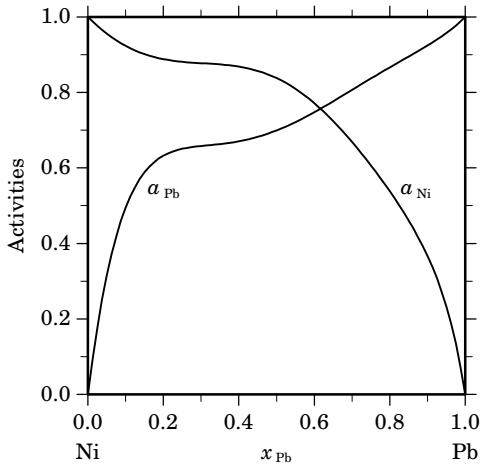

Fig. 3. Activities in the liquid phase at T=1900 K.

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