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

 ******************************************************************************



 problem   case=Ethanol o/f=1.2,1.4,1.6,1.8,2.0,2.2,
       rocket  equilibrium  tcest,k=3800
   p,bar=10,20,30,
   pi/p=10,20,30,
 react
   fuel=C2H5OH(L) moles=1.0  t,k=298.15
   oxid=O2 moles=1.0  t,k=298.15
 output  transport
     plot t p gam m son cp h
 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=T

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

 Pc,BAR =    10.000000    20.000000    30.000000

 Pc/P =    10.0000    20.0000    30.0000

 SUBSONIC AREA RATIOS =

 SUPERSONIC AREA RATIOS =

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

    REACTANT           MOLES    (ENERGY/R),K   TEMP,K  DENSITY
        EXPLODED FORMULA
 F: C2H5OH(L)        1.000000  -0.333766E+05   298.15  0.0000
          C  2.00000  H  6.00000  O  1.00000
 O: O2               1.000000  -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 7/97  *C               tpis79  *CH              g 4/02  CH2
  g 4/02  CH3              g11/00  CH2OH            g 7/00  CH3O
  g 8/99  CH4              g 7/00  CH3OH           srd 01  CH3OOH
  tpis79  *CO              g 9/99  *CO2             tpis91  COOH
  tpis91  *C2              g 6/01  C2H              g 1/91  C2H2,acetylene
  g 5/01  C2H2,vinylidene  g 4/02  CH2CO,ketene     g 3/02  O(CH)2O
  srd 01  HO(CO)2OH        g 7/01  C2H3,vinyl       g 6/96  CH3CO,acetyl
  g 1/00  C2H4             g 8/88  C2H4O,ethylen-o  g 8/88  CH3CHO,ethanal
  g 6/00  CH3COOH          srd 01  OHCH2COOH        g 7/00  C2H5
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g 7/00	C2H6	g 8/88	C2H5OH	g 7/00	CH3OCH3
srd 01	CH3O2CH3	g 8/00	C2O	tpis79	*C3
n 4/98	C3H3,1-propynl	n 4/98	C3H3,2-propynl	g 2/00	C3H4,allene
g 1/00	C3H4,propyne	g 5/90	C3H4,cyclo-	g 3/01	C3H5,allyl
g 2/00	C3H6,propylene	g 1/00	C3H6,cyclo-	g 6/01	C3H6O,propylox
g 6/97	C3H6O,acetone	g 1/02	C3H6O,propanal	g 7/01	C3H7,n-propyl
g 9/85	C3H7,i-propyl	g 2/00	C3H8	g 2/00	C3H8O,1propanol
g 2/00	C3H8O,2propanol	g 7/88	C3O2	g tpis	*C4
g 7/01	C4H2,butadiyne	g 8/00	C4H4,1,3-cyclo-	n10/92	C4H6,butadiene
n10/93	C4H6,1butyne	n10/93	C4H6,2butyne	g 8/00	C4H6,cyclo-
n 4/88	C4H8,1-butene	n 4/88	C4H8,cis2-buten	n 4/88	C4H8,tr2-butene
n 4/88	C4H8,isobutene	g 8/00	C4H8,cyclo-	g10/00	(CH3COOH)2
n10/84	C4H9,n-butyl	n10/84	C4H9,i-butyl	g 1/93	C4H9,s-butyl
g 1/93	C4H9,t-butyl	g12/00	C4H10,n-butane	g 8/00	C4H10,isobutane
g 8/00	*C5	g 5/90	C5H6,1,3cyclo-	g 1/93	C5H8,cyclo-
n 4/87	C5H10,1-pentene	g 2/01	C5H10,cyclo-	n10/84	C5H11,pentyl
g 1/93	C5H11,t-pentyl	n10/85	C5H12,n-pentane	n10/85	C5H12,i-pentane
n10/85	CH3C(CH3)2CH3	g 2/93	C6H2	g11/00	C6H5,phenyl
g 8/00	C6H5O,phenoxy	g 8/00	C6H6	g 8/00	C6H5OH,phenol
g 1/93	C6H10,cyclo-	n 4/87	C6H12,1-hexene	g 6/90	C6H12,cyclo-
n10/83	C6H13,n-hexyl	g 6/01	C6H14,n-hexane	g 7/01	C7H7,benzyl
g 1/93	C7H8	g12/00	C7H8O,cresol-mx	n 4/87	C7H14,1-heptene
n10/83	C7H15,n-heptyl	n10/85	C7H16,n-heptane	n10/85	C7H16,2-methylh
n 4/89	C8H8,styrene	n10/86	C8H10,ethylbenz	n 4/87	C8H16,1-octene
n10/83	C8H17,n-octyl	n 4/85	C8H18,n-octane	n 4/85	C8H18,isooctane
n10/83	C9H19,n-nonyl	g 3/01	C10H8,naphthale	n10/83	C10H21,n-decyl
g 8/00	C12H9,o-bipheny	g 8/00	C12H10,biphenyl	g 6/97	*H
g 1/01	HCO	g 6/01	HCCO	g 4/02	HO2
tpis78	*H2	g 5/01	HCHO,formaldehy	g 6/01	HCOOH
g 8/89	H2O	g 6/99	H2O2	g 6/01	(HCOOH)2
g 5/97	*O	g 4/02	*OH	tpis89	*O2
g 8/01	O3	n 4/83	C(gr)	n 4/83	C(gr)
n 4/83	C(gr)	g11/99	H2O(cr)	g 8/01	H2O(L)
g 8/01	H2O(L)				

SPECIES WITH TRANSPORT PROPERTIES

PURE SPECIES

C	CH4	CH3OH	CO
CO2	C2H2,acetylene		
C2H4	C2H6	C2H5OH	H
H2	H2O		
O	OH	O2	

BINARY INTERACTIONS

C	O
CH4	O2
CO	CO2
CO	O2
CO2	H2
CO2	H2O
CO2	O2
H	H2
H	O
H2	H2O

```
     H2              O2
     H2O             O2
     O               O2


 O/F =   1.200000

                       EFFECTIVE FUEL     EFFECTIVE OXIDANT        MIXTURE
 ENTHALPY                  h(2)/R             h(1)/R              h0/R
 (KG-MOL)(K)/KG       -0.72450014E+03    -0.48137850E-07    -0.32931825E+03

 KG-FORM.WT./KG             bi(2)              bi(1)              b0i
  *C                    0.43413669E-01     0.00000000E+00     0.19733486E-01
  *H                    0.13024101E+00     0.00000000E+00     0.59200458E-01
  *O                    0.21706834E-01     0.62502344E-01     0.43958930E-01

 POINT ITN      T           C          H          O
   1   22    2858.658     -14.547    -10.007    -17.958
 Pinf/Pt = 1.752674
   2    4    2643.861     -14.479    -10.140    -18.685
 Pinf/Pt = 1.761153
   2    2    2642.002     -14.477    -10.141    -18.692
 Pinf/Pt = 1.761231
   2    1    2641.985     -14.477    -10.141    -18.692
   3    4    1985.833     -13.535    -10.486    -22.080
   4    4    1751.027     -12.843    -10.610    -23.983
   5    3    1624.789     -12.356    -10.682    -25.252



             THEORETICAL ROCKET PERFORMANCE ASSUMING EQUILIBRIUM

          COMPOSITION DURING EXPANSION FROM INFINITE AREA COMBUSTOR

 Pin =   145.0 PSIA
 CASE = Ethanol

            REACTANT                        MOLES         ENERGY      TEMP
                                                        KJ/KG-MOL       K
 FUEL       C2H5OH(L)                    1.0000000   -277510.001    298.150
 OXIDANT    O2                           1.0000000         0.000    298.150

 O/F=    1.20000  %FUEL= 45.454545  R,EQ.RATIO= 1.571176  PHI,EQ.RATIO= 1.736482

                CHAMBER   THROAT     EXIT     EXIT     EXIT
 Pinf/P           1.0000   1.7612   10.000   20.000   30.000
 P, BAR           10.000   5.6778   1.0000  0.50000  0.33333
 T, K            2858.66  2641.98  1985.83  1751.03  1624.79
 RHO, KG/CU M   8.4246-1 5.2044-1 1.2272-1 6.9608-2 5.0014-2
 H, KJ/KG       -2738.12 -3382.70 -5032.21 -5563.01 -5843.63
 U, KJ/KG       -3925.12 -4473.68 -5847.11 -6281.32 -6510.12
 G, KJ/KG       -39667.2 -37512.8 -30685.9 -28183.4 -26833.2
 S, KJ/(KG)(K)   12.9183  12.9183  12.9183  12.9183  12.9183

 M, (1/n)         20.024   20.135   20.262   20.268   20.269
```

