

## ANEXOS

### ANEXO A

Balanço de massa das pelotas auto-redutoras de cromita

Componente	Cromita	Coque de petróleo	Cimento Portland ARI	Ferro-silício	Sílica	Cal dolomítica
Cr <sub>2</sub> O <sub>3</sub>	41,2					
Fe <sub>2</sub> O <sub>3</sub>	Na		2,78			
FeO	16,86					
SiO <sub>2</sub>	5,66		19,05		100	4
Al <sub>2</sub> O <sub>3</sub>	17,29		4,92			
MgO	15,63		0,55			31,7
CaO	0,38		64,30			57,4
CaO livre			1,01			
CO <sub>2</sub>	na					
M Voláteis	na	10,8				
Fe total	13,1			25		
P	0,007					
C fixo		88,8				
Cinzas		0,4				
S		0,8				
Si				75		
Ca				0,14		
SO <sub>2</sub>			2,63			
K <sub>2</sub> O			0,73			
Na <sub>2</sub> O			0,04			
Outros			3,99			6,9

Composição das pelotas:

Pelota	1	2	3	4	5
	(%)	(%)	(%)	%	(%)
Cromita	77,63	76,81	76,00	74,36	70,51
Coque de petróleo (20% excesso)	17,37	17,19	17,00	16,64	15,77
Fe-75%Si	0,00	1,00	2,00	4,00	2,00
Cimento Portland ARI	5,00	5,00	5,00	5,00	5,00
Sílica	0,00	0,00	0,00	0,00	2,88
Cal dolomítica hidratada	0,00	0,00	0,00	0,00	3,83

Composição da escória (calculada teoricamente)

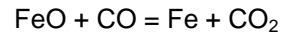
Dissolução Cromita	P1				P2				P3			
	1	%	0	%	1	%	0	%	1	%	0	%
CaO	3,5605	10,2501	3,2655	72,7040	3,5574	9,8759	3,2655	53,5711	3,5543	9,5266	3,2655	42,4103
MgO	12,1611	35,0098	0,0275	0,6123	120329	33,4054	0,0275	0,4511	11,9063	31,9123	0,0275	0,3572
SiO <sub>2</sub>	5,3464	15,3913	0,9525	21,2067	6,9041	19,1669	2,5566	41,9421	8,4624	22,6817	4,1608	54,0377
Al <sub>2</sub> O <sub>3</sub>	13,6682	39,3487	0,2460	5,4770	13,5264	37,5486	0,2460	4,0357	13,3864	35,8794	0,2460	3,1949
Basic. quat.	0,8268		2,7476		0,7631		1,1750		0,7076		0,7473	
m esc cromit. total	34,7361		4,4915		36,0208		6,0956		37,3094		7,6998	
m esc s/cromit	4,4915				6,0956				7,6998			
T liquidus (°C)		2000		2100		1850		1470		1820		1500
CaO/SiO <sub>2</sub>		0,666		3,428		0,515		1,2773		0,42		0,785

Dissolução cromita	P4				P5			
	1	%	0	%	1	%	0	%
CaO	3,5481	8,8971	3,2655	29,9365	5,7319	13,7731	5,4639	38,6265
MgO	11,6500	29,2135	0,0275	0,2521	12,2623	29,4653	1,2416	8,7774
SiO <sub>2</sub>	11,5778	29,0326	7,3691	67,5561	11,1849	26,8762	7,1940	50,8570
Al <sub>2</sub> O <sub>3</sub>	13,1028	32,8567	0,2460	2,2552	12,4372	29,8854	0,2460	1,7391
Basic quat	0,6158		0,4324		0,7618		0,9013	
m esc.cromit total	39,8787		10,9081		41,6162		14,1455	
m esc s/cromita	10,9081				14,1455			
T liquidus (°C)		1680,00		1550,00				
CaO/SiO <sub>2</sub>		0,306453		0,44314		0,51		0,76

## ANEXO B

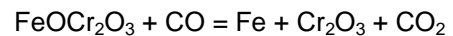
Cálculos para uma atividade do FeO.Cr<sub>2</sub>O<sub>3</sub> unitária.

Análise termodinâmico



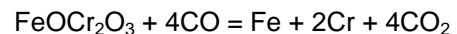
$$\Delta G^\circ = -4120 + 4,99T$$

T (°C)	T (K)	10000/T	$\Delta G^\circ$	$-\Delta G^\circ/RT$	$\exp(-\Delta G^\circ/RT)$	K eq	pCO <sub>2</sub> /pCO	Log (pCO <sub>2</sub> /pCO)
600	873	11,45	236,27	-0,14	0,8727	0,8727	0,8727	-0,05915
700	973	10,28	735,27	-0,38	0,6837	0,6837	0,6837	-0,16517
800	1073	9,32	1234,27	-0,58	0,5605	0,5605	0,5605	-0,25142
900	1173	8,53	1733,27	-0,74	0,4754	0,4754	0,4754	-0,32296
1000	1273	7,86	2232,27	-0,88	0,4137	0,4137	0,4137	-0,38327
1100	1373	7,28	2731,27	-1,00	0,3675	0,3675	0,3675	-0,43479
1200	1473	6,79	3230,27	-1,10	0,3317	0,3317	0,3317	-0,47932
1300	1573	6,36	3729,27	-1,19	0,3033	0,3033	0,3033	-0,51818
1400	1673	5,98	4228,27	-1,27	0,2803	0,2803	0,2803	-0,55240
1500	1773	5,64	4727,27	-1,34	0,2614	0,2614	0,2614	-0,58276
1600	1873	5,34	5226,27	-1,40	0,2455	0,2455	0,2455	-0,60987
1700	1973	5,07	5725,27	-1,46	0,2321	0,2321	0,2321	-0,63424



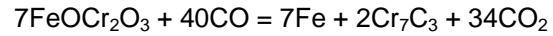
$$\Delta G^\circ = 8550 + 3,02T$$

T (°C)	T (K)	10000/T	$\Delta G^\circ$	$-\Delta G^\circ/RT$	$\exp(-\Delta G^\circ/RT)$	K eq	$p\text{CO}_2/p\text{CO}$	Log ( $p\text{CO}_2/p\text{CO}$ )
600	873	11,45	11186,46	-6,45	0,0016	0,0016	0,0016	-2,80069
700	973	10,28	11488,46	-5,94	0,0026	0,0026	0,0026	-2,58069
800	1073	9,32	11790,46	-5,53	0,0040	0,0040	0,0040	-2,40169
900	1173	8,53	12092,46	-5,19	0,0056	0,0056	0,0056	-2,25322
1000	1273	7,86	12394,46	-4,90	0,0074	0,0074	0,0074	-2,12807
1100	1373	7,28	12696,46	-4,65	0,0095	0,0095	0,0095	-2,02115
1200	1473	6,79	12998,46	-4,44	0,0118	0,0118	0,0118	-1,92875
1300	1573	6,36	13300,46	-4,26	0,0142	0,0142	0,0142	-1,84810
1400	1673	5,98	13602,46	-4,09	0,0167	0,0167	0,0167	-1,77708
1500	1773	5,64	13904,46	-3,95	0,0193	0,0193	0,0193	-1,71408
1600	1873	5,34	14206,46	-3,82	0,0220	0,0220	0,0220	-1,65781
1700	1973	5,07	14508,46	-3,70	0,0247	0,0247	0,0247	-1,60724



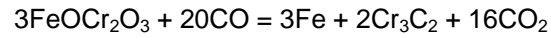
$$\Delta G^\circ = 72430 + 5,02T$$

T (°C)	T (K)	10000/T	$\Delta G^\circ$	$-\Delta G^\circ/RT$	$\exp(-\Delta G^\circ/RT)$	K eq	$p\text{CO}_2/p\text{CO}$	Log ( $p\text{CO}_2/p\text{CO}$ )
600	873	11,45	76812,46	-44,28	$5,8737 \times 10^{-20}$	$5,8737 \times 10^{-20}$	$1,5568 \times 10^{-5}$	-4,80777
700	973	10,28	77314,46	-39,99	$4,2916 \times 10^{-18}$	$4,2916 \times 10^{-18}$	$4,5515 \times 10^{-5}$	-4,34185
800	1073	9,32	77816,46	-36,50	$1,4091 \times 10^{-16}$	$1,4091 \times 10^{-16}$	$1,0895 \times 10^{-4}$	-3,96276
900	1173	8,53	78318,46	-33,60	$2,5511 \times 10^{-15}$	$2,5511 \times 10^{-15}$	$2,2474 \times 10^{-4}$	-3,64832
1000	1273	7,86	78820,46	-31,16	$2,9303 \times 10^{-14}$	$2,9303 \times 10^{-14}$	$4,1374 \times 10^{-4}$	-3,38327
1100	1373	7,28	79322,46	-29,08	$2,3586 \times 10^{-13}$	$2,3586 \times 10^{-13}$	$6,9689 \times 10^{-4}$	-3,15684
1200	1473	6,79	79824,46	-27,27	$1,4303 \times 10^{-12}$	$1,4303 \times 10^{-12}$	$1,0936 \times 10^{-3}$	-2,96115
1300	1573	6,36	80326,46	-25,70	$6,8970 \times 10^{-12}$	$6,8970 \times 10^{-12}$	$1,6206 \times 10^{-3}$	-2,79034
1400	1673	5,98	80828,46	-24,31	$2,7556 \times 10^{-11}$	$2,7556 \times 10^{-11}$	$2,2912 \times 10^{-3}$	-2,63994
1500	1773	5,64	81330,46	-23,09	$9,4173 \times 10^{-11}$	$9,4173 \times 10^{-11}$	$3,1152 \times 10^{-3}$	-2,50652
1600	1873	5,34	81832,46	-21,99	$2,8225 \times 10^{-10}$	$2,8225 \times 10^{-10}$	$4,0988 \times 10^{-3}$	-2,38734
1700	1973	5,07	82334,46	-21,00	$7,5689 \times 10^{-10}$	$7,5689 \times 10^{-10}$	$5,2451 \times 10^{-3}$	-2,28024



