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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=100,
 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 = 100.000000

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	3730.278	-9.575	-14.967
2	2	3723.353	-9.593	-14.984
Pinf/Pt = 1.730122				
3	3	3542.876	-9.813	-15.178
Pinf/Pt = 1.727754				
3	2	3543.310	-9.812	-15.178
4	2	3716.555	-9.601	-14.991
4	2	3715.486	-9.602	-14.992
4	2	3715.394	-9.602	-14.992
2	2	3726.907	-9.584	-14.976
Pinf/Pt = 1.730186				
3	3	3546.007	-9.804	-15.170
Pinf/Pt = 1.727819				
3	2	3546.443	-9.803	-15.169
4	2	3720.093	-9.592	-14.983
4	2	3719.022	-9.593	-14.984
4	2	3718.930	-9.593	-14.984
END OF CHAMBER ITERATIONS				
4	4	3546.443	-9.803	-15.169
5	5	2536.289	-11.567	-16.767
5	3	2580.779	-11.467	-16.674
5	2	2580.903	-11.466	-16.674
6	5	1889.077	-13.342	-18.417
6	3	1904.473	-13.291	-18.369
7	4	1209.461	-16.595	-21.526
7	2	1183.876	-16.783	-21.709
7	1	1183.862	-16.783	-21.709

SINGULAR MATRIX, ITERATION 3 VARIABLE 2(EQLBRM)

8	12	642.619	-26.659	-23.828
8	2	636.040	-26.398	-24.841

THEORETICAL ROCKET PERFORMANCE ASSUMING EQUILIBRIUM

COMPOSITION DURING EXPANSION FROM FINITE AREA COMBUSTOR

Pin = 1450.4 PSIA
 Ac/At = 3.0000 Pinj/Pinf = 1.022603
 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	1.0468	1.7669	1.7669	65.691	1111.77	19812.6	387789.2
P, BAR	100.00	95.533	56.597	56.597	1.5223	0.08995	0.00505	0.00026
T, K	3730.28	3718.93	3546.44	3546.44	2580.90	1904.47	1183.86	636.04
RHO, KG/CU M	5.1130 0	4.9007 0	3.0842 0	3.0842 0	1.2304-1	1.0184-2	9.2375-4	8.7846-5
H, KJ/KG	0.00000	-45.579	-1035.77	-1035.77	-6508.45	-9500.44	-11546.1	-12767.4
U, KJ/KG	-1955.80	-1994.96	-2870.84	-2870.84	-7745.72	-10383.7	-12092.5	-13060.9
G, KJ/KG	-58737.3	-58647.8	-56920.0	-56920.0	-47177.8	-39510.8	-30201.1	-22790.0
S, KJ/(KG)(K)	15.7461	15.7578	15.7578	15.7578	15.7578	15.7578	15.7578	15.7578
M, (1/n)	15.858	15.862	16.069	16.069	17.344	17.928	18.015	18.015
(dLV/dLP)t	-1.04715	-1.04708	-1.04248	-1.04248	-1.01396	-1.00167	-1.00001	-1.00000
(dLV/dLT)p	1.7849	1.7862	1.7446	1.7446	1.3386	1.0550	1.0003	1.0000
Cp, KJ/(KG)(K)	10.1792	10.2076	10.0551	10.0551	7.0314	3.6764	2.4293	2.0394
GAMMAS	1.1324	1.1322	1.1289	1.1289	1.1213	1.1611	1.2347	1.2925
SON VEL,M/SEC	1488.2	1485.6	1439.3	1439.3	1177.9	1012.7	821.4	616.0
MACH NUMBER	0.000	0.203	1.000	1.000	3.063	4.304	5.851	8.204

PERFORMANCE PARAMETERS

Ae/At	3.0001	1.0000	1.0000	10.000	100.00	1000.00	10000.0
CSTAR, M/SEC	2203.0	2203.0	2203.0	2203.0	2203.0	2203.0	2203.0
CF	0.1371	0.6533	0.6533	1.6378	1.9787	2.1814	2.2938
Ivac, M/SEC	6758.5	2714.3	2714.3	3950.8	4561.6	4919.1	5111.3
Isp, M/SEC	301.9	1439.3	1439.3	3607.9	4359.0	4805.4	5053.2

