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        NASA-GLENN CHEMICAL EQUILIBRIUM PROGRAM CEA2, FEBRUARY 5, 2004
                  BY  BONNIE MCBRIDE AND SANFORD GORDON
      REFS: NASA RP-1311, PART I, 1994 AND NASA RP-1311, PART II, 1996

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### CEA analysis performed on Sun 01-Sep-2019 13:35:08

# Problem Type: "Rocket" (Infinite Area Combustor)

prob case=hw1_____8729 ro equilibrium

# Pressure (5 values):
p,psia= 14.7, 6.758, 2.73, 1.049, 0.406
# Chamber/Exit Pressure Ratio (5 values):
pi/p= 204.14, 443.86, 1098.9, 2860.5, 7383.7

# Oxidizer/Fuel Wt. ratio (1 value):
o/f= 2.56

# You selected the following fuels and oxidizers:
reac
fuel RP-1             wt%=100.0000
oxid O2(L)            wt%=100.0000

# You selected these options for output:
# short version of output
output short
# Proportions of any products will be expressed as Mass Fractions.
output massf
# Heat will be expressed as siunits
output siunits

# Input prepared by this script:prepareInputFile.cgi

### IMPORTANT:  The following line is the end of your CEA input file!
end

             THEORETICAL ROCKET PERFORMANCE ASSUMING EQUILIBRIUM

          COMPOSITION DURING EXPANSION FROM INFINITE AREA COMBUSTOR

Pin =    14.7 PSIA
CASE = hw1_____________

            REACTANT                    WT FRACTION      ENERGY      TEMP
                                         (SEE NOTE)     KJ/KG-MOL      K
FUEL        RP-1                         1.0000000    -24717.700    298.150
OXIDANT     O2(L)                        1.0000000    -12979.000     90.170

