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NASA-GLENN CHEMICAL EQUILIBRIUM PROGRAM CEA2, MAY 21, 2004
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 REFS: NASA RP-1311, PART I, 1994 AND NASA RP-1311, PART II, 1996

problem

rocket fac ac/at=3.0 tcest,k=3800
 p,bar=50,
 sup,ae/at=1,10,100,1000,10000,100000,1000000,
 react
 name=H2 moles=1.0 t,k=298.15
 name=O2 moles=0.5 t,k=298.15
 end

OPTIONS: TP=F HP=F SP=F TV=F UV=F SV=F DETN=F SHOCK=F REFL=F INCD=F
 RKT=T FROZ=F EQL=T IONS=F SIUNIT=T DEBUGF=F SHKDBG=F DETDBG=F TRNSPT=F

TRACE= 0.00E+00 S/R= 0.000000E+00 H/R= 0.000000E+00 U/R= 0.000000E+00

Pc, BAR = 50.000000

Pc/P =

SUBSONIC AREA RATIOS =

SUPERSONIC AREA RATIOS = 1.0000 10.0000 100.0000 1000.0000 10000.0000
 100000.0000*****

NFZ= 1 Mdot/Ac= 0.000000E+00 Ac/At= 3.000000E+00

REACTANT	MOLES	(ENERGY/R),K	TEMP,K	DENSITY
EXPLODED FORMULA				
N: H2	1.000000	-0.326752E-06	298.15	0.0000
H	2.00000			
N: O2	0.500000	-0.154035E-05	298.15	0.0000
O	2.00000			

SPECIES BEING CONSIDERED IN THIS SYSTEM
 (CONDENSED PHASE MAY HAVE NAME LISTED SEVERAL TIMES)
 LAST thermo.inp UPDATE: 9/09/04

g 6/97 *H	g 4/02 HO2	tpis78 *H2
g 8/89 H2O	g 6/99 H2O2	g 5/97 *O
g 4/02 *OH	tpis89 *O2	g 8/01 O3
g11/99 H2O(cr)	g 8/01 H2O(L)	g 8/01 H2O(L)

O/F = 0.000000

ENTHALPY	EFFECTIVE FUEL	EFFECTIVE OXIDANT	MIXTURE
(KG-MOL) (K) /KG	h(2)/R	h(1)/R	h0/R
	-0.60888815E-07	0.00000000E+00	-0.60888815E-07

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KG-FORM.WT./KG	bi(2)	bi(1)	b0i
*H	0.11101687E+00	0.00000000E+00	0.11101687E+00
*O	0.55508435E-01	0.00000000E+00	0.55508435E-01

POINT	ITN	T	H	O
1	8	3625.975	-9.844	-15.221
2	2	3619.092	-9.862	-15.238
Pinf/Pt = 1.728208				
3	3	3450.727	-10.084	-15.434
Pinf/Pt = 1.725829				
3	2	3451.137	-10.083	-15.433
4	2	3612.755	-9.870	-15.245
4	2	3611.759	-9.871	-15.246
4	2	3611.673	-9.871	-15.246
2	2	3622.631	-9.853	-15.229
Pinf/Pt = 1.728274				
3	3	3453.864	-10.074	-15.425
Pinf/Pt = 1.725895				
3	2	3454.274	-10.074	-15.425
4	2	3616.278	-9.861	-15.236
4	2	3615.280	-9.862	-15.237
4	2	3615.194	-9.862	-15.237
END OF CHAMBER ITERATIONS				
4	4	3454.274	-10.074	-15.425
5	5	2508.497	-11.830	-17.022
5	3	2551.626	-11.727	-16.927
5	2	2551.755	-11.727	-16.927
6	5	1906.125	-13.534	-18.612
6	3	1921.858	-13.482	-18.563
7	4	1243.207	-16.622	-21.560
7	3	1214.504	-16.823	-21.755
7	1	1214.486	-16.823	-21.755

SINGULAR MATRIX, ITERATION 3 VARIABLE 2(EQLBRM)