$$\Delta G^\circ = 194750 + 262,56T$$

T (°C)	T (K)	10000/T	$\Delta G^\circ$	$-\Delta G^\circ/RT$	$\exp(-\Delta G^\circ/RT)$	K eq	pCO <sub>2</sub> /pCO	pCO	pCO <sub>2</sub> =1-pCO	Log (pCO <sub>2</sub> /pCO)
600	873	11,45	423964,88	-244,41	$7,1512 \times 10^{-107}$	$7,1512 \times 10^{-107}$	0,0008	0,9992	0,0008	-3,1219
700	973	10,28	450220,88	-232,87	$7,3371 \times 10^{-102}$	$7,3371 \times 10^{-102}$	0,0011	0,9989	0,0011	-2,9745
800	1073	9,32	476476,88	-223,48	$8,7624 \times 10^{-98}$	$8,7624 \times 10^{-98}$	0,0014	0,9986	0,0014	-2,8546
900	1173	8,53	502732,88	-215,70	$2,1114 \times 10^{-94}$	$2,1114 \times 10^{-94}$	0,0018	0,9982	0,0018	-2,7552
1000	1273	7,86	528988,88	-209,13	$1,4668 \times 10^{-91}$	$1,4668 \times 10^{-91}$	0,0021	0,9979	0,0021	-2,6713
1100	1373	7,28	555244,88	-203,52	$4,0789 \times 10^{-89}$	$4,0789 \times 10^{-89}$	0,0025	0,9975	0,0025	-2,5997
1200	1473	6,79	581500,88	-198,68	$5,1909 \times 10^{-87}$	$5,1909 \times 10^{-87}$	0,0029	0,9971	0,0029	-2,5378
1300	1573	6,36	607756,88	-194,45	$3,5673 \times 10^{-85}$	$3,5673 \times 10^{-85}$	0,0033	0,9967	0,0033	-2,4838
1400	1673	5,98	634012,88	-190,72	$1,4785 \times 10^{-83}$	$1,4785 \times 10^{-83}$	0,0037	0,9964	0,0036	-2,4362
1500	1773	5,64	660268,88	-187,47	$4,0258 \times 10^{-82}$	$4,0258 \times 10^{-82}$	0,0040	0,9960	0,0040	-2,3940
1600	1873	5,34	686524,88	-184,47	$7,7026 \times 10^{-81}$	$7,7026 \times 10^{-81}$	0,0044	0,9956	0,0044	-2,3563
1700	1973	5,07	712780,88	-181,82	$1,0927 \times 10^{-79}$	$1,0927 \times 10^{-79}$	0,0048	0,9953	0,0047	-2,3224



$$\Delta G^0 = 20250 + 170,1T$$

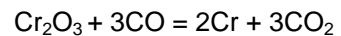
T (°C)	T (K)	10000/T	$\Delta G^0$	$-\Delta G^0/RT$	$\exp(-\Delta G^0/RT)$	K eq	pCO <sub>2</sub> /pCO	pCO	pCO <sub>2</sub> =1-pCO	Log (pCO <sub>2</sub> /pCO)
600	873	11,45	168747,3	-97,28	$5,6457 \times 10^{-43}$	$5,6457 \times 10^{-43}$	0,0023	0,9977	0,0023	-2,64052
700	973	10,28	185757,3	-96,08	$1,8740 \times 10^{-42}$	$1,8740 \times 10^{-42}$	0,0025	0,9975	0,0025	-2,60795
800	1073	9,32	202767,3	-95,10	$4,9741 \times 10^{-42}$	$4,9741 \times 10^{-42}$	0,0026	0,9974	0,0026	-2,58146
900	1173	8,53	219777,3	-94,29	$1,1178 \times 10^{-41}$	$1,1178 \times 10^{-41}$	0,0028	0,9973	0,0028	-2,55948
1000	1273	7,86	236787,3	-93,61	$2,2119 \times 10^{-41}$	$2,2119 \times 10^{-41}$	0,0029	0,9971	0,0029	-2,54095
1100	1373	7,28	253797,3	-93,03	$3,9627 \times 10^{-41}$	$3,9627 \times 10^{-41}$	0,0030	0,9970	0,0030	-2,52513
1200	1473	6,79	270807,3	-92,53	$6,5591 \times 10^{-41}$	$6,5591 \times 10^{-41}$	0,0031	0,9969	0,0031	-2,51145
1300	1573	6,36	287817,3	-92,09	$1,0183 \times 10^{-40}$	$1,0183 \times 10^{-40}$	0,0032	0,9968	0,0032	-2,49951
1400	1673	5,98	304827,3	-91,70	$1,4998 \times 10^{-40}$	$1,4998 \times 10^{-40}$	0,0032	0,9968	0,0032	-2,48900
1500	1773	5,64	321837,3	-91,35	$2,1148 \times 10^{-40}$	$2,1148 \times 10^{-40}$	0,0033	0,9967	0,0033	-2,47967
1600	1873	5,34	338847,3	-91,05	$2,8744 \times 10^{-40}$	$2,8744 \times 10^{-40}$	0,0034	0,9966	0,0034	-2,47134
1700	1973	5,07	355857,3	-90,77	$3,7871 \times 10^{-40}$	$3,7871 \times 10^{-40}$	0,0034	0,9966	0,0034	-2,46386





$$\Delta G^\circ = -11475 + 47,28T$$

T (°C)	T (K)	10000/T	$\Delta G^\circ$	$-\Delta G^\circ/RT$	$\exp(-\Delta G^\circ/RT)$	K eq	pCO <sub>2</sub> /pCO	pCO	pCO <sub>2</sub> =1-pCO	Log (pCO <sub>2</sub> /pCO)
600	873	11,45	29800,44	-17,18	$3,4597 \times 10^{-8}$	$3,4597 \times 10^{-8}$	0,0136	0,9865	0,0135	-1,86524
700	973	10,28	34528,44	-17,86	$1,7530 \times 10^{-8}$	$1,7530 \times 10^{-8}$	0,0115	0,9886	0,0114	-1,93906
800	1073	9,32	39256,44	-18,41	$1,0082 \times 10^{-8}$	$1,0082 \times 10^{-8}$	0,0100	0,9901	0,0099	-1,99911
900	1173	8,53	43984,44	-18,87	$6,3720 \times 10^{-9}$	$6,3720 \times 10^{-9}$	0,0089	0,9911	0,0089	-2,04893
1000	1273	7,86	48712,44	-19,26	$4,3282 \times 10^{-9}$	$4,3282 \times 10^{-9}$	0,0081	0,9920	0,0080	-2,09092
1100	1373	7,28	53440,44	-19,59	$3,1104 \times 10^{-9}$	$3,1104 \times 10^{-9}$	0,0075	0,9926	0,0074	-2,12680
1200	1473	6,79	58168,44	-19,87	$2,3378 \times 10^{-9}$	$2,3378 \times 10^{-9}$	0,0070	0,9931	0,0069	-2,15780
1300	1573	6,36	62896,44	-20,12	$1,8220 \times 10^{-9}$	$1,8220 \times 10^{-9}$	0,0065	0,9935	0,0065	-2,18486
1400	1673	5,98	67624,44	-20,34	$1,4630 \times 10^{-9}$	$1,4630 \times 10^{-9}$	0,0062	0,9939	0,0061	-2,20869
1500	1773	5,64	72352,44	-20,54	$1,2042 \times 10^{-9}$	$1,2042 \times 10^{-9}$	0,0059	0,9941	0,0059	-2,22983
1600	1873	5,34	77080,44	-20,71	$1,0120 \times 10^{-9}$	$1,0120 \times 10^{-9}$	0,0056	0,9944	0,0056	-2,24871
1700	1973	5,07	81808,44	-20,87	$8,6557 \times 10^{-10}$	$8,6557 \times 10^{-10}$	0,0054	0,9946	0,0054	-2,26567