O/F=    2.56000  %FUEL= 28.089888  R,EQ.RATIO= 1.330338  PHI,EQ.RATIO= 1.330338

                CHAMBER   THROAT     EXIT     EXIT     EXIT     EXIT     EXIT
Pinf/P            1.0000   1.7174   204.14   443.86  1098.90  2860.50  7383.70
P, BAR            1.0135  0.59017  0.00496  0.00228  0.00092  0.00035  0.00014
T, K             3086.62  2967.51  2034.81  1831.91  1582.78  1343.40  1141.98
RHO, KG/CU M    8.7468-2 5.3816-2 7.3381-4 3.7688-4 1.7651-4 7.9912-5 3.6420-5
H, KJ/KG         -788.46 -1398.07 -5584.57 -6082.92 -6594.06 -7055.17 -7443.16
U, KJ/KG        -1947.20 -2494.70 -6261.15 -6688.80 -7116.60 -7498.56 -7820.05
G, KJ/KG        -40422.5 -39502.8 -31712.7 -29605.7 -26917.9 -24305.2 -22106.8
```

S, KJ/(KG)(K)	12.8406	12.8406	12.8406	12.8406	12.8406	12.8406	12.8406
M, (1/n)	22.148	22.499	25.006	25.139	25.185	25.192	25.192
(dLV/dLP)t	-1.06302	-1.05755	-1.00405	-1.00108	-1.00015	-1.00001	-1.00000
(dLV/dLT)p	2.2575	2.1973	1.1189	1.0337	1.0051	1.0005	1.0000
Cp, KJ/(KG)(K)	11.5065	11.2853	3.1222	2.2774	1.9657	1.9157	1.9465
GAMMAs	1.1151	1.1118	1.1485	1.1822	1.2041	1.2084	1.2042
SON VEL,M/SEC	1136.7	1104.2	881.5	846.3	793.2	732.0	673.7
MACH NUMBER	0.000	1.000	3.513	3.845	4.296	4.837	5.415

PERFORMANCE PARAMETERS

Ae/At	1.0000	26.146	48.454	98.799	210.04	447.24
CSTAR, M/SEC	1705.6	1705.6	1705.6	1705.6	1705.6	1705.6
CF	0.6474	1.8158	1.9079	1.9978	2.0757	2.1389
Ivac, M/SEC	2097.3	3315.6	3440.3	3560.9	3665.5	3751.5
Isp, M/SEC	1104.2	3097.1	3254.1	3407.5	3540.3	3648.2

MASS FRACTIONS

*CO	0.40720	0.39541	0.30549	0.29525	0.27842	0.25314	0.22028
*CO2	0.24472	0.26325	0.40454	0.42062	0.44707	0.48678	0.53842
*H	0.00285	0.00254	0.00037	0.00013	0.00002	0.00000	0.00000
HO2	0.00003	0.00002	0.00000	0.00000	0.00000	0.00000	0.00000
*H2	0.00860	0.00832	0.00784	0.00860	0.00987	0.01171	0.01408
H2O	0.22255	0.23115	0.27809	0.27473	0.26457	0.24836	0.22722
*O	0.01853	0.01517	0.00017	0.00001	0.00000	0.00000	0.00000
*OH	0.05328	0.04678	0.00295	0.00063	0.00005	0.00000	0.00000
*O2	0.04224	0.03735	0.00056	0.00004	0.00000	0.00000	0.00000

* THERMODYNAMIC PROPERTIES FITTED TO 20000.K

NOTE. WEIGHT FRACTION OF FUEL IN TOTAL FUELS AND OF OXIDANT IN TOTAL OXIDANTS

THEORETICAL ROCKET PERFORMANCE ASSUMING EQUILIBRIUM

COMPOSITION DURING EXPANSION FROM INFINITE AREA COMBUSTOR

Pin = 6.8 PSIA
CASE = hw1_____

REACTANT		WT FRACTION (SEE NOTE)	ENERGY KJ/KG-MOL	TEMP K
FUEL	RP-1	1.0000000	-24717.700	298.150
OXIDANT	O2(L)	1.0000000	-12979.000	90.170

O/F= 2.56000 %FUEL= 28.089888 R,EQ.RATIO= 1.330338 PHI,EQ.RATIO= 1.330338

	CHAMBER	THROAT	EXIT	EXIT	EXIT	EXIT	EXIT
Pinf/P	1.0000	1.7151	204.14	443.86	1098.90	2860.50	7383.70
P, BAR	0.46595	0.27167	0.00228	0.00105	0.00042	0.00016	0.00006
T, K	2990.04	2879.97	2032.14	1850.41	1610.47	1369.11	1163.64
RHO, KG/CU M	4.1151-2	2.5307-2	3.3653-4	1.7126-4	7.9726-5	3.6047-5	1.6431-5
H, KJ/KG	-788.46	-1383.23	-5515.08	-6016.97	-6535.90	-7005.63	-7401.04