(dLV/dLP)t	-1.00638	-1.00343	-1.00021	-1.00004	-1.00002
(dLV/dLT)p	1.1355	1.0778	1.0059	1.0014	1.0005
Cp, KJ/(KG)(K)	3.5454	3.0523	2.3100	2.2356	2.2164
GAMMAs	1.1691	1.1816	1.2188	1.2254	1.2274
SON VEL,M/SEC	1178.0	1135.4	996.6	938.2	904.4
MACH NUMBER	0.000	1.000	2.149	2.533	2.755

TRANSPORT PROPERTIES (GASES ONLY)
CONDUCTIVITY IN UNITS OF MILLIWATTS/(CM)(K)

VISC,MILLIPOISE	0.91842	0.86830	0.70891	0.64856	0.61521

WITH EQUILIBRIUM REACTIONS

Cp, KJ/(KG)(K)	3.5454	3.0523	2.3100	2.2356	2.2165
CONDUCTIVITY	7.2003	5.5601	2.7339	2.3312	2.1785
PRANDTL NUMBER	0.4522	0.4767	0.5990	0.6220	0.6259

WITH FROZEN REACTIONS

Cp, KJ/(KG)(K)	2.3185	2.2928	2.1864	2.1352	2.1043
CONDUCTIVITY	3.3994	3.1602	2.4450	2.1928	2.0592
PRANDTL NUMBER	0.6264	0.6300	0.6339	0.6315	0.6287

PERFORMANCE PARAMETERS

Ae/At	1.0000	2.2480	3.5715	4.7408
CSTAR, M/SEC	1692.3	1692.3	1692.3	1692.3
CF	0.6709	1.2657	1.4045	1.4727
Ivac, M/SEC	2096.3	2522.4	2679.1	2759.6
Isp, M/SEC	1135.4	2142.0	2376.9	2492.2

MOLE FRACTIONS

*CO	0.30801	0.30559	0.28917	0.27770	0.26945
*CO2	0.08713	0.09174	0.11066	0.12227	0.13053
*H	0.01395	0.00850	0.00069	0.00016	0.00006
*H2	0.19325	0.19822	0.21929	0.23114	0.23945
H2O	0.38798	0.39130	0.38005	0.36872	0.36050
*O	0.00037	0.00011	0.00000	0.00000	0.00000
*OH	0.00901	0.00444	0.00013	0.00002	0.00000
*O2	0.00030	0.00009	0.00000	0.00000	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

*C	*CH	CH2	CH3	CH2OH
CH3O	CH4	CH3OH	CH3OOH	COOH
*C2	C2H	C2H2,acetylene	C2H2,vinylidene	CH2CO,ketene
O(CH)2O	HO(CO)2OH	C2H3,vinyl	CH3CO,acetyl	C2H4
C2H4O,ethylen-o	CH3CHO,ethanal	CH3COOH	OHCH2COOH	C2H5
C2H6	C2H5OH	CH3OCH3	CH3O2CH3	C2O
*C3	C3H3,1-propynl	C3H3,2-propynl	C3H4,allene	C3H4,propyne
C3H4,cyclo-	C3H5,allyl	C3H6,propylene	C3H6,cyclo-	C3H6O,propylox

FileEditor:KAL-Eta-p.out

C3H6O,acetone	C3H6O,propanal	C3H7,n-propyl	C3H7,i-propyl	C3H8
C3H8O,1propanol	C3H8O,2propanol	C3O2	*C4	C4H2,butadiyne
C4H4,1,3-cyclo-	C4H6,butadiene	C4H6,1butyne	C4H6,2butyne	C4H6,cyclo-
C4H8,1-butene	C4H8,cis2-buten	C4H8,tr2-butene	C4H8,isobutene	C4H8,cyclo-
(CH3COOH)2	C4H9,n-butyl	C4H9,i-butyl	C4H9,s-butyl	C4H9,t-butyl
C4H10,n-butane	C4H10,isobutane	*C5	C5H6,1,3cyclo-	C5H8,cyclo-
C5H10,1-pentene	C5H10,cyclo-	C5H11,pentyl	C5H11,t-pentyl	C5H12,n-pentane
C5H12,i-pentane	CH3C(CH3)2CH3	C6H2	C6H5,phenyl	C6H5O,phenoxy
C6H6	C6H5OH,phenol	C6H10,cyclo-	C6H12,1-hexene	C6H12,cyclo-
C6H13,n-hexyl	C6H14,n-hexane	C7H7,benzyl	C7H8	C7H8O,cresol-mx
C7H14,1-heptene	C7H15,n-heptyl	C7H16,n-heptane	C7H16,2-methylh	C8H8,styrene
C8H10,ethylbenz	C8H16,1-octene	C8H17,n-octyl	C8H18,n-octane	C8H18,isooctane
C9H19,n-nonyl	C10H8,naphthale	C10H21,n-decyl	C12H9,o-bipheny	C12H10,biphenyl
HCO	HCCO	HO2	HCHO,formaldehy	HCOOH
H2O2	(HCOOH)2	O3	C(gr)	H2O(cr)
H2O(L)				

POINT	ITN	T	C	H	O
1	3	2887.603	-13.933	-9.677	-17.865
Pinf/Pt = 1.757281					
2	4	2658.894	-13.834	-9.803	-18.628
Pinf/Pt = 1.765412					
2	2	2657.024	-13.833	-9.804	-18.635
Pinf/Pt = 1.765479					
2	1	2657.008	-13.833	-9.804	-18.635
3	4	1984.457	-12.834	-10.138	-22.090
4	4	1748.877	-12.135	-10.261	-24.003
5	3	1622.619	-11.647	-10.333	-25.276

THEORETICAL ROCKET PERFORMANCE ASSUMING EQUILIBRIUM

COMPOSITION DURING EXPANSION FROM INFINITE AREA COMBUSTOR

Pin = 290.1 PSIA
CASE = Ethanol

	REACTANT	MOLES	ENERGY KJ/KG-MOL	TEMP K
FUEL	C2H5OH(L)	1.0000000	-277510.001	298.150
OXIDANT	O2	1.0000000	0.000	298.150

O/F= 1.20000 %FUEL= 45.454545 R,EQ.RATIO= 1.571176 PHI,EQ.RATIO= 1.736482

	CHAMBER	THROAT	EXIT	EXIT	EXIT
Pinf/P	1.0000	1.7655	10.000	20.000	30.000
P, BAR	20.000	11.328	2.0000	1.0000	0.66667
T, K	2887.60	2657.01	1984.46	1748.88	1622.62
RHO, KG/CU M	1.6725 0	1.0342 0	2.4563-1	1.3939-1	1.0016-1

H, KJ/KG	-2738.12	-3389.13	-5038.16	-5568.39	-5848.65
U, KJ/KG	-3933.90	-4484.49	-5852.39	-6285.80	-6514.24
G, KJ/KG	-39211.2	-36949.6	-30103.7	-27658.3	-26343.8
S, KJ/(KG)(K)	12.6309	12.6309	12.6309	12.6309	12.6309
M, (1/n)	20.078	20.169	20.264	20.269	20.270
(dLV/dLP)t	-1.00493	-1.00256	-1.00014	-1.00003	-1.00001
(dLV/dLT)p	1.1038	1.0577	1.0041	1.0010	1.0004
Cp, KJ/(KG)(K)	3.2543	2.8595	2.2891	2.2298	2.2140
GAMMAs	1.1766	1.1887	1.2204	1.2259	1.2276
SON VEL,M/SEC	1186.2	1141.1	996.8	937.8	903.9
MACH NUMBER	0.000	1.000	2.152	2.537	2.759

TRANSPORT PROPERTIES (GASES ONLY)
CONDUCTIVITY IN UNITS OF MILLIWATTS/(CM)(K)