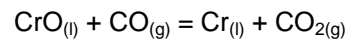
$$\Delta G^\circ = 63880 + 2,00T$$

T (°C)	T (K)	10000/T	$\Delta G^\circ$	$-\Delta G^\circ/RT$	$\exp(-\Delta G^\circ/RT)$	K eq	pCO <sub>2</sub> /pCO	Log (pCO <sub>2</sub> /pCO)
600	873	11,45	65626	-37,83	$3,7119 \times 10^{-17}$	$3,7119 \times 10^{-17}$	$3,3358 \times 10^{-6}$	-5,47680
700	973	10,28	65826	-34,05	$1,6342 \times 10^{-15}$	$1,6342 \times 10^{-15}$	$1,1779 \times 10^{-5}$	-4,92890
800	1073	9,32	66026	-30,97	$3,5533 \times 10^{-14}$	$3,5533 \times 10^{-14}$	$3,2876 \times 10^{-5}$	-4,48312
900	1173	8,53	66226	-28,41	$4,5703 \times 10^{-13}$	$4,5703 \times 10^{-13}$	$7,7028 \times 10^{-5}$	-4,11335
1000	1273	7,86	66426	-26,26	$3,9353 \times 10^{-12}$	$3,9353 \times 10^{-12}$	$1,5788 \times 10^{-4}$	-3,80167
1100	1373	7,28	66626	-24,42	$2,4763 \times 10^{-11}$	$2,4763 \times 10^{-11}$	$2,9148 \times 10^{-4}$	-3,53540
1200	1473	6,79	66826	-22,83	$1,2139 \times 10^{-10}$	$1,2139 \times 10^{-10}$	$4,9513 \times 10^{-4}$	-3,30528
1300	1573	6,36	67026	-21,44	$4,8613 \times 10^{-10}$	$4,8613 \times 10^{-10}$	$7,8629 \times 10^{-4}$	-3,10441
1400	1673	5,98	67226	-20,22	$1,6493 \times 10^{-9}$	$1,6493 \times 10^{-9}$	$1,1815 \times 10^{-3}$	-2,92756
1500	1773	5,64	67426	-19,14	$4,8754 \times 10^{-9}$	$4,8754 \times 10^{-9}$	$1,6956 \times 10^{-3}$	-2,77066
1600	1873	5,34	67626	-18,17	$1,2837 \times 10^{-8}$	$1,2837 \times 10^{-8}$	$2,3414 \times 10^{-3}$	-2,63052
1700	1973	5,07	67826	-17,30	$3,0639 \times 10^{-8}$	$3,0639 \times 10^{-8}$	$3,1291 \times 10^{-3}$	-2,50458



$$\Delta G^\circ = -39810 + 40,87$$

T (°C)	T (K)	10000/T	$\Delta G^\circ$	$-\Delta G^\circ/RT$	$\exp(-\Delta G^\circ/RT)$	K eq	$p\text{CO}_2/p\text{CO}$	pCO	$p\text{CO}_2=1-p\text{CO}$	Log ( $p\text{CO}_2/p\text{CO}$ )
600	873	11,45	-4130,49	2,38	10,8175	10,817496	0,2613	0,7387	2,8268	0,4512927
700	973	10,28	-43,49	0,02	1,0227	1,022750	0,6142	0,3858	0,6282	-0,2019283
800	1073	9,32	4043,51	-1,90	0,1501	0,150088	0,8830	0,1170	0,1325	-0,8777026
900	1173	8,53	8130,51	-3,49	0,0306	0,030551	0,9712	0,0288	0,0297	-1,5276759
1000	1273	7,86	12217,51	-4,83	0,0080	0,007986	0,9921	0,0079	0,0079	-2,1011146
1100	1373	7,28	16304,51	-5,98	0,0025	0,002538	0,9975	0,0025	0,0025	-2,5966137
1200	1473	6,79	20391,51	-6,97	0,0009	0,000942	0,9991	0,0009	0,0009	-3,0261590
1300	1573	6,36	24478,51	-7,83	0,0004	0,000397	0,9996	0,0004	0,0004	-3,4014548
1400	1673	5,98	28565,51	-8,59	0,0002	0,000185	0,9998	0,0002	0,0002	-3,7320019
1500	1773	5,64	32652,51	-9,27	0,0001	0,000094	0,9999	0,0001	0,0001	-4,0253041
1600	1873	5,34	36739,51	-9,87	0,0001	0,000052	0,9999	0,0001	0,0001	-4,2873042
1700	1973	5,07	40826,51	-10,41	0,0000	0,000030	1,0000	0,0000	0,0000	-4,5227530



$$\Delta G^\circ = 16780 + 3,22T$$

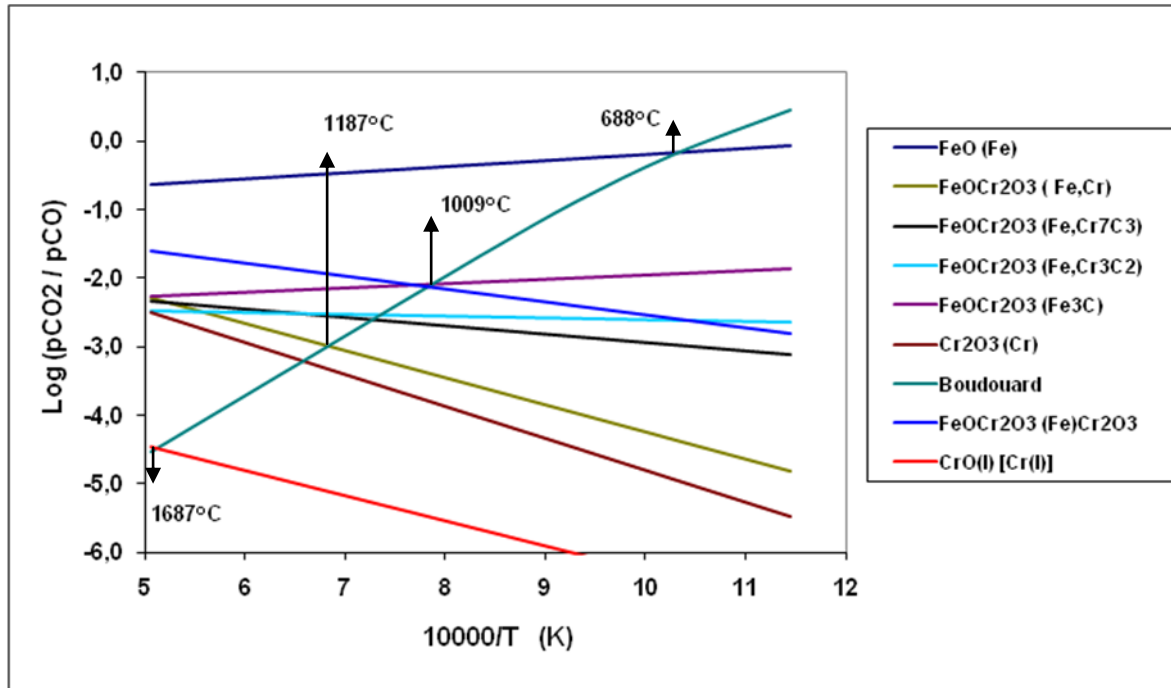
T (°C)	T (K)	10000/T	$\Delta G^\circ$	$-\Delta G^\circ/RT$	$\exp(-\Delta G^\circ/RT)$	K eq	$p\text{CO}_2/p\text{CO}$	$\text{Log}(p\text{CO}_2/p\text{CO})$
700	973	10,28	19913,06	-10,3	3,3641x10-5	3,3641x10-5	4,2051x10-7	-6,376220875
800	1073	9,32	20235,06	-9,4909	7,55369x10-5	7,55369x10-5	9,4421x10-7	-6,024930834
900	1173	8,53	20557,06	-8,8199	0,000147759	0,000147759	1,847x10-6	-5,733536792
1000	1273	7,86	20879,06	-8,2544	0,000260116	0,000260116	3,2514x10-6	-5,487923433
1100	1373	7,28	21201,06	-7,7712	0,000421699	0,000421699	5,2712x10-6	-5,278087694
1200	1473	6,79	21523,06	-7,3537	0,000640246	0,000640246	8,0031x10-6	-5,09674289
1300	1573	6,36	21845,06	-6,9892	0,000921796	0,000921796	1,1522x10-5	-4,938455276
1400	1673	5,98	22167,06	-6,6683	0,001270573	0,001270573	1,5882x10-5	-4,79909027
1500	1773	5,64	22849,06	-6,3836	0,001689055	0,001689055	2,1113x10-5	-4,675446077
1600	1873	5,34	22811,06	-6,1293	0,002178138	0,002178138	2,7227x10-5	-4,565004681
1700	1973	5,07	23133,06	-5,9008	0,002737357	0,002737357	3,4217x10-5	-4,465758561

Dados:

$$a_{\text{CrO}} = 0,0075$$

$$a_{\text{Cr}} = 0,6$$

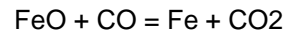
Relação  $p\text{CO}_2/p\text{CO}$  em função da temperatura da reação de Boudouard e das reações de redução pelo CO selecionadas acima considerando  $p\text{CO}_2+p\text{CO} = 1$  e atividade do  $\text{FeO}(\text{Cr}_2\text{O}_3)$  no minério igual a 1.



## ANEXO C

Cálculos para uma atividade do  $\text{FeO.Cr}_2\text{O}_3$  não unitária.

