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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

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problem

rocket fac ac/at=3.0 tcest,k=3800  
 p,bar=50,  
 sup,ae/at=10,40,160,640,2560,  
 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 = 10.0000 40.0000 160.0000 640.0000 2560.0000

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 5	2508.497	-11.830	-17.022
4 3	2551.626	-11.727	-16.927
4 2	2551.755	-11.727	-16.927
5 4	2171.457	-12.716	-17.846
5 2	2178.627	-12.696	-17.826
6 4	1790.429	-13.937	-18.991
6 3	1781.085	-13.971	-19.023
7 4	1344.522	-15.978	-20.938
7 2	1347.423	-15.961	-20.921
8 4	965.153	-19.041	-23.925
8 2	959.631	-19.103	-23.986

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	EXIT	EXIT	EXIT
Pinj/P	1.0000	1.0467	1.7648	65.032	356.49	1928.06	10854.1	63476.7
P, BAR	50.000	47.771	28.331	0.76885	0.14026	0.02593	0.00461	0.00079

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T, K	3625.98	3615.19	3454.27	2551.75	2178.63	1781.08	1347.42	959.63
RHO, KG/CU M	2.6023 0	2.4943 0	1.5693 0	6.2465-2	1.3704-2	3.1440-3	7.4065-4	1.7785-4
H, KJ/KG	0.00000	-44.687	-1016.19	-6413.48	-8328.54	-9889.02	-11137.2	-12071.9
U, KJ/KG	-1921.40	-1959.85	-2821.58	-7644.34	-9352.04	-10713.8	-11759.2	-12514.8
G, KJ/KG	-58419.7	-58333.4	-56710.4	-47556.1	-43455.1	-38605.9	-32862.1	-27544.3
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	17.237	17.698	17.954	18.013	18.015
(dLV/dLP)t	-1.05156	-1.05149	-1.04667	-1.01644	-1.00639	-1.00117	-1.00005	-1.00000
(dLV/dLT)p	1.8796	1.8809	1.8365	1.4016	1.1832	1.0409	1.0021	1.0000
Cp, KJ/(KG)(K)	11.2724	11.3039	11.1322	7.8259	5.4297	3.4437	2.5778	2.2633
GAMMAS	1.1293	1.1291	1.1257	1.1169	1.1296	1.1690	1.2192	1.2562
SON VEL,M/SEC	1473.1	1470.5	1425.6	1172.5	1075.3	981.9	870.8	745.9
MACH NUMBER	0.000	0.203	1.000	3.055	3.796	4.529	5.420	6.588

## PERFORMANCE PARAMETERS

Ae/At	3.0001	1.0000	10.000	40.000	160.00	640.00	2560.00
CSTAR, M/SEC	2185.7	2185.7	2185.7	2185.7	2185.7	2185.7	2185.7
CF	0.1368	0.6523	1.6386	1.8673	2.0347	2.1593	2.2481
Ivac, M/SEC	6705.2	2692.0	3925.1	4332.1	4632.7	4851.4	5003.8
Isp, M/SEC	299.0	1425.6	3581.5	4081.3	4447.2	4719.6	4913.6

## MOLE FRACTIONS

*H	0.03922	0.03919	0.03437	0.00838	0.00212	0.00014	0.00000	0.00000
HO2	0.00021	0.00020	0.00014	0.00001	0.00000	0.00000	0.00000	0.00000
*H2	0.12671	0.12652	0.11806	0.05447	0.02537	0.00565	0.00026	0.00000
H2O	0.66999	0.67063	0.69877	0.88178	0.94997	0.98997	0.99958	1.00000
H2O2	0.00003	0.00003	0.00002	0.00000	0.00000	0.00000	0.00000	0.00000
*O	0.01814	0.01809	0.01547	0.00297	0.00063	0.00003	0.00000	0.00000
*OH	0.10904	0.10864	0.09785	0.03274	0.01200	0.00181	0.00004	0.00000
*O2	0.03666	0.03668	0.03530	0.01965	0.00990	0.00240	0.00012	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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