U, KJ/KG	-1920.75	-2456.72	-6193.32	-6629.94	-7067.73	-7457.51	-7785.09
G, KJ/KG	-40058.5	-39207.7	-32204.5	-30319.5	-27687.3	-24987.1	-22683.9
S, KJ/(KG)(K)	13.1336	13.1336	13.1336	13.1336	13.1336	13.1336	13.1336
M, (1/n)	21.956	22.306	24.912	25.100	25.178	25.191	25.192
(dLV/dLP)t	-1.06707	-1.06167	-1.00627	-1.00192	-1.00030	-1.00002	-1.00000
(dLV/dLT)p	2.3765	2.3168	1.1851	1.0598	1.0101	1.0010	1.0001
Cp, KJ/(KG)(K)	12.7872	12.5652	3.7931	2.5525	2.0232	1.9202	1.9409
GAMMAs	1.1113	1.1081	1.1329	1.1680	1.1994	1.2080	1.2049
SON VEL,M/SEC	1121.8	1090.7	876.6	846.1	798.7	738.8	680.3
MACH NUMBER	0.000	1.000	3.508	3.822	4.245	4.773	5.346

PERFORMANCE PARAMETERS

Ae/At	1.0000	26.676	49.840	102.11	217.15	461.91
CSTAR, M/SEC	1688.1	1688.1	1688.1	1688.1	1688.1	1688.1
CF	0.6461	1.8213	1.9156	2.0084	2.0889	2.1543
Ivac, M/SEC	2074.9	3295.2	3423.3	3547.3	3654.4	3742.2
Isp, M/SEC	1090.7	3074.6	3233.7	3390.4	3526.2	3636.6

MASS FRACTIONS

*CO	0.40894	0.39732	0.30589	0.29608	0.28061	0.25644	0.22451
*CO2	0.24200	0.26026	0.40391	0.41932	0.44363	0.48160	0.53178
*H	0.00319	0.00287	0.00053	0.00022	0.00004	0.00000	0.00000
HO2	0.00002	0.00001	0.00000	0.00000	0.00000	0.00000	0.00000
*H2	0.00877	0.00851	0.00783	0.00849	0.00970	0.01147	0.01377
H2O	0.21787	0.22641	0.27609	0.27462	0.26592	0.25048	0.22995
*O	0.02057	0.01702	0.00035	0.00004	0.00000	0.00000	0.00000
*OH	0.05340	0.04719	0.00423	0.00112	0.00010	0.00000	0.00000
*O2	0.04525	0.04042	0.00117	0.00011	0.00000	0.00000	0.00000

* THERMODYNAMIC PROPERTIES FITTED TO 20000.K

NOTE. WEIGHT FRACTION OF FUEL IN TOTAL FUELS AND OF OXIDANT IN TOTAL OXIDANTS

THEORETICAL ROCKET PERFORMANCE ASSUMING EQUILIBRIUM

COMPOSITION DURING EXPANSION FROM INFINITE AREA COMBUSTOR

Pin = 2.7 PSIA
CASE = hw1_____

REACTANT		WT FRACTION (SEE NOTE)	ENERGY KJ/KG-MOL	TEMP K
FUEL	RP-1	1.0000000	-24717.700	298.150
OXIDANT	O2(L)	1.0000000	-12979.000	90.170

O/F= 2.56000 %FUEL= 28.089888 R,EQ.RATIO= 1.330338 PHI,EQ.RATIO= 1.330338

	CHAMBER	THROAT	EXIT	EXIT	EXIT	EXIT	EXIT
Pinf/P	1.0000	1.7126	204.14	443.86	1098.90	2860.50	7383.70
P, BAR	0.18823	0.10991	0.00092	0.00042	0.00017	0.00007	0.00003
T, K	2882.14	2781.56	2018.48	1863.36	1642.43	1401.68	1191.44
RHO, KG/CU M	1.7080-2	1.0498-2	1.3611-4	6.8498-5	3.1558-5	1.4222-5	6.4829-6
H, KJ/KG	-788.46	-1366.35	-5430.79	-5934.75	-6461.87	-6942.24	-7347.14
U, KJ/KG	-1890.51	-2413.24	-6108.21	-6553.84	-7004.64	-7404.91	-7740.36
G, KJ/KG	-39635.5	-38857.7	-32637.0	-31050.2	-28599.4	-25834.9	-23406.0
S, KJ/(KG)(K)	13.4786	13.4786	13.4786	13.4786	13.4786	13.4786	13.4786
M, (1/n)	21.744	22.092	24.774	25.025	25.160	25.189	25.192
(dLV/dLP)t	-1.07168	-1.06636	-1.00967	-1.00355	-1.00065	-1.00006	-1.00000
(dLV/dLT)p	2.5198	2.4607	1.2880	1.1107	1.0221	1.0023	1.0002
Cp, KJ/(KG)(K)	14.4163	14.1918	4.8623	3.0941	2.1591	1.9356	1.9352
GAMMAs	1.1071	1.1040	1.1171	1.1480	1.1894	1.2067	1.2057