Análise termodinâmica



$$\Delta G^\circ = -4120 + 4,99T$$

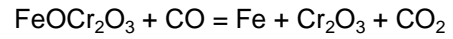
T (°C)	T (K)	10000/T	$\Delta G^\circ$	$-\Delta G^\circ/RT$	$\exp(-\Delta G^\circ/RT)$	K eq	$p\text{CO}_2/p\text{CO}$	Log ( $p\text{CO}_2/p\text{CO}$ )
600	873	11,45	236,27	-0,14	0,8727	0,8727	0,8727	-0,05915
700	973	10,28	735,27	-0,38	0,6837	0,6837	0,6837	-0,16517
800	1073	9,32	1234,27	-0,58	0,5605	0,5605	0,5605	-0,25142
900	1173	8,53	1733,27	-0,74	0,4754	0,4754	0,4754	-0,32296
1000	1273	7,86	2232,27	-0,88	0,4137	0,4137	0,4137	-0,38327
1100	1373	7,28	2731,27	-1,00	0,3675	0,3675	0,3675	-0,43479
1200	1473	6,79	3230,27	-1,10	0,3317	0,3317	0,3317	-0,47932
1300	1573	6,36	3729,27	-1,19	0,3033	0,3033	0,3033	-0,51818
1400	1673	5,98	4228,27	-1,27	0,2803	0,2803	0,2803	-0,55240
1500	1773	5,64	4727,27	-1,34	0,2614	0,2614	0,2614	-0,58276
1600	1873	5,34	5226,27	-1,40	0,2455	0,2455	0,2455	-0,60987
1700	1973	5,07	5725,27	-1,46	0,2321	0,2321	0,2321	-0,63424

Dados:

$$N \text{FeOCr}_2\text{O}_3 = 0,52$$

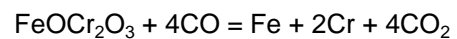
$$N \text{MgOAl}_2\text{O}_3 = 0,38$$

$$N \text{MgOCr}_2\text{O}_3 = 0,1$$



$$\Delta G^\circ = 8550 + 3,02T$$

T (°C)	T (K)	10000/T	$\Delta G^\circ$	$-\Delta G^\circ/RT$	$\exp(-\Delta G^\circ/RT)$	K eq	pCO <sub>2</sub> /pCO	Log (pCO <sub>2</sub> /pCO)
600	873	11,45	11186,46	-6,45	0,0016	0,0016	0,0003	-3,58320
700	973	10,28	11488,46	-5,94	0,0026	0,0026	0,0004	-3,36320
800	1073	9,32	11790,46	-5,53	0,0040	0,0040	0,0007	-3,18421
900	1173	8,53	12092,46	-5,19	0,0056	0,0056	0,0009	-3,03573
1000	1273	7,86	12394,46	-4,90	0,0074	0,0074	0,0012	-2,91058
1100	1373	7,28	12696,46	-4,65	0,0095	0,0095	0,0016	-2,80367
1200	1473	6,79	12998,46	-4,44	0,0118	0,0118	0,0019	-2,71126
1300	1573	6,36	13300,46	-4,26	0,0142	0,0142	0,0023	-2,63061
1400	1673	5,98	13602,46	-4,09	0,0167	0,0167	0,0028	-2,55960
1500	1773	5,64	13904,46	-3,95	0,0193	0,0193	0,0032	-2,49660
1600	1873	5,34	14206,46	-3,82	0,0220	0,0220	0,0036	-2,44033
1700	1973	5,07	14508,46	-3,70	0,0247	0,0247	0,0041	-2,38976



$$\Delta G^\circ = 72430 + 5,02T$$

T (°C)	T (K)	10000/T	$\Delta G^\circ$	$-\Delta G^\circ/RT$	$\exp(-\Delta G^\circ/RT)$	K eq	pCO <sub>2</sub> /pCO	Log (pCO <sub>2</sub> /pCO)
600	873	11,45	76812,46	-44,28	$5,8737 \times 10^{-20}$	$5,8737 \times 10^{-20}$	$9,7681 \times 10^{-6}$	-5,01019
700	973	10,28	77314,46	-39,99	$4,2916 \times 10^{-18}$	$4,2916 \times 10^{-18}$	$2,8559 \times 10^{-5}$	-4,54426
800	1073	9,32	77816,46	-36,50	$1,4091 \times 10^{-16}$	$1,4091 \times 10^{-16}$	$6,8363 \times 10^{-5}$	-4,16518
900	1173	8,53	78318,46	-33,60	$2,5511 \times 10^{-15}$	$2,5511 \times 10^{-15}$	$1,4102 \times 10^{-4}$	-3,85073
1000	1273	7,86	78820,46	-31,16	$2,9303 \times 10^{-14}$	$2,9303 \times 10^{-14}$	$2,5960 \times 10^{-4}$	-3,58569
1100	1373	7,28	79322,46	-29,08	$2,3586 \times 10^{-13}$	$2,3586 \times 10^{-13}$	$4,3727 \times 10^{-4}$	-3,35925
1200	1473	6,79	79824,46	-27,27	$1,4303 \times 10^{-12}$	$1,4303 \times 10^{-12}$	$6,8618 \times 10^{-4}$	-3,16356
1300	1573	6,36	80326,46	-25,70	$6,8970 \times 10^{-12}$	$6,8970 \times 10^{-12}$	$1,0168 \times 10^{-3}$	-2,99275
1400	1673	5,98	80828,46	-24,31	$2,7556 \times 10^{-11}$	$2,7556 \times 10^{-11}$	$1,4376 \times 10^{-3}$	-2,84236
1500	1773	5,64	81330,46	-23,09	$9,4173 \times 10^{-11}$	$9,4173 \times 10^{-11}$	1,9546E-03	-2,70894
1600	1873	5,34	81832,46	-21,99	$2,8225 \times 10^{-10}$	$2,8225 \times 10^{-10}$	2,5718E-03	-2,58976
1700	1973	5,07	82334,46	-21,00	$7,5689 \times 10^{-10}$	$7,5689 \times 10^{-10}$	3,2911E-03	-2,48266

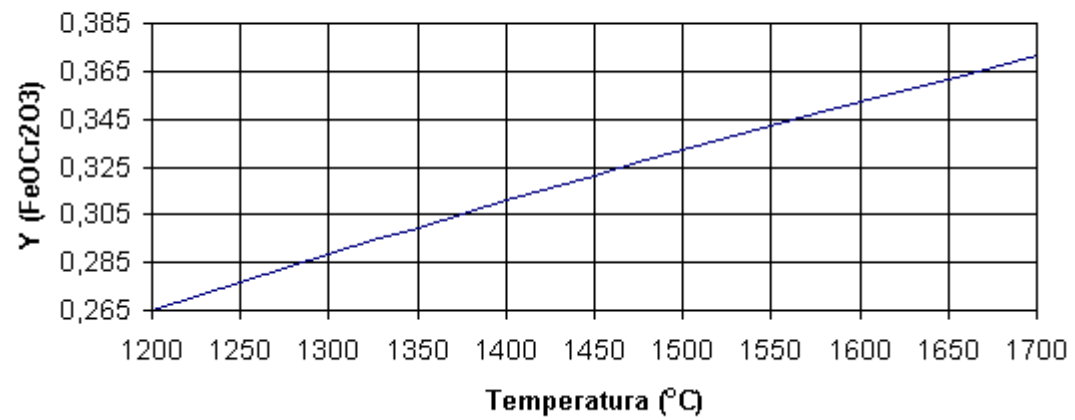


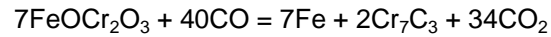
T (°C)	T (K)	Ln(yFeOCr <sub>2</sub> O <sub>3</sub> )	y FeOCr <sub>2</sub> O <sub>3</sub>	a FeOCr <sub>2</sub> O <sub>3</sub>
1200	1473	-1,33	0,265	0,138
1250	1523	-1,28	0,277	0,144
1300	1573	-1,24	0,289	0,150
1350	1623	-1,20	0,300	0,156
1400	1673	-1,17	0,311	0,162
1450	1723	-1,13	0,322	0,167
1500	1773	-1,10	0,332	0,173
1550	1823	-1,07	0,342	0,178
1600	1873	-1,04	0,352	0,183
1650	1923	-1,02	0,362	0,188
1700	1973	-0,99	0,371	0,193

Media (y) = 0,318

Media (a) = 0,165

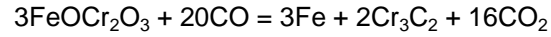
Varição do coeficiente de atividade do  $\text{FeO} \cdot \text{Cr}_2\text{O}_3$  com a temperatura