MOLE FRACTIONS

*H	0.03354	0.03351	0.02917	0.02917	0.00632	0.00024	0.00000	0.00000
HO2	0.00027	0.00026	0.00018	0.00018	0.00001	0.00000	0.00000	0.00000
*H2	0.12070	0.12052	0.11189	0.11189	0.04814	0.00782	0.00003	0.00000
H2O	0.68966	0.69025	0.71805	0.71805	0.89677	0.98578	0.99995	1.00000
H2O2	0.00005	0.00005	0.00003	0.00003	0.00000	0.00000	0.00000	0.00000
*O	0.01572	0.01568	0.01331	0.01331	0.00226	0.00006	0.00000	0.00000
*OH	0.10590	0.10552	0.09457	0.09457	0.02931	0.00288	0.00000	0.00000
*O2	0.03417	0.03419	0.03278	0.03278	0.01718	0.00322	0.00002	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	305.914	-52.076	-24.964
4	2	306.530	-51.478	-25.960

SINGULAR MATRIX, ITERATION 4 VARIABLE 2(EQLBRM)

5	13	142.317	-107.889	-27.119
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ADD H2O(cr)

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5      3      193.288      -79.674      -28.668
THE TEMPERATURE= 0.1933E+03 IS OUT OF RANGE FOR POINT      5(EQLBRM)

SINGULAR MATRIX, ITERATION 2 VARIABLE 2(EQLBRM)
5      11      195.342      -79.791      -26.495
THE TEMPERATURE= 0.1953E+03 IS OUT OF RANGE FOR POINT      5(EQLBRM)
5      2      194.977      -79.447      -27.526
THE TEMPERATURE= 0.1950E+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

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Pin = 1450.4 PSIA
Ac/At = 3.0000      Pinj/Pinf = 1.022603
CASE =
    
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NAME	REACTANT	MOLES	ENERGY KJ/KG-MOL	TEMP K
H2		1.0000000	0.000	298.150
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	1.0468	1.7669	8245881.*****	
P, BAR	100.00	95.533	56.597	0.00001	0.00000
T, K	3730.28	3718.93	3546.44	306.53	194.98
RHO, KG/CU M	5.1130 0	4.9007 0	3.0842 0	8.5722-6	8.4794-7
H, KJ/KG	0.00000	-45.579	-1035.77	-13407.7	-13702.9
U, KJ/KG	-1955.80	-1994.96	-2870.84	-13549.2	-13790.1
G, KJ/KG	-58737.3	-58647.8	-56920.0	-18238.0	-16775.3
S, KJ/(KG)(K)	15.7461	15.7578	15.7578	15.7578	15.7578
M, (1/n)	15.858	15.862	16.069	18.015	18.593
MW, MOL WT	15.858	15.862	16.069	18.015	18.015
(dLV/dLP)t	-1.04715	-1.04708	-1.04248	-1.00000*****	
(dLV/dLT)p	1.7849	1.7862	1.7446	1.0000*****	
Cp, KJ/(KG)(K)	10.1792	10.2076	10.0551	1.8665*****	
GAMMAS	1.1324	1.1322	1.1289	1.3285	1.0551
SON VEL,M/SEC	1488.2	1485.6	1439.3	433.5	303.3
MACH NUMBER	0.000	0.203	1.000	11.945	17.260

PERFORMANCE PARAMETERS

Ae/At	3.0001	1.0000	100000.0	1000000.
CSTAR, M/SEC	2203.0	2203.0	2203.0	2203.0
CF	0.1371	0.6533	2.3506	2.3764
Ivac, M/SEC	6758.5	2714.3	5205.7	5251.7
Isp, M/SEC	301.9	1439.3	5178.4	5235.0

MOLE FRACTIONS

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*H	0.03354	0.03351	0.02917	0.00000	0.00000
HO2	0.00027	0.00026	0.00018	0.00000	0.00000
*H2	0.12070	0.12052	0.11189	0.00000	0.00000
H2O	0.68966	0.69025	0.71805	1.00000	0.96893
H2O2	0.00005	0.00005	0.00003	0.00000	0.00000
*O	0.01572	0.01568	0.01331	0.00000	0.00000
*OH	0.10590	0.10552	0.09457	0.00000	0.00000
*O2	0.03417	0.03419	0.03278	0.00000	0.00000
H2O(cr)	0.00000	0.00000	0.00000	0.00000	0.03107

* 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)