SON VEL,M/SEC	1104.6	1075.1	869.9	843.0	803.5	747.2	688.6
MACH NUMBER	0.000	1.000	3.503	3.805	4.192	4.695	5.260

PERFORMANCE PARAMETERS

Ae/At	1.0000	27.213	51.360	106.17	226.21	480.70
CSTAR, M/SEC	1667.7	1667.7	1667.7	1667.7	1667.7	1667.7
CF	0.6446	1.8271	1.9237	2.0198	2.1036	2.1717
Ivac, M/SEC	2048.9	3269.4	3401.2	3529.6	3640.1	3730.4
Isp, M/SEC	1075.1	3047.1	3208.2	3368.5	3508.2	3621.8

MASS FRACTIONS

*CO	0.41026	0.39885	0.30634	0.29661	0.28290	0.26038	0.22966
*CO2	0.23992	0.25784	0.40320	0.41849	0.44003	0.47542	0.52368
*H	0.00360	0.00326	0.00077	0.00038	0.00009	0.00001	0.00000
HO2	0.00001	0.00001	0.00000	0.00000	0.00000	0.00000	0.00000
*H2	0.00895	0.00869	0.00784	0.00839	0.00950	0.01118	0.01340
H2O	0.21276	0.22118	0.27295	0.27364	0.26723	0.25301	0.23326
*O	0.02288	0.01916	0.00069	0.00011	0.00000	0.00000	0.00000
*OH	0.05308	0.04722	0.00588	0.00202	0.00024	0.00001	0.00000
*O2	0.04853	0.04378	0.00233	0.00036	0.00001	0.00000	0.00000

* THERMODYNAMIC PROPERTIES FITTED TO 20000.K

NOTE. WEIGHT FRACTION OF FUEL IN TOTAL FUELS AND OF OXIDANT IN TOTAL OXIDANTS

THEORETICAL ROCKET PERFORMANCE ASSUMING EQUILIBRIUM

COMPOSITION DURING EXPANSION FROM INFINITE AREA COMBUSTOR

Pin = 1.0 PSIA
CASE = hw1_____

REACTANT		WT FRACTION (SEE NOTE)	ENERGY KJ/KG-MOL	TEMP K
FUEL	RP-1	1.0000000	-24717.700	298.150
OXIDANT	O2(L)	1.0000000	-12979.000	90.170

O/F= 2.56000 %FUEL= 28.089888 R,EQ.RATIO= 1.330338 PHI,EQ.RATIO= 1.330338

	CHAMBER	THROAT	EXIT	EXIT	EXIT	EXIT	EXIT
Pinf/P	1.0000	1.7101	204.14	443.86	1098.90	2860.50	7383.70
P, BAR	0.07233	0.04229	0.00035	0.00016	0.00007	0.00003	0.00001
T, K	2773.91	2682.25	1993.99	1864.30	1671.85	1438.42	1223.77
RHO, KG/CU M	6.7531-3	4.1488-3	5.2579-5	2.6186-5	1.1894-5	5.3243-6	2.4252-6
H, KJ/KG	-788.46	-1349.10	-5339.61	-5843.28	-6376.95	-6868.70	-7284.53
U, KJ/KG	-1859.46	-2368.49	-6013.45	-6465.55	-6930.30	-7343.59	-7688.43
G, KJ/KG	-39196.3	-38487.8	-32948.5	-31656.5	-29525.5	-26785.2	-24228.9
S, KJ/(KG)(K)	13.8461	13.8461	13.8461	13.8461	13.8461	13.8461	13.8461
M, (1/n)	21.535	21.877	24.604	24.910	25.121	25.184	25.192
(dLV/dLP)t	-1.07639	-1.07116	-1.01401	-1.00621	-1.00145	-1.00016	-1.00001
(dLV/dLT)p	2.6760	2.6175	1.4227	1.1950	1.0485	1.0060	1.0004
Cp, KJ/(KG)(K)	16.2990	16.0705	6.3066	4.0054	2.4555	1.9794	1.9322
GAMMAs	1.1028	1.1000	1.1043	1.1271	1.1720	1.2028	1.2062
SON VEL,M/SEC	1086.8	1058.9	862.6	837.5	805.3	755.8	698.0
MACH NUMBER	0.000	1.000	3.497	3.797	4.151	4.614	5.164

PERFORMANCE PARAMETERS

Ae/At	1.0000	27.695	52.765	110.48	236.62	502.57
CSTAR, M/SEC	1646.3	1646.3	1646.3	1646.3	1646.3	1646.3
CF	0.6432	1.8326	1.9313	2.0307	2.1182	2.1894
Ivac, M/SEC	2021.6	3240.3	3375.3	3508.7	3623.4	3716.5
Isp, M/SEC	1058.9	3017.0	3179.6	3343.2	3487.2	3604.5

MASS FRACTIONS

*CO	0.41089	0.39971	0.30679	0.29671	0.28470	0.26448	0.23528
*CO2	0.23893	0.25650	0.40249	0.41833	0.43720	0.46896	0.51484