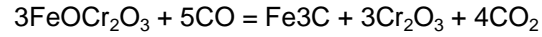
$$\Delta G^\circ = 194750 + 262,56T$$

T (°C)	T (K)	10000/T	$\Delta G^\circ$	$-\Delta G^\circ/RT$	$\exp(-\Delta G^\circ/RT)$	K eq	$p\text{CO}_2/p\text{CO}$	pCO	$p\text{CO}_2=1-p\text{CO}$	Log (pCO <sub>2</sub> /pCO)
600	873	11,45	423964,88	-244,41	$7,1512 \times 10^{-107}$	$1,5371 \times 10^{-112}$	0,0005	0,9995	0,0005	0,0005
700	973	10,28	450220,88	-232,87	$7,3371 \times 10^{-102}$	$1,5770 \times 10^{-107}$	0,0007	0,9993	0,0007	0,0007
800	1073	9,32	476476,88	-223,48	$8,7624 \times 10^{-98}$	$1,8834 \times 10^{-103}$	0,0010	0,9990	0,0010	0,0010
900	1173	8,53	502732,88	-215,70	$2,1114 \times 10^{-94}$	$4,5382 \times 10^{-100}$	0,0012	0,9988	0,0012	0,0012
1000	1273	7,86	528988,88	-209,13	$1,4968 \times 10^{-91}$	$3,2173 \times 10^{-97}$	0,0015	0,9986	0,0014	0,0015
1100	1373	7,28	555244,88	-203,52	$4,0789 \times 10^{-89}$	$8,7673 \times 10^{-95}$	0,0017	0,9983	0,0017	0,0017
1200	1473	6,79	581500,88	-198,68	$5,1909 \times 10^{-87}$	$1,1157 \times 10^{-92}$	0,0020	0,9980	0,0020	0,0020
1300	1573	6,36	607756,88	-194,45	$3,5673 \times 10^{-85}$	$7,6677 \times 10^{-91}$	0,0022	0,9978	0,0022	0,0022
1400	1673	5,98	634012,88	-190,72	$1,4785 \times 10^{-83}$	$3,1779 \times 10^{-89}$	0,0025	0,9975	0,0025	0,0025
1500	1773	5,64	660268,88	-187,42	$4,0258 \times 10^{-82}$	$8,6531 \times 10^{-88}$	0,0027	0,9973	0,0027	0,0027
1600	1873	5,34	686524,88	-184,47	$7,7026 \times 10^{-81}$	$1,6556 \times 10^{-86}$	0,0030	0,9970	0,0030	0,0030
1700	1973	5,07	712780,88	-181,82	$1,0927 \times 10^{-79}$	$2,3487 \times 10^{-85}$	0,0032	0,9968	0,0032	0,0032



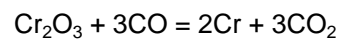
$$\Delta G^\circ = 20250 + 170,1T$$

T (°C)	T (K)	10000/T	$\Delta G^\circ$	$-\Delta G^\circ/RT$	$\exp(-\Delta G^\circ/RT)$	K eq	pCO <sub>2</sub> /pCO	pCO	pCO <sub>2</sub> =1-pCO	Log (pCO <sub>2</sub> /pCO)
600	873	11,45	168747,3	-97,28	$5,6457 \times 10^{-43}$	$2,1024 \times 10^{-45}$	0,0016	0,9984	0,0016	-2,79233
700	973	10,28	185757,3	-96,08	$1,8740 \times 10^{-42}$	$6,9786 \times 10^{-45}$	0,0017	0,9983	0,0017	-2,75976
800	1073	9,32	202767,3	-95,10	$4,9741 \times 10^{-42}$	$1,8523 \times 10^{-44}$	0,0018	0,9982	0,0018	-2,73327
900	1173	8,53	219777,3	-94,29	$1,1178 \times 10^{-41}$	$4,1625 \times 10^{-44}$	0,0019	0,9981	0,0019	-2,71129
1000	1273	7,86	236787,3	-93,61	$2,2119 \times 10^{-41}$	$8,2369 \times 10^{-44}$	0,0020	0,9980	0,0020	-2,69276
1100	1373	7,28	253797,3	-93,03	$3,9627 \times 10^{-41}$	$1,4757 \times 10^{-43}$	0,0021	0,9979	0,0021	-2,67694
1200	1473	6,79	270807,3	-92,53	$6,5591 \times 10^{-41}$	$2,4425 \times 10^{-43}$	0,0022	0,9978	0,0022	-2,66326
1300	1573	6,36	287817,3	-92,09	$1,0183 \times 10^{-40}$	$3,7919 \times 10^{-43}$	0,0022	0,9978	0,0022	-2,65132
1400	1673	5,98	304827,3	-91,70	$1,4998 \times 10^{-40}$	$5,5852 \times 10^{-43}$	0,0023	0,9977	0,0023	-2,64081
1500	1773	5,64	321837,3	-91,35	$2,1148 \times 10^{-40}$	$7,8751 \times 10^{-43}$	0,0023	0,9977	0,0023	-2,63148
1600	1873	5,34	338847,3	-91,05	$2,8744 \times 10^{-40}$	$1,0704 \times 10^{-42}$	0,0024	0,9976	0,0024	-2,62315
1700	1973	5,07	355857,3	-90,77	$3,7871 \times 10^{-40}$	$1,4103 \times 10^{-42}$	0,0024	0,9976	0,0024	-2,61567



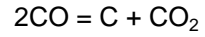
$$\Delta G^\circ = -11475 + 47,28T$$

T (°C)	T (K)	10000/T	$\Delta G^\circ$	$-\Delta G^\circ/RT$	$\exp(-\Delta G^\circ/RT)$	K eq	$p\text{CO}_2/p\text{CO}$	pCO	$p\text{CO}_2=1-p\text{CO}$	Log (pCO <sub>2</sub> /pCO)
600	873	11,45	29800,44	-17,18	$3,4597 \times 10^{-8}$	$1,2883 \times 10^{-10}$	0,0034	0,9966	0,0034	-2,47249
700	973	10,28	34528,44	-17,86	$1,7530 \times 10^{-8}$	$6,5278 \times 10^{-11}$	0,0028	0,9972	0,0028	-2,54631
800	1073	9,32	39256,44	-18,41	$1,0082 \times 10^{-8}$	$3,7544 \times 10^{-11}$	0,0025	0,9975	0,0025	-2,60637
900	1173	8,53	43984,44	-18,87	$6,3720 \times 10^{-9}$	$2,3728 \times 10^{-11}$	0,0022	0,9978	0,0022	-2,65618
1000	1273	7,86	48712,44	-19,26	$4,3282 \times 10^{-9}$	$1,6118 \times 10^{-11}$	0,0020	0,9980	0,0020	-2,69817
1100	1373	7,28	53440,44	-19,59	$3,1104 \times 10^{-9}$	$1,1583 \times 10^{-11}$	0,0018	0,9982	0,0018	-2,73405
1200	1473	6,79	58168,44	-19,87	$2,3378 \times 10^{-9}$	$8,7056 \times 10^{-12}$	0,0017	0,9983	0,0017	-2,76505
1300	1573	6,36	62896,44	-20,12	$1,8220 \times 10^{-9}$	$6,7850 \times 10^{-12}$	0,0016	0,9984	0,0016	-2,79211
1400	1673	5,98	67624,44	-20,34	$1,4630 \times 10^{-9}$	$5,4481 \times 10^{-12}$	0,0015	0,9985	0,0015	-2,81594
1500	1773	5,64	72352,44	-20,54	$1,2042 \times 10^{-9}$	$4,4843 \times 10^{-12}$	0,0015	0,9985	0,0015	-2,83708
1600	1873	5,34	77080,44	-20,71	$1,0120 \times 10^{-9}$	$3,7685 \times 10^{-12}$	0,0014	0,9986	0,0014	-2,85596
1700	1973	5,07	81808,44	-20,87	$8,6557 \times 10^{-10}$	$3,2233 \times 10^{-12}$	0,0013	0,9987	0,0013	-2,87293



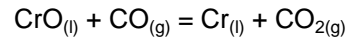
$$\Delta G^\circ = 63880 + 2,00T$$

T (°C)	T (K)	10000/T	$\Delta G^\circ$	$-\Delta G^\circ/RT$	$\exp(-\Delta G^\circ/RT)$	K eq	pCO <sub>2</sub> /pCO	Log (pCO <sub>2</sub> /pCO)
600	873	11,45	65626	-37,83	$3,7119 \times 10^{-17}$	$3,7119 \times 10^{-17}$	$3,3358 \times 10^{-6}$	-5,47680
700	973	10,28	65826	-34,05	$1,6342 \times 10^{-15}$	$1,6342 \times 10^{-15}$	$1,1779 \times 10^{-5}$	-4,92890
800	1073	9,32	66026	-30,97	$3,5533 \times 10^{-14}$	$3,5533 \times 10^{-14}$	$3,2876 \times 10^{-5}$	-4,48312
900	1173	8,53	66226	-28,41	$4,5703 \times 10^{-13}$	$4,5703 \times 10^{-13}$	$7,7028 \times 10^{-5}$	-4,11335
1000	1273	7,86	66426	-26,26	$3,9353 \times 10^{-12}$	$3,9353 \times 10^{-12}$	$1,5788 \times 10^{-4}$	-3,80167
1100	1373	7,28	66626	-24,42	$2,4763 \times 10^{-11}$	$2,4763 \times 10^{-11}$	$2,9148 \times 10^{-4}$	-3,53540
1200	1473	6,79	66826	-22,83	$1,2139 \times 10^{-10}$	$1,2139 \times 10^{-10}$	$4,9513 \times 10^{-4}$	-3,30528
1300	1573	6,36	67026	-21,44	$4,8613 \times 10^{-10}$	$4,8613 \times 10^{-10}$	$7,8629 \times 10^{-4}$	-3,10441
1400	1673	5,98	67226	-20,22	$1,6493 \times 10^{-9}$	$1,6493 \times 10^{-9}$	$1,1815 \times 10^{-3}$	-2,92756
1500	1773	5,64	67426	-19,14	$4,8754 \times 10^{-9}$	$4,8754 \times 10^{-9}$	$1,6956 \times 10^{-3}$	-2,77066
1600	1873	5,34	67626	-18,17	$1,2837 \times 10^{-8}$	$1,2837 \times 10^{-8}$	$2,3414 \times 10^{-3}$	-2,63052
1700	1973	5,07	67826	-17,30	$3,0639 \times 10^{-8}$	$3,0639 \times 10^{-8}$	$3,1291 \times 10^{-3}$	-2,50458