VISC,MILLIPOISE	0.92511	0.87183	0.70856	0.64800	0.61463

WITH EQUILIBRIUM REACTIONS

Cp, KJ/(KG)(K)	3.2543	2.8595	2.2891	2.2298	2.2140
CONDUCTIVITY	6.3525	4.9676	2.6625	2.3107	2.1690
PRANDTL NUMBER	0.4739	0.5018	0.6092	0.6253	0.6274

WITH FROZEN REACTIONS

Cp, KJ/(KG)(K)	2.3214	2.2945	2.1861	2.1347	2.1037
CONDUCTIVITY	3.4229	3.1719	2.4432	2.1905	2.0569
PRANDTL NUMBER	0.6274	0.6307	0.6340	0.6315	0.6286

PERFORMANCE PARAMETERS

Ae/At	1.0000	2.2401	3.5585	4.7238
CSTAR, M/SEC	1694.7	1694.7	1694.7	1694.7
CF	0.6733	1.2655	1.4039	1.4717
Ivac, M/SEC	2101.0	2524.4	2680.7	2761.1
Isp, M/SEC	1141.1	2144.8	2379.2	2494.2

MOLE FRACTIONS

*CO	0.30906	0.30632	0.28917	0.27758	0.26930
*CO2	0.08714	0.09167	0.11072	0.12239	0.13069
*H	0.01088	0.00639	0.00048	0.00011	0.00004
HCO	0.00001	0.00000	0.00000	0.00000	0.00000
*H2	0.19384	0.19874	0.21944	0.23129	0.23962
H2O	0.39141	0.39336	0.38010	0.36862	0.36035
*O	0.00023	0.00006	0.00000	0.00000	0.00000
*OH	0.00724	0.00340	0.00009	0.00001	0.00000
*O2	0.00019	0.00005	0.00000	0.00000	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

*C	*CH	CH2	CH3	CH2OH

CH3O	CH4	CH3OH	CH3OOH	COOH
*C2	C2H	C2H2,acetylene	C2H2,vinylidene	CH2CO,ketene
O(CH)2O	HO(CO)2OH	C2H3,vinyl	CH3CO,acetyl	C2H4
C2H4O,ethylen-o	CH3CHO,ethanal	CH3COOH	OHCH2COOH	C2H5
C2H6	C2H5OH	CH3OCH3	CH3O2CH3	C2O
*C3	C3H3,1-propynl	C3H3,2-propynl	C3H4,allene	C3H4,propyne
C3H4,cyclo-	C3H5,allyl	C3H6,propylene	C3H6,cyclo-	C3H6O,propylox
C3H6O,acetone	C3H6O,propanal	C3H7,n-propyl	C3H7,i-propyl	C3H8
C3H8O,1propanol	C3H8O,2propanol	C3O2	*C4	C4H2,butadiyne
C4H4,1,3-cyclo-	C4H6,butadiene	C4H6,1butyne	C4H6,2butyne	C4H6,cyclo-
C4H8,1-butene	C4H8,cis2-buten	C4H8,tr2-butene	C4H8,isobutene	C4H8,cyclo-
(CH3COOH)2	C4H9,n-butyl	C4H9,i-butyl	C4H9,s-butyl	C4H9,t-butyl
C4H10,n-butane	C4H10,isobutane	*C5	C5H6,1,3cyclo-	C5H8,cyclo-
C5H10,1-pentene	C5H10,cyclo-	C5H11,pentyl	C5H11,t-pentyl	C5H12,n-pentane
C5H12,i-pentane	CH3C(CH3)2CH3	C6H2	C6H5,phenyl	C6H5O,phenoxy
C6H6	C6H5OH,phenol	C6H10,cyclo-	C6H12,1-hexene	C6H12,cyclo-
C6H13,n-hexyl	C6H14,n-hexane	C7H7,benzyl	C7H8	C7H8O,cresol-mx
C7H14,1-heptene	C7H15,n-heptyl	C7H16,n-heptane	C7H16,2-methylh	C8H8,styrene
C8H10,ethylbenz	C8H16,1-octene	C8H17,n-octyl	C8H18,n-octane	C8H18,isooctane
C9H19,n-nonyl	C10H8,naphthale	C10H21,n-decyl	C12H9,o-bipheny	C12H10,biphenyl
HCCO	HO2	HCHO,formaldehy	HCOOH	H2O2
(HCOOH)2	O3	C(gr)	H2O(cr)	H2O(L)

POINT	ITN	T	C	H	O
1	3	2902.224	-13.568	-9.482	-17.820
Pinf/Pt = 1.759818					
2	4	2666.030	-13.452	-9.605	-18.602
Pinf/Pt = 1.767606					
2	2	2664.195	-13.451	-9.606	-18.608
Pinf/Pt = 1.767667					
2	1	2664.181	-13.451	-9.606	-18.609
3	4	1983.751	-12.425	-9.934	-22.095
4	4	1747.842	-11.723	-10.057	-24.012
5	3	1621.583	-11.234	-10.129	-25.287

THEORETICAL ROCKET PERFORMANCE ASSUMING EQUILIBRIUM

COMPOSITION DURING EXPANSION FROM INFINITE AREA COMBUSTOR

Pin = 435.1 PSIA
CASE = Ethanol

	REACTANT	MOLES	ENERGY KJ/KG-MOL	TEMP K
FUEL	C2H5OH(L)	1.0000000	-277510.001	298.150
OXIDANT	O2	1.0000000	0.000	298.150

O/F= 1.20000 %FUEL= 45.454545 R,EQ.RATIO= 1.571176 PHI,EQ.RATIO= 1.736482

	CHAMBER	THROAT	EXIT	EXIT	EXIT
Pinf/P	1.0000	1.7677	10.000	20.000	30.000
P, BAR	30.000	16.972	3.0000	1.5000	1.0000
T, K	2902.22	2664.18	1983.75	1747.84	1621.58
RHO, KG/CU M	2.4996 0	1.5465 0	3.6860-1	2.0921-1	1.5034-1
H, KJ/KG	-2738.12	-3392.37	-5041.00	-5570.95	-5851.03
U, KJ/KG	-3938.32	-4489.79	-5854.90	-6287.93	-6516.20
G, KJ/KG	-38908.9	-36596.4	-29764.8	-27354.5	-26061.0
S, KJ/(KG)(K)	12.4631	12.4631	12.4631	12.4631	12.4631
M, (1/n)	20.106	20.185	20.265	20.269	20.270
(dLV/dLP)t	-1.00421	-1.00214	-1.00012	-1.00002	-1.00001
(dLV/dLT)p	1.0882	1.0482	1.0033	1.0008	1.0003
Cp, KJ/(KG)(K)	3.1129	2.7689	2.2799	2.2273	2.2130
GAMMAs	1.1808	1.1923	1.2211	1.2261	1.2277
SON VEL,M/SEC	1190.4	1143.9	996.9	937.6	903.7
MACH NUMBER	0.000	1.000	2.153	2.539	2.761

TRANSPORT PROPERTIES (GASES ONLY)
CONDUCTIVITY IN UNITS OF MILLIWATTS/(CM)(K)

VISC,MILLIPOISE	0.92848	0.87351	0.70838	0.64773	0.61435

WITH EQUILIBRIUM REACTIONS

Cp, KJ/(KG)(K)	3.1129	2.7689	2.2799	2.2274	2.2130
CONDUCTIVITY	5.9320	4.6849	2.6311	2.3018	2.1649
PRANDTL NUMBER	0.4872	0.5163	0.6138	0.6268	0.6280

WITH FROZEN REACTIONS

Cp, KJ/(KG)(K)	2.3229	2.2952	2.1860	2.1344	2.1034
CONDUCTIVITY	3.4347	3.1774	2.4423	2.1893	2.0558
PRANDTL NUMBER	0.6279	0.6310	0.6340	0.6315	0.6286

PERFORMANCE PARAMETERS

Ae/At	1.0000	2.2363	3.5524	4.7159
CSTAR, M/SEC	1695.9	1695.9	1695.9	1695.9
CF	0.6745	1.2655	1.4036	1.4713
Ivac, M/SEC	2103.3	2525.3	2681.5	2761.7
Isp, M/SEC	1143.9	2146.1	2380.3	2495.2