*H	0.00405	0.00370	0.00106	0.00061	0.00019	0.00002	0.00000
HO2	0.00001	0.00001	0.00000	0.00000	0.00000	0.00000	0.00000
*H2	0.00910	0.00886	0.00791	0.00832	0.00929	0.01087	0.01300
H2O	0.20775	0.21600	0.26892	0.27147	0.26798	0.25563	0.23688
*O	0.02522	0.02135	0.00123	0.00030	0.00002	0.00000	0.00000

*OH	0.05231	0.04681	0.00757	0.00329	0.00057	0.00003	0.00000
*O2	0.05173	0.04707	0.00403	0.00097	0.00004	0.00000	0.00000

* THERMODYNAMIC PROPERTIES FITTED TO 20000.K

NOTE. WEIGHT FRACTION OF FUEL IN TOTAL FUELS AND OF OXIDANT IN TOTAL OXIDANTS

THEORETICAL ROCKET PERFORMANCE ASSUMING EQUILIBRIUM

COMPOSITION DURING EXPANSION FROM INFINITE AREA COMBUSTOR

Pin = 0.4 PSIA
CASE = hw1_____

REACTANT		WT FRACTION (SEE NOTE)	ENERGY KJ/KG-MOL	TEMP K
FUEL	RP-1	1.0000000	-24717.700	298.150
OXIDANT	O2(L)	1.0000000	-12979.000	90.170

O/F= 2.56000 %FUEL= 28.089888 R,EQ.RATIO= 1.330338 PHI,EQ.RATIO= 1.330338

	CHAMBER	THROAT	EXIT	EXIT	EXIT	EXIT	EXIT
Pinf/P	1.0000	1.7078	204.14	443.86	1098.90	2860.50	7383.70
P, BAR	0.02799	0.01639	0.00014	0.00006	0.00003	0.00001	0.00000
T, K	2672.19	2588.39	1962.49	1852.85	1691.50	1475.55	1258.85
RHO, KG/CU M	2.6887-3	1.6510-3	2.0520-5	1.0137-5	4.5372-6	2.0078-6	9.1244-7
H, KJ/KG	-788.46	-1332.59	-5248.20	-5749.50	-6286.75	-6788.95	-7216.40
U, KJ/KG	-1829.60	-2325.40	-5916.43	-6371.61	-6848.19	-7276.34	-7631.90
G, KJ/KG	-38771.6	-38124.6	-33143.5	-32086.3	-30330.1	-27762.7	-25110.0
S, KJ/(KG)(K)	14.2143	14.2143	14.2143	14.2143	14.2143	14.2143	14.2143
M, (1/n)	21.340	21.677	24.418	24.763	25.050	25.172	25.191
(dLV/dLP)t	-1.08091	-1.07578	-1.01880	-1.00977	-1.00294	-1.00041	-1.00003
(dLV/dLT)p	2.8359	2.7780	1.5757	1.3103	1.0979	1.0152	1.0012
Cp, KJ/(KG)(K)	18.3392	18.1056	8.0159	5.2869	3.0126	2.0897	1.9371
GAMMAs	1.0988	1.0961	1.0949	1.1102	1.1492	1.1940	1.2060
SON VEL,M/SEC	1069.6	1043.2	855.4	831.1	803.3	762.9	707.9
MACH NUMBER	0.000	1.000	3.492	3.790	4.128	4.541	5.065

PERFORMANCE PARAMETERS

Ae/At	1.0000	28.103	53.936	114.47	247.61	526.44
CSTAR, M/SEC	1625.3	1625.3	1625.3	1625.3	1625.3	1625.3
CF	0.6418	1.8375	1.9381	2.0403	2.1314	2.2061
Ivac, M/SEC	1994.9	3210.3	3347.4	3485.4	3604.9	3701.4
Isp, M/SEC	1043.2	2986.5	3149.9	3316.1	3464.2	3585.5

MASS FRACTIONS

*CO	0.41080	0.39983	0.30711	0.29651	0.28554	0.26824	0.24096
*CO2	0.23908	0.25630	0.40199	0.41865	0.43588	0.46306	0.50592
*H	0.00452	0.00414	0.00138	0.00090	0.00037	0.00006	0.00000
HO2	0.00001	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
*H2	0.00922	0.00900	0.00800	0.00830	0.00912	0.01057	0.01258
H2O	0.20314	0.21119	0.26447	0.26831	0.26767	0.25798	0.24053
*O	0.02742	0.02342	0.00190	0.00064	0.00006	0.00000	0.00000
*OH	0.05117	0.04603	0.00906	0.00468	0.00118	0.00009	0.00000
*O2	0.05466	0.05008	0.00610	0.00202	0.00018	0.00000	0.00000

* THERMODYNAMIC PROPERTIES FITTED TO 20000.K

NOTE. WEIGHT FRACTION OF FUEL IN TOTAL FUELS AND OF OXIDANT IN TOTAL OXIDANTS