$$\Delta G^\circ = -39810 + 40,87T$$

T (°C)	T (K)	10000/T	$\Delta G^\circ$	$-\Delta G^\circ/RT$	$\exp(-\Delta G^\circ/RT)$	K eq	pCO	$p\text{CO}_2=1-p\text{CO}$	$p\text{CO}_2/p\text{CO}$	Log (pCO <sub>2</sub> /pCO)
600	873	11,45	-4130,49	2,38	10,8175	10,817496	0,2613	0,7387	2,8268	0,4512927
700	973	10,28	-43,49	0,02	1,0227	1,022750	0,6142	0,3858	0,6282	-0,2019283
800	1073	9,32	4043,51	-1,90	0,1501	0,150088	0,8830	0,1170	0,1325	-0,8777026
900	1173	8,53	8130,51	-3,49	0,0306	0,030551	0,9712	0,0288	0,0297	-1,5276759
1000	1273	7,86	12217,51	-4,83	0,0080	0,007986	0,9921	0,0079	0,0079	-2,1011146
1100	1373	7,28	16304,51	-5,98	0,0025	0,002538	0,9975	0,0025	0,0025	-2,5966137
1200	1473	6,79	20391,51	-6,97	0,0009	0,000942	0,9991	0,0009	0,0009	-3,0261590
1300	1573	6,36	24478,51	-7,83	0,0004	0,000397	0,9996	0,0004	0,0004	-3,4014548
1400	1673	5,98	28565,51	-8,59	0,0002	0,000185	0,9998	0,0002	0,0002	-3,7320019
1500	1773	5,64	32652,51	-9,27	0,0001	0,000094	0,9999	0,0001	0,0001	-4,0253041
1600	1873	5,34	36739,51	-9,87	0,0001	0,000052	0,9999	0,0001	0,0001	-4,2873042
1700	1973	5,07	40826,51	-10,41	0,0000	0,000030	1,0000	0,0000	0,0000	-4,5227530



$$\Delta G^\circ = 16780 + 3,22T$$

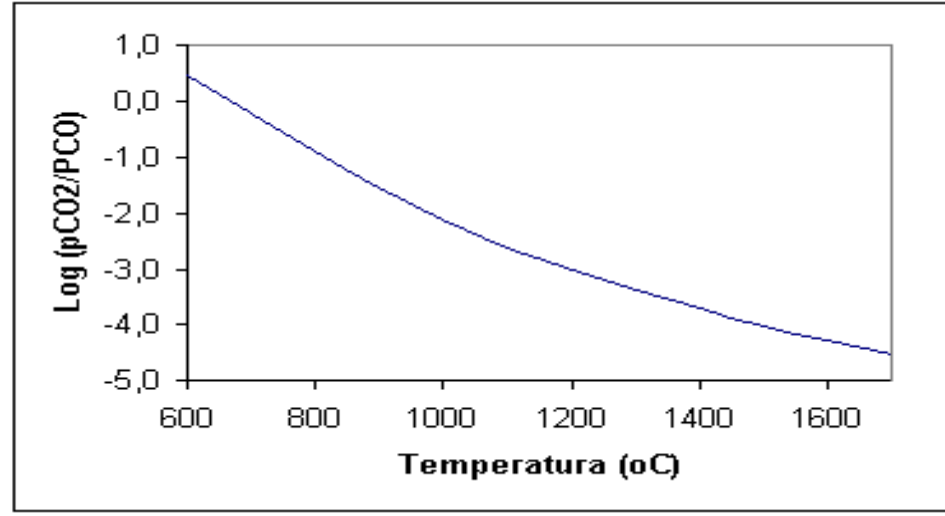
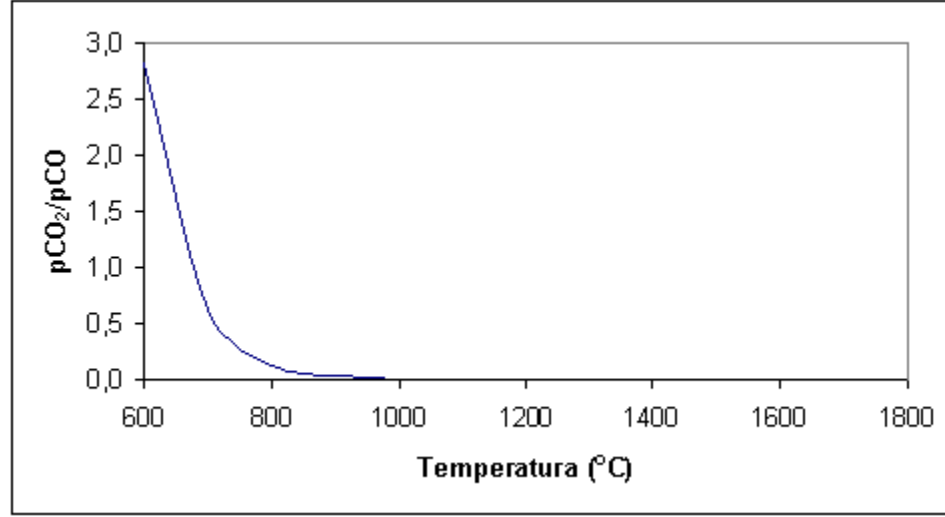
T (°C)	T (K)	10000/T	$\Delta G^\circ$	$-\Delta G^\circ/RT$	$\exp(-\Delta G^\circ/RT)$	K eq	$p\text{CO}_2/p\text{CO}$	$\text{Log}(p\text{CO}_2/p\text{CO})$
700	973	10,28	19913,06	-10,3	3,3641x10-5	3,3641x10-5	4,2051x10-7	-6,376220875
800	1073	9,32	20235,06	-9,4909	7,55369x10-5	7,55369x10-5	9,4421x10-7	-6,024930834
900	1173	8,53	20557,06	-8,8199	0,000147759	0,000147759	1,847x10-6	-5,733536792
1000	1273	7,86	20879,06	-8,2544	0,000260116	0,000260116	3,2514x10-6	-5,487923433
1100	1373	7,28	21201,06	-7,7712	0,000421699	0,000421699	5,2712x10-6	-5,278087694
1200	1473	6,79	21523,06	-7,3537	0,000640246	0,000640246	8,0031x10-6	-5,09674289
1300	1573	6,36	21845,06	-6,9892	0,000921796	0,000921796	1,1522x10-5	-4,938455276
1400	1673	5,98	22167,06	-6,6683	0,001270573	0,001270573	1,5882x10-5	-4,79909027
1500	1773	5,64	22849,06	-6,3836	0,001689055	0,001689055	2,1113x10-5	-4,675446077
1600	1873	5,34	22811,06	-6,1293	0,002178138	0,002178138	2,7227x10-5	-4,565004681
1700	1973	5,07	23133,06	-5,9008	0,002737357	0,002737357	3,4217x10-5	-4,465758561

Dados:

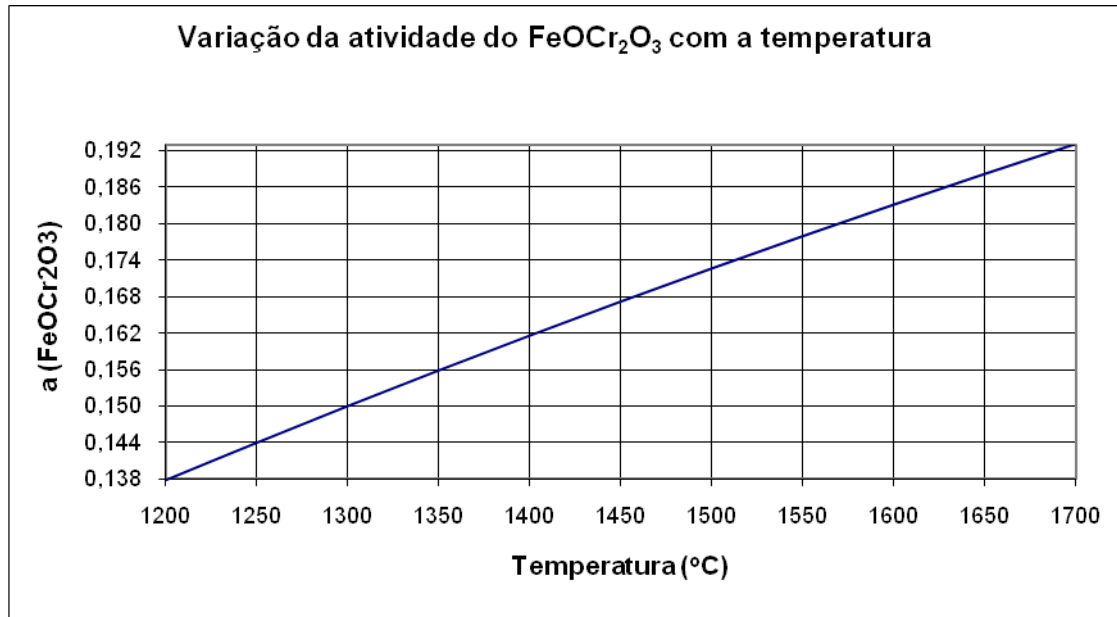
$$a_{\text{CrO}} = 0,0075$$

$$a_{\text{Cr}} = 0,6$$

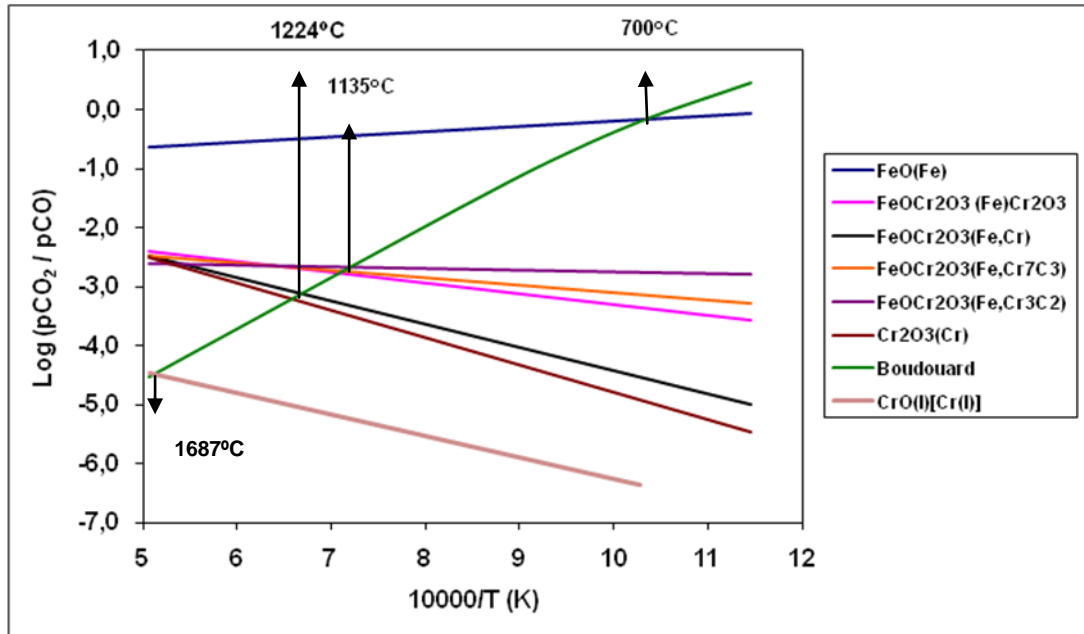




Varição da atividade do  $\text{FeOCr}_2\text{O}_3$  com a temperatura



Relação  $p\text{CO}_2/p\text{CO}$  em função da temperatura da reação de Boudouard das reações de redução pelo CO selecionadas acima considerando  $p\text{CO}_2+p\text{CO} = 1$  e atividade do  $\text{FeO} \cdot \text{Cr}_2\text{O}_3$  no minério igual a 0,165.



## ANEXO D

### Balanço térmico de redução da cromita

Dados

Base: 100 g de mistura

Anexo A (Rosenqvist)

Substancia	$(-)\Delta H_{298}$ (kJ/mol)	$(-)\Delta H_{298}$ (kcal/mol)
Cr	0	0,00
Si	0	0,00
SiO <sub>2</sub>	910	217,70
Cr <sub>2</sub> O <sub>3</sub>	1130	270,33
Fe	0	0,00
FeO	264	63,16
C	0	0,00
CO	110,5	26,44

	PA ou PM (g)	mol
Cr <sub>2</sub> O <sub>3</sub>	152	0,27
FeO	72	0,23
Si (1% Fe-75%Si)	28	0,02679
Si (2% Fe-75%Si)	28	0,05357
Si (4% Fe-75%Si)	28	0,10714

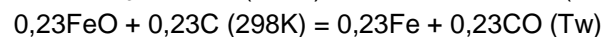
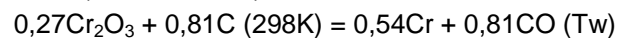
	PA ou PM (g)	P1 mol	P2 mol	P3 mol	P4 mol
CaO	56	0,063580357	0,063495357	0,06346964	0,0633589
MgO	40	0,3040275	0,3008225	0,2976575	0,29125
Al <sub>2</sub> O <sub>3</sub>	102	0,134001961	0,132611765	0,13123922	0,1284588
SiO <sub>2</sub>	60	0,089106667	0,115068333	0,14104	0,1929633

Pelotas	Q necessário (cal/g)					
	1500°C	Q adic. (%)	1550°C	Q adic. (%)	1600°C	Q adic. (%)
1 (0% Fe-75%Si)	960,73	0,00	983,17	0,00	996,78	0,00
2 (1% Fe-75%Si)	916,89	4,56	939,29	4,46	952,91	4,40
3 (2% Fe-75%Si)	873,07	9,12	895,44	8,92	909,06	8,80
4 (4% Fe-75%Si)	785,53	20,07	807,83	19,58	821,45	19,29

Anexo B (Rosenqvist)		kJ/mol	kcal/mol
Cr	H <sub>1773</sub> -H <sub>298</sub>	50,5	12,08
	H <sub>1823</sub> -H <sub>298</sub>	52,5	12,56
	H <sub>1873</sub> -H <sub>298</sub>	54,5	13,04
Si	H <sub>1773</sub> -H <sub>298</sub>	86	20,57
	H <sub>1823</sub> -H <sub>298</sub>	87	20,81
	H <sub>1873</sub> -H <sub>298</sub>	88	21,05
SiO <sub>2</sub>	H <sub>1773</sub> -H <sub>298</sub>	102	24,40
	H <sub>1823</sub> -H <sub>298</sub>	105,5	25,24
	H <sub>1873</sub> -H <sub>298</sub>	109,5	26,20
Fe	H <sub>1773</sub> -H <sub>298</sub>	57,5	13,76
	H <sub>1823</sub> -H <sub>298</sub>	75	17,94
	H <sub>1873</sub> -H <sub>298</sub>	77	18,42
FeO	H <sub>1773</sub> -H <sub>298</sub>	111	26,56
	H <sub>1823</sub> -H <sub>298</sub>	115	27,51
	H <sub>1873</sub> -H <sub>298</sub>	119	28,47
C	H <sub>1773</sub> -H <sub>298</sub>	29,5	7,06
	H <sub>1823</sub> -H <sub>298</sub>	31	7,42
	H <sub>1873</sub> -H <sub>298</sub>	32	7,66
CO	H <sub>1773</sub> -H <sub>298</sub>	48,5	11,60
	H <sub>1823</sub> -H <sub>298</sub>	50,5	12,08
	H <sub>1873</sub> -H <sub>298</sub>	52,5	12,56
CaO	H <sub>1773</sub> -H <sub>298</sub>	76,5	18,30
	H <sub>1823</sub> -H <sub>298</sub>	79,5	19,02
	H <sub>1873</sub> -H <sub>298</sub>	82	19,62
MgO	H <sub>1773</sub> -H <sub>298</sub>	73	17,46
	H <sub>1823</sub> -H <sub>298</sub>	75,5	18,06
	H <sub>1873</sub> -H <sub>298</sub>	78	18,66

		kJ/mol	kcal/mol
Al <sub>2</sub> O <sub>3</sub>	H <sub>1773</sub> -H <sub>298</sub>	178	42,58
	H <sub>1823</sub> -H <sub>298</sub>	185	44,26
	H <sub>1873</sub> -H <sub>298</sub>	191	45,69

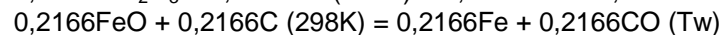
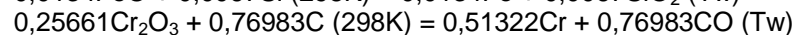
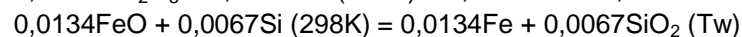
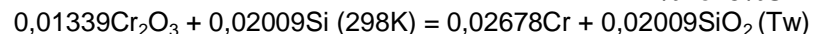
P1 (0% Fe-75%Si)



				Tw (K)		
				1773	1823	1873
Entrada		kcal	Saída	kcal	kcal	kcal
0,27Cr <sub>2</sub> O <sub>3</sub>		0	0,54Cr	6,524	6,782	7,041
0,81C	298	0	0,81CO	9,398	9,786	10,173
0,23FeO		0	0,23Fe	3,164	4,127	4,237
0,23C		0	0,23CO	2,669	2,779	2,889
			0,063CaO	1,153	1,198	1,236
			0,30MgO	5,239	5,419	5,598
			0,134Al <sub>2</sub> O <sub>3</sub>	5,706	5,931	6,123
			0,09SiO <sub>2</sub>	2,196	2,272	2,358
0,81C + 0,405O <sub>2</sub> = 0,81CO	(-ΔH <sub>298</sub> )	21,413	0,27Cr <sub>2</sub> O <sub>3</sub> = 0,54Cr + 0,405O <sub>2</sub>	ΔH <sub>298</sub>	72,990	72,990
0,23C + 0,115O <sub>2</sub> = 0,23CO	(-ΔH <sub>298</sub> )	6,080	0,23FeO = 0,23Fe + 0,115O <sub>2</sub>	ΔH <sub>298</sub>	14,526	14,526
		27,493	Total	123,566	125,809	127,171
				27,493	27,493	27,493
			Deficiência de calor	96,07	98,32	99,68