MOLE FRACTIONS

*CO	0.30959	0.30668	0.28916	0.27752	0.26923
*CO2	0.08715	0.09163	0.11075	0.12246	0.13077
*H	0.00933	0.00537	0.00039	0.00009	0.00003
HCO	0.00001	0.00000	0.00000	0.00000	0.00000
*H2	0.19415	0.19899	0.21951	0.23136	0.23970
H2O	0.39316	0.39435	0.38011	0.36856	0.36028
*O	0.00017	0.00005	0.00000	0.00000	0.00000
*OH	0.00630	0.00288	0.00007	0.00001	0.00000
*O2	0.00014	0.00004	0.00000	0.00000	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

*C	*CH	CH2	CH3	CH2OH
CH3O	CH4	CH3OH	CH3OOH	COOH
*C2	C2H	C2H2,acetylene	C2H2,vinylidene	CH2CO,ketene
O(CH)2O	HO(CO)2OH	C2H3,vinyl	CH3CO,acetyl	C2H4
C2H4O,ethylen-o	CH3CHO,ethanal	CH3COOH	OHCH2COOH	C2H5
C2H6	C2H5OH	CH3OCH3	CH3O2CH3	C2O
*C3	C3H3,1-propynl	C3H3,2-propynl	C3H4,allene	C3H4,propyne
C3H4,cyclo-	C3H5,allyl	C3H6,propylene	C3H6,cyclo-	C3H6O,propylox
C3H6O,acetone	C3H6O,propanal	C3H7,n-propyl	C3H7,i-propyl	C3H8
C3H8O,1propanol	C3H8O,2propanol	C3O2	*C4	C4H2,butadiyne
C4H4,1,3-cyclo-	C4H6,butadiene	C4H6,1butyne	C4H6,2butyne	C4H6,cyclo-
C4H8,1-butene	C4H8,cis2-buten	C4H8,tr2-butene	C4H8,isobutene	C4H8,cyclo-
(CH3COOH)2	C4H9,n-butyl	C4H9,i-butyl	C4H9,s-butyl	C4H9,t-butyl
C4H10,n-butane	C4H10,isobutane	*C5	C5H6,1,3cyclo-	C5H8,cyclo-
C5H10,1-pentene	C5H10,cyclo-	C5H11,pentyl	C5H11,t-pentyl	C5H12,n-pentane
C5H12,i-pentane	CH3C(CH3)2CH3	C6H2	C6H5,phenyl	C6H5O,phenoxy
C6H6	C6H5OH,phenol	C6H10,cyclo-	C6H12,1-hexene	C6H12,cyclo-
C6H13,n-hexyl	C6H14,n-hexane	C7H7,benzyl	C7H8	C7H8O,cresol-mx
C7H14,1-heptene	C7H15,n-heptyl	C7H16,n-heptane	C7H16,2-methylh	C8H8,styrene
C8H10,ethylbenz	C8H16,1-octene	C8H17,n-octyl	C8H18,n-octane	C8H18,isooctane
C9H19,n-nonyl	C10H8,naphthale	C10H21,n-decyl	C12H9,o-bipheny	C12H10,biphenyl
HCCO	HO2	HCHO,formaldehy	HCOOH	H2O2
(HCOOH)2	O3	C(gr)	H2O(cr)	H2O(L)

O/F = 1.400000

ENTHALPY	EFFECTIVE FUEL h(2)/R	EFFECTIVE OXIDANT h(1)/R	MIXTURE h0/R
(KG-MOL)(K)/KG	-0.72450014E+03	-0.48137850E-07	-0.30187506E+03

KG-FORM.WT./KG	bi(2)	bi(1)	b0i
*C	0.43413669E-01	0.00000000E+00	0.18089029E-01
*H	0.13024101E+00	0.00000000E+00	0.54267086E-01
*O	0.21706834E-01	0.62502344E-01	0.45504215E-01

POINT	ITN	T	C	H	O
1	5	3098.072	-15.798	-10.360	-16.787
Pinf/Pt = 1.732738					
2	4	2928.566	-15.967	-10.533	-17.217
Pinf/Pt = 1.735314					
2	2	2928.107	-15.967	-10.533	-17.218
3	5	2360.749	-15.956	-11.000	-19.330
4	4	2122.541	-15.627	-11.143	-20.637
5	3	1985.609	-15.346	-11.220	-21.547

THEORETICAL ROCKET PERFORMANCE ASSUMING EQUILIBRIUM

COMPOSITION DURING EXPANSION FROM INFINITE AREA COMBUSTOR

Pin = 145.0 PSIA
CASE = Ethanol

REACTANT		MOLES	ENERGY KJ/KG-MOL	TEMP K
FUEL	C2H5OH(L)	1.0000000	-277510.001	298.150
OXIDANT	O2	1.0000000	0.000	298.150

O/F= 1.40000 %FUEL= 41.666667 R,EQ.RATIO= 1.391335 PHI,EQ.RATIO= 1.488413

	CHAMBER	THROAT	EXIT	EXIT	EXIT
Pinf/P	1.0000	1.7353	10.000	20.000	30.000
P, BAR	10.000	5.7626	1.0000	0.50000	0.33333
T, K	3098.07	2928.11	2360.75	2122.54	1985.61
RHO, KG/CU M	8.2858-1	5.1051-1	1.1219-1	6.2562-2	4.4618-2
H, KJ/KG	-2509.94	-3153.49	-4921.69	-5507.44	-5820.86
U, KJ/KG	-3716.83	-4282.29	-5813.05	-6306.64	-6567.95
G, KJ/KG	-41519.4	-40022.9	-34647.1	-32233.5	-30822.7
S, KJ/(KG)(K)	12.5915	12.5915	12.5915	12.5915	12.5915
M, (1/n)	21.343	21.568	22.021	22.082	22.098
(dLV/dLP)t	-1.01993	-1.01403	-1.00216	-1.00071	-1.00033
(dLV/dLT)p	1.4028	1.2996	1.0554	1.0196	1.0097
Cp, KJ/(KG)(K)	5.4738	4.7520	2.7490	2.3841	2.2675
GAMMAs	1.1365	1.1402	1.1776	1.1954	1.2031
SON VEL,M/SEC	1171.2	1134.5	1024.6	977.4	948.1
MACH NUMBER	0.000	1.000	2.144	2.505	2.714

TRANSPORT PROPERTIES (GASES ONLY)
CONDUCTIVITY IN UNITS OF MILLIWATTS/(CM)(K)

VISC,MILLIPOISE	0.99827	0.96036	0.82556	0.76525	0.72963

WITH EQUILIBRIUM REACTIONS

Cp, KJ/(KG)(K)	5.4738	4.7520	2.7490	2.3841	2.2675
CONDUCTIVITY	11.4468	9.5376	4.2881	3.1230	2.6909
PRANDTL NUMBER	0.4774	0.4785	0.5293	0.5842	0.6148

WITH FROZEN REACTIONS

Cp, KJ/(KG)(K)	2.2595	2.2442	2.1748	2.1352	2.1092
CONDUCTIVITY	3.4677	3.2882	2.6883	2.4372	2.2933
PRANDTL NUMBER	0.6504	0.6555	0.6679	0.6704	0.6710

PERFORMANCE PARAMETERS

Ae/At	1.0000	2.3506	3.7809	5.0444
CSTAR, M/SEC	1726.6	1726.6	1726.6	1726.6
CF	0.6571	1.2720	1.4181	1.4904
Ivac, M/SEC	2129.5	2602.1	2774.9	2863.6

Isp, M/SEC	1134.5	2196.2	2448.5	2573.3

MOLE FRACTIONS

*CO	0.26814	0.26488	0.25359	0.24688	0.24182
*CO2	0.11793	0.12525	0.14474	0.15256	0.15792
*H	0.02387	0.01877	0.00489	0.00194	0.00099
HO2	0.00001	0.00000	0.00000	0.00000	0.00000
*H2	0.12710	0.12756	0.13791	0.14581	0.15136
H2O	0.42468	0.43731	0.45558	0.45197	0.44758
*O	0.00323	0.00183	0.00007	0.00001	0.00000
*OH	0.03079	0.02191	0.00313	0.00083	0.00032
*O2	0.00424	0.00249	0.00009	0.00001	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