8	12	663.188	-26.140	-24.186
8	2	656.418	-25.871	-25.198

THEORETICAL ROCKET PERFORMANCE ASSUMING EQUILIBRIUM

COMPOSITION DURING EXPANSION FROM FINITE AREA COMBUSTOR

Pin = 725.2 PSIA
 Ac/At = 3.0000 Pinj/Pinf = 1.022557
 CASE =

	REACTANT	MOLES	ENERGY KJ/KG-MOL	TEMP K
NAME	H2	1.0000000	0.000	298.150
NAME	O2	0.5000000	0.000	298.150

O/F= 0.00000 %FUEL= 0.000000 R,EQ.RATIO= 1.000000 PHI,EQ.RATIO= 0.000000

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	INJECTOR	COMB END	THROAT	EXIT	EXIT	EXIT	EXIT	EXIT
Pinj/P	1.0000	1.0467	1.7648	1.7648	65.032	1084.84	19098.0	372177.4
P, BAR	50.000	47.771	28.331	28.331	0.76885	0.04609	0.00262	0.00013
T, K	3625.98	3615.19	3454.27	3454.27	2551.75	1921.86	1214.49	656.42
RHO, KG/CU M	2.6023 0	2.4943 0	1.5693 0	1.5693 0	6.2465-2	5.1611-3	4.6707-4	4.4345-5
H, KJ/KG	0.00000	-44.687	-1016.19	-1016.19	-6413.48	-9395.03	-11471.1	-12725.7
U, KJ/KG	-1921.40	-1959.85	-2821.58	-2821.58	-7644.34	-10288.1	-12031.7	-13028.6
G, KJ/KG	-58419.7	-58333.4	-56710.4	-56710.4	-47556.1	-40381.7	-31052.6	-23309.3
S, KJ/(KG)(K)	16.1115	16.1233	16.1233	16.1233	16.1233	16.1233	16.1233	16.1233
M, (1/n)	15.691	15.695	15.908	15.908	17.237	17.894	18.015	18.015
(dLV/dLP)t	-1.05156	-1.05149	-1.04667	-1.04667	-1.01644	-1.00236	-1.00001	-1.00000
(dLV/dLT)p	1.8796	1.8809	1.8365	1.8365	1.4016	1.0768	1.0005	1.0000
Cp, KJ/(KG)(K)	11.2724	11.3039	11.1322	11.1322	7.8259	4.0089	2.4563	2.0527
GAMMAS	1.1293	1.1291	1.1257	1.1257	1.1169	1.1521	1.2317	1.2901
SON VEL,M/SEC	1473.1	1470.5	1425.6	1425.6	1172.5	1014.3	830.9	625.2
MACH NUMBER	0.000	0.203	1.000	1.000	3.055	4.274	5.765	8.070

PERFORMANCE PARAMETERS

Ae/At	3.0001	1.0000	1.0000	10.000	100.00	1000.00	10000.0
CSTAR, M/SEC	2185.7	2185.7	2185.7	2185.7	2185.7	2185.7	2185.7
CF	0.1368	0.6523	0.6523	1.6386	1.9833	2.1915	2.3082
Ivac, M/SEC	6705.2	2692.0	2692.0	3925.1	4540.8	4906.8	5105.0
Isp, M/SEC	299.0	1425.6	1425.6	3581.5	4334.8	4789.8	5044.9

MOLE FRACTIONS

*H	0.03922	0.03919	0.03437	0.03437	0.00838	0.00045	0.00000	0.00000
HO2	0.00021	0.00020	0.00014	0.00014	0.00001	0.00000	0.00000	0.00000
*H2	0.12671	0.12652	0.11806	0.11806	0.05447	0.01072	0.00006	0.00000
H2O	0.66999	0.67063	0.69877	0.69877	0.88178	0.98029	0.99990	1.00000
H2O2	0.00003	0.00003	0.00002	0.00002	0.00000	0.00000	0.00000	0.00000
*O	0.01814	0.01809	0.01547	0.01547	0.00297	0.00011	0.00000	0.00000
*OH	0.10904	0.10864	0.09785	0.09785	0.03274	0.00402	0.00001	0.00000
*O2	0.03666	0.03668	0.03530	0.03530	0.01965	0.00441	0.00003	0.00000

* THERMODYNAMIC PROPERTIES FITTED TO 20000.K

PRODUCTS WHICH WERE CONSIDERED BUT WHOSE MOLE FRACTIONS
WERE LESS THAN 5.000000E-06 FOR ALL ASSIGNED CONDITIONS

O3	H2O(cr)	H2O(L)
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SINGULAR MATRIX, ITERATION 4 VARIABLE 2(EQLBRM)

4	13	316.982	-50.580	-25.290
4	2	317.525	-50.000	-26.287

SINGULAR MATRIX, ITERATION 4 VARIABLE 2(EQLBRM)