P2

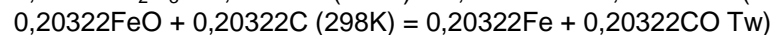
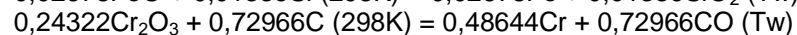
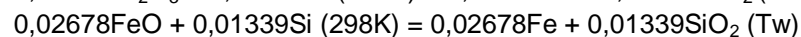
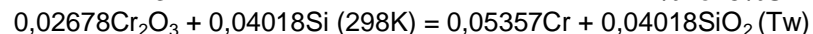
1%Fe75%Si = 0,75g Si



Entrada	kcal	Saída	Tw (K)		
			1773	1823	1873
			kcal	kcal	kcal
0,01339Cr <sub>2</sub> O <sub>3</sub>	0	0,02678Cr	0,324	0,336	0,349
0,02009Si	0	0,02009SiO <sub>2</sub>	0,490	0,507	0,526
0,0134FeO	0	0,0134Fe	0,184	0,240	0,247
0,0067Si	0	0,0067SiO <sub>2</sub>	0,163	0,169	0,176
0,25661Cr <sub>2</sub> O <sub>3</sub>	298	0,51322Cr	6,200	6,446	6,692
0,76983C	0	0,76983CO	8,932	9,301	9,669
0,2166FeO	0	0,2166Fe	2,980	3,886	3,990
0,2166C	0	0,2166CO	2,513	2,617	2,720
		0,063CaO	1,153	1,198	1,236
		0,30MgO	5,239	5,419	5,598
		0,134Al <sub>2</sub> O <sub>3</sub>	5,706	5,931	6,123
		0,09SiO <sub>2</sub>	2,196	2,272	2,358
0,02009Si + 0,02009O <sub>2</sub> = 0,02009SiO <sub>2</sub>	(-ΔH <sub>298</sub> ) 4,374	0,01339Cr <sub>2</sub> O <sub>3</sub> = 0,02678Cr + 0,02009O <sub>2</sub>	ΔH <sub>298</sub> 3,620	3,620	3,620
0,0067Si + 0,0067O <sub>2</sub> = 0,0067SiO <sub>2</sub>	(-ΔH <sub>298</sub> ) 1,459	0,0134FeO = 0,0134Fe + 0,0067O <sub>2</sub>	ΔH <sub>298</sub> 0,846	0,846	0,846
0,76983C + 0,384915O <sub>2</sub> = 0,76983CO	(-ΔH <sub>298</sub> ) 20,351	0,25661Cr <sub>2</sub> O <sub>3</sub> = 0,51322Cr + 0,384915O <sub>2</sub>	ΔH <sub>298</sub> 69,371	69,371	69,371
0,2166C + 0,1083O <sub>2</sub> = 0,2166CO	(-ΔH <sub>298</sub> ) 5,726	0,2166FeO = 0,2166Fe + 0,1083O <sub>2</sub>	ΔH <sub>298</sub> 13,680	13,680	13,680
	31,909	Total	123,598	125,838	127,200
			31,909	31,909	31,909
		Deficiência de calor	91,69	93,93	95,29

P3

2%Fe75%Si = 1,5 g Si

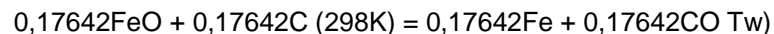
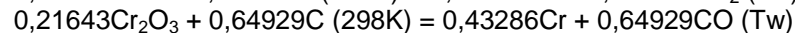
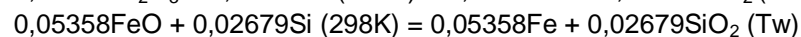
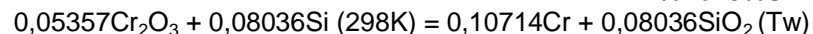


Entrada	kcal	Saída	Tw (K)		
			1773	1823	1873
0,02678Cr <sub>2</sub> O <sub>3</sub>	0	0,05357Cr	0,647	0,673	0,698
0,04018Si	0	0,04018SiO <sub>2</sub>	0,980	1,014	1,053
0,02678FeO	0	0,02678Fe	0,368	0,481	0,493
0,01339Si	0	0,01339SiO <sub>2</sub>	0,327	0,338	0,351
0,24322Cr <sub>2</sub> O <sub>3</sub>	0	0,48644Cr	5,877	6,110	6,342
0,72966C	0	0,72966CO	8,466	8,815	9,164
0,20322FeO	0	0,20322Fe	2,795	3,646	3,744
0,20322C	0	0,20322CO	2,358	2,455	2,552
		0,063CaO	1,153	1,198	1,236
		0,30MgO	5,239	5,419	5,598
		0,134Al <sub>2</sub> O <sub>3</sub>	5,706	5,931	6,123
		0,09SiO <sub>2</sub>	2,196	2,272	2,358
0,04018Si + 0,04018O <sub>2</sub> = 0,04018SiO <sub>2</sub>	(-ΔH <sub>298</sub> ) 8,747	0,02678Cr <sub>2</sub> O <sub>3</sub> = 0,05356Cr + 0,04017O <sub>2</sub>	ΔH <sub>298</sub> 7,240	7,240	7,240
0,01339Si + 0,01339O <sub>2</sub> = 0,01339SiO <sub>2</sub>	(-ΔH <sub>298</sub> ) 2,915	0,02678FeO = 0,02678Fe + 0,01339O <sub>2</sub>	ΔH <sub>298</sub> 1,691	1,691	1,691
0,72966C + 0,36483O <sub>2</sub> = 0,72966CO	(-ΔH <sub>298</sub> ) 19,289	0,24322Cr <sub>2</sub> O <sub>3</sub> = 0,48644Cr + 0,36483O <sub>2</sub>	ΔH <sub>298</sub> 65,751	65,751	65,751
0,20322C + 0,10161O <sub>2</sub> = 0,20322CO	(-ΔH <sub>298</sub> ) 5,372	0,20322FeO = 0,20322Fe + 0,10161O <sub>2</sub>	ΔH <sub>298</sub> 12,835	12,835	12,835
	36,323	Total	123,631	125,867	127,229
			36,323	36,323	36,323
		Deficiência de calor	87,31	89,54	90,91



P4

4%Fe75%Si = 3 g Si



			Tw (K)		
			1773	1823	1873
Entrada	kcal	Saída	kcal	kcal	kcal
0,05357Cr <sub>2</sub> O <sub>3</sub>	0	0,10714Cr	1,294	1,346	1,397
0,08036Si	0	0,08036SiO <sub>2</sub>	1,961	2,028	2,105
0,05358FeO	0	0,05358Fe	0,737	0,961	0,987
0,02679Si	0	0,02679SiO <sub>2</sub>	0,654	0,676	0,702
0,21643Cr <sub>2</sub> O <sub>3</sub>	298	0,43286Cr	5,230	5,437	5,644
0,64929C	0	0,64929CO	7,534	7,844	8,155
0,17642FeO	0	0,17642Fe	2,427	3,165	3,250
0,17642C	0	0,17642CO	2,047	2,131	2,216
		0,063CaO	1,153	1,198	1,236
		0,30MgO	5,239	5,419	5,598
		0,134Al <sub>2</sub> O <sub>3</sub>	5,706	5,931	6,123
		0,09SiO <sub>2</sub>	2,196	2,272	2,358
0,08036Si + 0,0803O <sub>2</sub> = 0,0803SiO <sub>2</sub>	(-ΔH <sub>298</sub> ) 17,482	0,05357Cr <sub>2</sub> O <sub>3</sub> = 0,10714Cr + 0,080355O <sub>2</sub>	ΔH <sub>298</sub> 14,482	14,482	14,482
0,02679Si + 0,02679O <sub>2</sub> = 0,02679SiO <sub>2</sub>	(-ΔH <sub>298</sub> ) 5,832	0,05358FeO = 0,05358Fe + 0,02679O <sub>2</sub>	ΔH <sub>298</sub> 3,384	3,384	3,384
0,64929C + 0,32464O <sub>2</sub> = 0,64929CO	(-ΔH <sub>298</sub> ) 17,164	0,21643Cr <sub>2</sub> O <sub>3</sub> = 0,5296Cr + 0,32464O <sub>2</sub>	ΔH <sub>298</sub> 58,509	58,509	58,509
0,17642C + 0,08821O <sub>2</sub> = 0,17642CO	(-ΔH <sub>298</sub> ) 4,664	0,17642FeO = 0,17642Fe + 0,08821O <sub>2</sub>	ΔH <sub>298</sub> 11,142	11,142	11,142
	45,142	Total	123,694	125,925	127,287
			45,142	45,142	45,142
		Deficiência de calor	78,55	80,78	82,14