*C	*CH	CH2	CH3	CH2OH
CH3O	CH4	CH3OH	CH3OOH	COOH
*C2	C2H	C2H2,acetylene	C2H2,vinylidene	CH2CO,ketene
O(CH)2O	HO(CO)2OH	C2H3,vinyl	CH3CO,acetyl	C2H4
C2H4O,ethylen-o	CH3CHO,ethanal	CH3COOH	OHCH2COOH	C2H5
C2H6	C2H5OH	CH3OCH3	CH3O2CH3	C2O
*C3	C3H3,1-propynl	C3H3,2-propynl	C3H4,allene	C3H4,propyne
C3H4,cyclo-	C3H5,allyl	C3H6,propylene	C3H6,cyclo-	C3H6O,propylox
C3H6O,acetone	C3H6O,propanal	C3H7,n-propyl	C3H7,i-propyl	C3H8
C3H8O,1propanol	C3H8O,2propanol	C3O2	*C4	C4H2,butadiyne
C4H4,1,3-cyclo-	C4H6,butadiene	C4H6,1butyne	C4H6,2butyne	C4H6,cyclo-
C4H8,1-butene	C4H8,cis2-buten	C4H8,tr2-butene	C4H8,isobutene	C4H8,cyclo-
(CH3COOH)2	C4H9,n-butyl	C4H9,i-butyl	C4H9,s-butyl	C4H9,t-butyl
C4H10,n-butane	C4H10,isobutane	*C5	C5H6,1,3cyclo-	C5H8,cyclo-
C5H10,1-pentene	C5H10,cyclo-	C5H11,pentyl	C5H11,t-pentyl	C5H12,n-pentane
C5H12,i-pentane	CH3C(CH3)2CH3	C6H2	C6H5,phenyl	C6H5O,phenoxy
C6H6	C6H5OH,phenol	C6H10,cyclo-	C6H12,1-hexene	C6H12,cyclo-
C6H13,n-hexyl	C6H14,n-hexane	C7H7,benzyl	C7H8	C7H8O,cresol-mx
C7H14,1-heptene	C7H15,n-heptyl	C7H16,n-heptane	C7H16,2-methylh	C8H8,styrene
C8H10,ethylbenz	C8H16,1-octene	C8H17,n-octyl	C8H18,n-octane	C8H18,isooctane
C9H19,n-nonyl	C10H8,naphthale	C10H21,n-decyl	C12H9,o-bipheny	C12H10,biphenyl
HCO	HCCO	HCHO,formaldehy	HCOOH	H2O2
(HCOOH)2	O3	C(gr)	H2O(cr)	H2O(L)

POINT	ITN	T	C	H	O
1	3	3157.883	-15.266	-10.051	-16.614
Pinf/Pt = 1.736382					
2	4	2973.265	-15.408	-10.216	-17.071
Pinf/Pt = 1.739669					
2	2	2972.631	-15.408	-10.217	-17.073
3	5	2364.791	-15.278	-10.655	-19.310
4	4	2118.875	-14.915	-10.793	-20.660

5 3 1979.970 -14.622 -10.868 -21.588

THEORETICAL ROCKET PERFORMANCE ASSUMING EQUILIBRIUM

COMPOSITION DURING EXPANSION FROM INFINITE AREA COMBUSTOR

Pin = 290.1 PSIA
CASE = Ethanol

REACTANT		MOLES	ENERGY KJ/KG-MOL	TEMP K
FUEL	C2H5OH(L)	1.0000000	-277510.001	298.150
OXIDANT	O2	1.0000000	0.000	298.150

O/F= 1.40000 %FUEL= 41.666667 R,EQ.RATIO= 1.391335 PHI,EQ.RATIO= 1.488413

	CHAMBER	THROAT	EXIT	EXIT	EXIT
Pinf/P	1.0000	1.7397	10.000	20.000	30.000
P, BAR	20.000	11.496	2.0000	1.0000	0.66667
T, K	3157.88	2972.63	2364.79	2118.88	1979.97
RHO, KG/CU M	1.6350 0	1.0079 0	2.2426-1	1.2540-1	8.9508-2
H, KJ/KG	-2509.94	-3164.22	-4939.88	-5525.09	-5837.69
U, KJ/KG	-3733.19	-4304.85	-5831.71	-6322.56	-6582.50
G, KJ/KG	-41422.3	-39793.8	-34079.5	-31634.5	-30235.4
S, KJ/(KG)(K)	12.3223	12.3223	12.3223	12.3223	12.3223
M, (1/n)	21.464	21.669	22.047	22.092	22.103
(dLV/dLP)t	-1.01667	-1.01129	-1.00153	-1.00049	-1.00022
(dLV/dLT)p	1.3317	1.2382	1.0392	1.0135	1.0066
Cp, KJ/(KG)(K)	4.8593	4.2133	2.5888	2.3184	2.2322
GAMMAs	1.1425	1.1472	1.1846	1.1994	1.2056
SON VEL,M/SEC	1182.2	1143.9	1027.8	978.0	947.6
MACH NUMBER	0.000	1.000	2.145	2.511	2.723

TRANSPORT PROPERTIES (GASES ONLY)
CONDUCTIVITY IN UNITS OF MILLIWATTS/(CM)(K)

VISC,MILLIPOISE	1.0128	0.97134	0.82662	0.76431	0.72814

WITH EQUILIBRIUM REACTIONS

Cp, KJ/(KG)(K)	4.8593	4.2133	2.5888	2.3184	2.2322
CONDUCTIVITY	10.0494	8.3065	3.8466	2.9226	2.5776
PRANDTL NUMBER	0.4897	0.4927	0.5563	0.6063	0.6306

WITH FROZEN REACTIONS

Cp, KJ/(KG)(K)	2.2649	2.2486	2.1753	2.1345	2.1080
CONDUCTIVITY	3.5168	3.3247	2.6902	2.4325	2.2870
PRANDTL NUMBER	0.6522	0.6570	0.6684	0.6707	0.6712

PERFORMANCE PARAMETERS

Ae/At	1.0000	2.3321	3.7442	4.9930
CSTAR, M/SEC	1734.7	1734.7	1734.7	1734.7
CF	0.6594	1.2709	1.4156	1.4872
Ivac, M/SEC	2141.0	2609.1	2780.4	2868.5
Isp, M/SEC	1143.9	2204.5	2455.7	2579.8

MOLE FRACTIONS

*CO	0.26873	0.26552	0.25394	0.24689	0.24165
*CO2	0.11952	0.12644	0.14486	0.15273	0.15817
*H	0.01991	0.01527	0.00353	0.00134	0.00068
HCO	0.00001	0.00000	0.00000	0.00000	0.00000
HO2	0.00001	0.00000	0.00000	0.00000	0.00000
*H2	0.12614	0.12694	0.13816	0.14614	0.15171
H2O	0.43256	0.44396	0.45715	0.45233	0.44757
*O	0.00241	0.00128	0.00004	0.00000	0.00000
*OH	0.02746	0.01882	0.00227	0.00057	0.00022
*O2	0.00323	0.00177	0.00005	0.00000	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

*C	*CH	CH2	CH3	CH2OH
CH3O	CH4	CH3OH	CH3OOH	COOH
*C2	C2H	C2H2,acetylene	C2H2,vinylidene	CH2CO,ketene
O(CH)2O	HO(CO)2OH	C2H3,vinyl	CH3CO,acetyl	C2H4
C2H4O,ethylen-o	CH3CHO,ethanal	CH3COOH	OHCH2COOH	C2H5
C2H6	C2H5OH	CH3OCH3	CH3O2CH3	C2O
*C3	C3H3,1-propynl	C3H3,2-propynl	C3H4,allene	C3H4,propyne
C3H4,cyclo-	C3H5,allyl	C3H6,propylene	C3H6,cyclo-	C3H6O,propylox
C3H6O,acetone	C3H6O,propanal	C3H7,n-propyl	C3H7,i-propyl	C3H8
C3H8O,1propanol	C3H8O,2propanol	C3O2	*C4	C4H2,butadiyne
C4H4,1,3-cyclo-	C4H6,butadiene	C4H6,1butyne	C4H6,2butyne	C4H6,cyclo-
C4H8,1-butene	C4H8,cis2-buten	C4H8,tr2-butene	C4H8,isobutene	C4H8,cyclo-
(CH3COOH)2	C4H9,n-butyl	C4H9,i-butyl	C4H9,s-butyl	C4H9,t-butyl
C4H10,n-butane	C4H10,isobutane	*C5	C5H6,1,3cyclo-	C5H8,cyclo-
C5H10,1-pentene	C5H10,cyclo-	C5H11,pentyl	C5H11,t-pentyl	C5H12,n-pentane
C5H12,i-pentane	CH3C(CH3)2CH3	C6H2	C6H5,phenyl	C6H5O,phenoxy
C6H6	C6H5OH,phenol	C6H10,cyclo-	C6H12,1-hexene	C6H12,cyclo-
C6H13,n-hexyl	C6H14,n-hexane	C7H7,benzyl	C7H8	C7H8O,cresol-mx
C7H14,1-heptene	C7H15,n-heptyl	C7H16,n-heptane	C7H16,2-methylh	C8H8,styrene
C8H10,ethylbenz	C8H16,1-octene	C8H17,n-octyl	C8H18,n-octane	C8H18,isooctane
C9H19,n-nonyl	C10H8,naphthale	C10H21,n-decyl	C12H9,o-bipheny	C12H10,biphenyl
HCCO	HCHO,formaldehy	HCOOH	H2O2	(HCOOH)2
O3	C(gr)	H2O(cr)	H2O(L)	