5	13	147.565	-104.375	-27.377
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ADD H2O(cr)

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5      3      189.410      -81.388      -29.016
THE TEMPERATURE= 0.1894E+03 IS OUT OF RANGE FOR POINT      5 (EQLBRM)

SINGULAR MATRIX, ITERATION 2 VARIABLE 2(EQLBRM)
5      11      192.718      -80.917      -26.729
THE TEMPERATURE= 0.1927E+03 IS OUT OF RANGE FOR POINT      5 (EQLBRM)
5      3      190.730      -81.045      -28.400
THE TEMPERATURE= 0.1907E+03 IS OUT OF RANGE FOR POINT      5 (EQLBRM)
5      1      190.731      -80.795      -28.900
THE TEMPERATURE= 0.1907E+03 IS OUT OF RANGE FOR POINT      5 (EQLBRM)

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THEORETICAL ROCKET PERFORMANCE ASSUMING EQUILIBRIUM

COMPOSITION DURING EXPANSION FROM FINITE AREA COMBUSTOR

Pin = 725.2 PSIA
Ac/At = 3.0000 Pinj/Pinf = 1.022557
CASE =

REACTANT	MOLES	ENERGY KJ/KG-MOL	TEMP K
NAME H2	1.0000000	0.000	298.150
NAME O2	0.5000000	0.000	298.150

O/F= 0.00000 %FUEL= 0.000000 R,EQ.RATIO= 1.000000 PHI,EQ.RATIO= 0.000000

	INJECTOR	COMB END	THROAT	EXIT	EXIT
Pinj/P	1.0000	1.0467	1.7648	7891511.*****	
P, BAR	50.000	47.771	28.331	0.00001	0.00000
T, K	3625.98	3615.19	3454.27	317.52	190.73
RHO, KG/CU M	2.6023 0	2.4943 0	1.5693 0	4.3235-6	4.2750-7
H, KJ/KG	0.00000	-44.687	-1016.19	-13387.2	-13693.0
U, KJ/KG	-1921.40	-1959.85	-2821.58	-13533.8	-13778.8
G, KJ/KG	-58419.7	-58333.4	-56710.4	-18506.8	-16768.2
S, KJ/(KG)(K)	16.1115	16.1233	16.1233	16.1233	16.1233
M, (1/n)	15.691	15.695	15.908	18.015	18.474
MW, MOL WT	15.691	15.695	15.908	18.015	18.015
(dLV/dLP)t	-1.05156	-1.05149	-1.04667	-1.00000*****	
(dLV/dLT)p	1.8796	1.8809	1.8365	1.0000*****	
Cp, KJ/(KG)(K)	11.2724	11.3039	11.1322	1.8697*****	
GAMMAS	1.1293	1.1291	1.1257	1.3278	0.6157
SON VEL,M/SEC	1473.1	1470.5	1425.6	441.1	229.9
MACH NUMBER	0.000	0.203	1.000	11.730	22.763

PERFORMANCE PARAMETERS

Ae/At	3.0001	1.0000	100000.0	1000000.
CSTAR, M/SEC	2185.7	2185.7	2185.7	2185.7
CF	0.1368	0.6523	2.3674	2.3943
Ivac, M/SEC	6705.2	2692.0	5202.7	5249.6
Isp, M/SEC	299.0	1425.6	5174.4	5233.2

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MOLE FRACTIONS

*H	0.03922	0.03919	0.03437	0.00000	0.00000
HO2	0.00021	0.00020	0.00014	0.00000	0.00000
*H2	0.12671	0.12652	0.11806	0.00000	0.00000
H2O	0.66999	0.67063	0.69877	1.00000	0.97518
H2O2	0.00003	0.00003	0.00002	0.00000	0.00000
*O	0.01814	0.01809	0.01547	0.00000	0.00000
*OH	0.10904	0.10864	0.09785	0.00000	0.00000
*O2	0.03666	0.03668	0.03530	0.00000	0.00000
H2O(cr)	0.00000	0.00000	0.00000	0.00000	0.02482

* THERMODYNAMIC PROPERTIES FITTED TO 20000.K

PRODUCTS WHICH WERE CONSIDERED BUT WHOSE MOLE FRACTIONS
WERE LESS THAN 5.000000E-06 FOR ALL ASSIGNED CONDITIONS

O3 H2O(L)