POINT	ITN	T	C	H	O
1	3	3190.970	-14.949	-9.869	-16.521

Pinf/Pt = 1.738613

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  2    4    2997.065     -15.073     -10.030     -16.995
Pinf/Pt = 1.742295
  2    2    2996.323     -15.073     -10.030     -16.997
  3    5    2366.162     -14.878     -10.453     -19.303
  4    4    2116.685     -14.499     -10.588     -20.674
  5    3    1976.944     -14.200     -10.662     -21.610
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THEORETICAL ROCKET PERFORMANCE ASSUMING EQUILIBRIUM

COMPOSITION DURING EXPANSION FROM INFINITE AREA COMBUSTOR

Pin = 435.1 PSIA
CASE = Ethanol

REACTANT		MOLES	ENERGY KJ/KG-MOL	TEMP K
FUEL	C2H5OH(L)	1.0000000	-277510.001	298.150
OXIDANT	O2	1.0000000	0.000	298.150

O/F= 1.40000 %FUEL= 41.666667 R,EQ.RATIO= 1.391335 PHI,EQ.RATIO= 1.488413

	CHAMBER	THROAT	EXIT	EXIT	EXIT
Pinf/P	1.0000	1.7423	10.000	20.000	30.000
P, BAR	30.000	17.219	3.0000	1.5000	1.0000
T, K	3190.97	2996.32	2366.16	2116.68	1976.94
RHO, KG/CU M	2.4347 0	1.5014 0	3.3637-1	1.8832-1	1.3448-1
H, KJ/KG	-2509.94	-3170.21	-4949.21	-5534.04	-5846.19
U, KJ/KG	-3742.14	-4317.07	-5841.08	-6330.54	-6589.79
G, KJ/KG	-41329.6	-39621.9	-33734.7	-31284.5	-29896.6
S, KJ/(KG)(K)	12.1655	12.1655	12.1655	12.1655	12.1655
M, (1/n)	21.532	21.723	22.059	22.096	22.105
(dLV/dLP)t	-1.01485	-1.00983	-1.00125	-1.00039	-1.00018
(dLV/dLT)p	1.2932	1.2062	1.0320	1.0108	1.0052
Cp, KJ/(KG)(K)	4.5370	3.9389	2.5172	2.2900	2.2172
GAMMAs	1.1461	1.1515	1.1880	1.2012	1.2066
SON VEL,M/SEC	1188.4	1149.2	1029.3	978.1	947.2
MACH NUMBER	0.000	1.000	2.146	2.514	2.727

TRANSPORT PROPERTIES (GASES ONLY)
CONDUCTIVITY IN UNITS OF MILLIWATTS/(CM)(K)

VISC,MILLIPOISE	1.0208	0.97717	0.82699	0.76375	0.72735

WITH EQUILIBRIUM REACTIONS

Cp, KJ/(KG)(K)	4.5370	3.9389	2.5172	2.2900	2.2172
CONDUCTIVITY	9.3081	7.6694	3.6449	2.8348	2.5287
PRANDTL NUMBER	0.4975	0.5019	0.5711	0.6170	0.6378

WITH FROZEN REACTIONS

Cp, KJ/(KG)(K)	2.2678	2.2510	2.1754	2.1341	2.1074

CONDUCTIVITY	3.5439	3.3441	2.6906	2.4298	2.2836
PRANDTL NUMBER	0.6532	0.6577	0.6686	0.6708	0.6712

PERFORMANCE PARAMETERS

Ae/At	1.0000	2.3222	3.7252	4.9667
CSTAR, M/SEC	1738.8	1738.8	1738.8	1738.8
CF	0.6609	1.2703	1.4144	1.4856
Ivac, M/SEC	2147.2	2612.5	2783.2	2871.0
Isp, M/SEC	1149.1	2208.7	2459.3	2583.1

MOLE FRACTIONS

*CO	0.26903	0.26585	0.25409	0.24687	0.24156
*CO2	0.12044	0.12709	0.14493	0.15282	0.15830
COOH	0.00001	0.00000	0.00000	0.00000	0.00000
*H	0.01777	0.01341	0.00291	0.00108	0.00054
HCO	0.00001	0.00000	0.00000	0.00000	0.00000
HO2	0.00001	0.00000	0.00000	0.00000	0.00000
*H2	0.12562	0.12662	0.13829	0.14630	0.15189
H2O	0.43701	0.44758	0.45785	0.45247	0.44754
*O	0.00199	0.00101	0.00002	0.00000	0.00000
*OH	0.02541	0.01701	0.00188	0.00046	0.00017
*O2	0.00271	0.00142	0.00003	0.00000	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

*C	*CH	CH2	CH3	CH2OH
CH3O	CH4	CH3OH	CH3OOH	*C2
C2H	C2H2,acetylene	C2H2,vinylidene	CH2CO,ketene	O(CH)2O
HO(CO)2OH	C2H3,vinyl	CH3CO,acetyl	C2H4	C2H4O,ethylen-o
CH3CHO,ethanal	CH3COOH	OHCH2COOH	C2H5	C2H6
C2H5OH	CH3OCH3	CH3O2CH3	C2O	*C3
C3H3,1-propynl	C3H3,2-propynl	C3H4,allene	C3H4,propyne	C3H4,cyclo-
C3H5,allyl	C3H6,propylene	C3H6,cyclo-	C3H6O,propylox	C3H6O,acetone
C3H6O,propanal	C3H7,n-propyl	C3H7,i-propyl	C3H8	C3H8O,1propanol
C3H8O,2propanol	C3O2	*C4	C4H2,butadiyne	C4H4,1,3-cyclo-
C4H6,butadiene	C4H6,1butyne	C4H6,2butyne	C4H6,cyclo-	C4H8,1-butene
C4H8,cis2-buten	C4H8,tr2-butene	C4H8,isobutene	C4H8,cyclo-	(CH3COOH)2
C4H9,n-butyl	C4H9,i-butyl	C4H9,s-butyl	C4H9,t-butyl	C4H10,n-butane
C4H10,isobutane	*C5	C5H6,1,3cyclo-	C5H8,cyclo-	C5H10,1-pentene
C5H10,cyclo-	C5H11,pentyl	C5H11,t-pentyl	C5H12,n-pentane	C5H12,i-pentane
CH3C(CH3)2CH3	C6H2	C6H5,phenyl	C6H5O,phenoxy	C6H6
C6H5OH,phenol	C6H10,cyclo-	C6H12,1-hexene	C6H12,cyclo-	C6H13,n-hexyl
C6H14,n-hexane	C7H7,benzyl	C7H8	C7H8O,cresol-mx	C7H14,1-heptene
C7H15,n-heptyl	C7H16,n-heptane	C7H16,2-methylh	C8H8,styrene	C8H10,ethylbenz
C8H16,1-octene	C8H17,n-octyl	C8H18,n-octane	C8H18,isooctane	C9H19,n-nonyl
C10H8,naphthale	C10H21,n-decyl	C12H9,o-bipheny	C12H10,biphenyl	HCCO
HCHO,formaldehy	HCOOH	H2O2	(HCOOH)2	O3
C(gr)	H2O(cr)	H2O(L)		

O/F = 1.600000

ENTHALPY	EFFECTIVE FUEL h(2)/R	EFFECTIVE OXIDANT h(1)/R	MIXTURE h0/R
(KG-MOL)(K)/KG	-0.72450014E+03	-0.48137850E-07	-0.27865390E+03

KG-FORM.WT./KG	bi(2)	bi(1)	b0i
*C	0.43413669E-01	0.00000000E+00	0.16697565E-01
*H	0.13024101E+00	0.00000000E+00	0.50092695E-01
*O	0.21706834E-01	0.62502344E-01	0.46811763E-01

POINT	ITN	T	C	H	O
1	4	3200.978	-16.575	-10.602	-16.153
Pinf/Pt = 1.724780					
2	4	3055.626	-16.876	-10.805	-16.446
Pinf/Pt = 1.723561					
2	2	3055.810	-16.876	-10.805	-16.446
3	5	2611.869	-17.644	-11.433	-17.686
4	4	2428.381	-17.757	-11.648	-18.420
5	4	2313.238	-17.732	-11.757	-18.967

THEORETICAL ROCKET PERFORMANCE ASSUMING EQUILIBRIUM

COMPOSITION DURING EXPANSION FROM INFINITE AREA COMBUSTOR

Pin = 145.0 PSIA
CASE = Ethanol

	REACTANT	MOLES	ENERGY KJ/KG-MOL	TEMP K
FUEL	C2H5OH(L)	1.0000000	-277510.001	298.150
OXIDANT	O2	1.0000000	0.000	298.150

O/F= 1.60000 %FUEL= 38.461538 R,EQ.RATIO= 1.248436 PHI,EQ.RATIO= 1.302361

	CHAMBER	THROAT	EXIT	EXIT	EXIT
Pinf/P	1.0000	1.7236	10.000	20.000	30.000
P, BAR	10.000	5.8019	1.0000	0.50000	0.33333
T, K	3200.98	3055.81	2611.87	2428.38	2313.24
RHO, KG/CU M	8.4047-1	5.1749-1	1.0813-1	5.8717-2	4.1260-2
H, KJ/KG	-2316.87	-2945.68	-4740.10	-5355.78	-5692.23
U, KJ/KG	-3506.68	-4066.85	-5664.92	-6207.32	-6500.13
G, KJ/KG	-41625.3	-40471.4	-36814.2	-35176.6	-34099.1
S, KJ/(KG)(K)	12.2801	12.2801	12.2801	12.2801	12.2801
M, (1/n)	22.369	22.662	23.482	23.711	23.807
(dLV/dLP)t	-1.03591	-1.03033	-1.01182	-1.00590	-1.00346
(dLV/dLT)p	1.7078	1.6278	1.2872	1.1534	1.0936
Cp, KJ/(KG)(K)	7.4329	7.0026	4.6570	3.5579	3.0266
GAMMAs	1.1235	1.1217	1.1289	1.1431	1.1555

SON VEL,M/SEC	1156.2	1121.4	1021.8	986.6	966.2
MACH NUMBER	0.000	1.000	2.155	2.499	2.689

TRANSPORT PROPERTIES (GASES ONLY)
CONDUCTIVITY IN UNITS OF MILLIWATTS/(CM)(K)

VISC,MILLIPOISE	1.0404	1.0096	0.91070	0.86638	0.83735

WITH EQUILIBRIUM REACTIONS

Cp, KJ/(KG)(K)	7.4329	7.0026	4.6570	3.5579	3.0266
CONDUCTIVITY	15.2180	13.7457	8.0212	5.7493	4.6220
PRANDTL NUMBER	0.5082	0.5143	0.5287	0.5361	0.5483

WITH FROZEN REACTIONS

Cp, KJ/(KG)(K)	2.1964	2.1859	2.1442	2.1211	2.1044
CONDUCTIVITY	3.4350	3.2913	2.8453	2.6562	2.5360
PRANDTL NUMBER	0.6653	0.6705	0.6863	0.6918	0.6948

PERFORMANCE PARAMETERS

Ae/At	1.0000	2.4379	4.0090	5.4135
CSTAR, M/SEC	1723.1	1723.1	1723.1	1723.1
CF	0.6508	1.2776	1.4307	1.5078
Ivac, M/SEC	2121.2	2621.6	2810.7	2909.2
Isp, M/SEC	1121.4	2201.5	2465.3	2598.2

MOLE FRACTIONS

*CO	0.22909	0.22296	0.20338	0.19685	0.19341
*CO2	0.14440	0.15543	0.18871	0.19907	0.20411
*H	0.02647	0.02273	0.01152	0.00742	0.00524
HO2	0.00003	0.00002	0.00000	0.00000	0.00000
*H2	0.08801	0.08559	0.08158	0.08296	0.08496
H2O	0.43210	0.44832	0.49186	0.50248	0.50586
*O	0.00895	0.00663	0.00148	0.00051	0.00021
*OH	0.05376	0.04462	0.01785	0.00945	0.00568
*O2	0.01716	0.01370	0.00362	0.00127	0.00053

* THERMODYNAMIC PROPERTIES FITTED TO 20000.K

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

*C	*CH	CH2	CH3	CH2OH
CH3O	CH4	CH3OH	CH3OOH	COOH
*C2	C2H	C2H2,acetylene	C2H2,vinylidene	CH2CO,ketene
O(CH)2O	HO(CO)2OH	C2H3,vinyl	CH3CO,acetyl	C2H4
C2H4O,ethylen-o	CH3CHO,ethanal	CH3COOH	OHCH2COOH	C2H5
C2H6	C2H5OH	CH3OCH3	CH3O2CH3	C2O
*C3	C3H3,1-propynl	C3H3,2-propynl	C3H4,allene	C3H4,propyne
C3H4,cyclo-	C3H5,allyl	C3H6,propylene	C3H6,cyclo-	C3H6O,propylox
C3H6O,acetone	C3H6O,propanal	C3H7,n-propyl	C3H7,i-propyl	C3H8
C3H8O,1propanol	C3H8O,2propanol	C3O2	*C4	C4H2,butadiyne
C4H4,1,3-cyclo-	C4H6,butadiene	C4H6,1butyne	C4H6,2butyne	C4H6,cyclo-

C4H8,1-butene	C4H8,cis2-buten	C4H8,tr2-butene	C4H8,isobutene	C4H8,cyclo-
(CH3COOH)2	C4H9,n-butyl	C4H9,i-butyl	C4H9,s-butyl	C4H9,t-butyl
C4H10,n-butane	C4H10,isobutane	*C5	C5H6,1,3cyclo-	C5H8,cyclo-
C5H10,1-pentene	C5H10,cyclo-	C5H11,pentyl	C5H11,t-pentyl	C5H12,n-pentane
C5H12,i-pentane	CH3C(CH3)2CH3	C6H2	C6H5,phenyl	C6H5O,phenoxy
C6H6	C6H5OH,phenol	C6H10,cyclo-	C6H12,1-hexene	C6H12,cyclo-
C6H13,n-hexyl	C6H14,n-hexane	C7H7,benzyl	C7H8	C7H8O,cresol-mx
C7H14,1-heptene	C7H15,n-heptyl	C7H16,n-heptane	C7H16,2-methylh	C8H8,styrene
C8H10,ethylbenz	C8H16,1-octene	C8H17,n-octyl	C8H18,n-octane	C8H18,isooctane
C9H19,n-nonyl	C10H8,naphthale	C10H21,n-decyl	C12H9,o-bipheny	C12H10,biphenyl
HCO	HCCO	HCHO,formaldehy	HCOOH	H2O2
(HCOOH)2	O3	C(gr)	H2O(cr)	H2O(L)

POINT	ITN	T	C	H	O
1	3	3279.399	-16.108	-10.313	-15.925
Pinf/Pt = 1.727160					
2	4	3122.887	-16.396	-10.512	-16.228
Pinf/Pt = 1.726168					
2	2	3123.048	-16.396	-10.512	-16.228
3	5	2642.144	-17.075	-11.114	-17.548
4	4	2441.167	-17.124	-11.313	-18.350
5	4	2316.403	-17.058	-11.413	-18.945

THEORETICAL ROCKET PERFORMANCE ASSUMING EQUILIBRIUM

COMPOSITION DURING EXPANSION FROM INFINITE AREA COMBUSTOR

Pin = 290.1 PSIA
CASE = Ethanol

REACTANT		MOLES	ENERGY KJ/KG-MOL	TEMP K
FUEL	C2H5OH(L)	1.0000000	-277510.001	298.150
OXIDANT	O2	1.0000000	0.000	298.150

O/F= 1.60000 %FUEL= 38.461538 R,EQ.RATIO= 1.248436 PHI,EQ.RATIO= 1.302361

	CHAMBER	THROAT	EXIT	EXIT	EXIT
Pinf/P	1.0000	1.7262	10.000	20.000	30.000
P, BAR	20.000	11.586	2.0000	1.0000	0.66667
T, K	3279.40	3123.05	2642.14	2441.17	2316.40
RHO, KG/CU M	1.6531 0	1.0183 0	2.1471-1	1.1715-1	8.2562-2
H, KJ/KG	-2316.87	-2957.44	-4771.06	-5389.80	-5726.58
U, KJ/KG	-3526.69	-4095.29	-5702.57	-6243.44	-6534.06
G, KJ/KG	-41746.6	-40507.3	-36538.8	-34741.1	-33577.7
S, KJ/(KG)(K)	12.0235	12.0235	12.0235	12.0235	12.0235
M, (1/n)	22.538	22.821	23.583	23.777	23.852

(dLV/dLP)t	-1.03232	-1.02678	-1.00916	-1.00420	-1.00236
(dLV/dLT)p	1.6245	1.5449	1.2210	1.1089	1.0637
Cp, KJ/(KG)(K)	6.6989	6.2726	4.0621	3.1428	2.7384
GAMMAs	1.1274	1.1259	1.1366	1.1529	1.1651
SON VEL,M/SEC	1167.9	1131.9	1029.0	992.0	969.9
MACH NUMBER	0.000	1.000	2.153	2.499	2.692

TRANSPORT PROPERTIES (GASES ONLY)
CONDUCTIVITY IN UNITS OF MILLIWATTS/(CM)(K)

VISC,MILLIPOISE	1.0603	1.0271	0.91918	0.87015	0.83844

WITH EQUILIBRIUM REACTIONS

Cp, KJ/(KG)(K)	6.6989	6.2726	4.0621	3.1428	2.7384
CONDUCTIVITY	13.6354	12.2200	6.8794	4.9216	4.0089
PRANDTL NUMBER	0.5209	0.5272	0.5428	0.5556	0.5727

WITH FROZEN REACTIONS

Cp, KJ/(KG)(K)	2.2032	2.1922	2.1481	2.1229	2.1048
CONDUCTIVITY	3.5005	3.3488	2.8723	2.6667	2.5373
PRANDTL NUMBER	0.6673	0.6723	0.6874	0.6927	0.6955

PERFORMANCE PARAMETERS

Ae/At	1.0000	2.4229	3.9686	5.3457
CSTAR, M/SEC	1735.3	1735.3	1735.3	1735.3
CF	0.6523	1.2767	1.4286	1.5049
Ivac, M/SEC	2137.2	2635.9	2823.4	2920.6
Isp, M/SEC	1131.9	2215.5	2479.1	2611.4

MOLE FRACTIONS

*CO	0.22791	0.22173	0.20276	0.19666	0.19334
*CO2	0.14840	0.15931	0.19103	0.20036	0.20492
COOH	0.00001	0.00000	0.00000	0.00000	0.00000
*H	0.02271	0.01929	0.00913	0.00555	0.00376
HCO	0.00001	0.00000	0.00000	0.00000	0.00000
HO2	0.00004	0.00002	0.00000	0.00000	0.00000
*H2	0.08563	0.08334	0.08041	0.08250	0.08489
H2O	0.44200	0.45777	0.49821	0.50661	0.50856
H2O2	0.00001	0.00000	0.00000	0.00000	0.00000
*O	0.00743	0.00536	0.00099	0.00029	0.00011
*OH	0.05094	0.04161	0.01497	0.00728	0.00413
*O2	0.01492	0.01156	0.00249	0.00074	0.00028

* THERMODYNAMIC PROPERTIES FITTED TO 20000.K

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

*C	*CH	CH2	CH3	CH2OH
CH3O	CH4	CH3OH	CH3OOH	*C2
C2H	C2H2,acetylene	C2H2,vinylidene	CH2CO,ketene	O(CH)2O
HO(CO)2OH	C2H3,vinyl	CH3CO,acetyl	C2H4	C2H4O,ethylen-o

CH3CHO,ethanal	CH3COOH	OHCH2COOH	C2H5	C2H6
C2H5OH	CH3OCH3	CH3O2CH3	C2O	*C3
C3H3,1-propynl	C3H3,2-propynl	C3H4,allene	C3H4,propyne	C3H4,cyclo-
C3H5,allyl	C3H6,propylene	C3H6,cyclo-	C3H6O,propylox	C3H6O,acetone
C3H6O,propanal	C3H7,n-propyl	C3H7,i-propyl	C3H8	C3H8O,1propanol
C3H8O,2propanol	C3O2	*C4	C4H2,butadiyne	C4H4,1,3-cyclo-
C4H6,butadiene	C4H6,1butyne	C4H6,2butyne	C4H6,cyclo-	C4H8,1-butene
C4H8,cis2-buten	C4H8,tr2-butene	C4H8,isobutene	C4H8,cyclo-	(CH3COOH)2
C4H9,n-butyl	C4H9,i-butyl	C4H9,s-butyl	C4H9,t-butyl	C4H10,n-butane
C4H10,isobutane	*C5	C5H6,1,3cyclo-	C5H8,cyclo-	C5H10,1-pentene
C5H10,cyclo-	C5H11,pentyl	C5H11,t-pentyl	C5H12,n-pentane	C5H12,i-pentane
CH3C(CH3)2CH3	C6H2	C6H5,phenyl	C6H5O,phenoxy	C6H6
C6H5OH,phenol	C6H10,cyclo-	C6H12,1-hexene	C6H12,cyclo-	C6H13,n-hexyl
C6H14,n-hexane	C7H7,benzyl	C7H8	C7H8O,cresol-mx	C7H14,1-heptene
C7H15,n-heptyl	C7H16,n-heptane	C7H16,2-methylh	C8H8,styrene	C8H10,ethylbenz
C8H16,1-octene	C8H17,n-octyl	C8H18,n-octane	C8H18,isooctane	C9H19,n-nonyl
C10H8,naphthale	C10H21,n-decyl	C12H9,o-bipheny	C12H10,biphenyl	HCCO
HCHO,formaldehy	HCOOH	(HCOOH)2	O3	C(gr)
H2O(cr)	H2O(L)			

POINT	ITN	T	C	H	O
1	3	3324.969	-15.832	-10.144	-15.796
Pinf/Pt = 1.728600					
2	4	3161.465	-16.111	-10.339	-16.106
Pinf/Pt = 1.727780					
2	2	3161.603	-16.111	-10.339	-16.106
3	5	2657.457	-16.733	-10.924	-17.479
4	4	2446.253	-16.743	-11.114	-18.323
5	4	2316.451	-16.655	-11.211	-18.943

THEORETICAL ROCKET PERFORMANCE ASSUMING EQUILIBRIUM

COMPOSITION DURING EXPANSION FROM INFINITE AREA COMBUSTOR

Pin = 435.1 PSIA
CASE = Ethanol

	REACTANT	MOLES	ENERGY KJ/KG-MOL	TEMP K
FUEL	C2H5OH(L)	1.0000000	-277510.001	298.150
OXIDANT	O2	1.0000000	0.000	298.150

O/F= 1.60000 %FUEL= 38.461538 R,EQ.RATIO= 1.248436 PHI,EQ.RATIO= 1.302361

	CHAMBER	THROAT	EXIT	EXIT	EXIT
Pinf/P	1.0000	1.7278	10.000	20.000	30.000
P, BAR	30.000	17.363	3.0000	1.5000	1.0000
T, K	3324.97	3161.60	2657.46	2446.25	2316.45

RHO, KG/CU M	2.4565 0	1.5134 0	3.2092-1	1.7559-1	1.2395-1
H, KJ/KG	-2316.87	-2964.24	-4788.20	-5408.29	-5745.05
U, KJ/KG	-3538.13	-4111.52	-5723.00	-6262.57	-6551.86
G, KJ/KG	-41798.2	-40505.7	-36343.4	-34455.6	-33251.1
S, KJ/(KG)(K)	11.8742	11.8742	11.8742	11.8742	11.8742
M, (1/n)	22.637	22.913	23.637	23.809	23.872
(dLV/dLP)t	-1.03021	-1.02471	-1.00778	-1.00341	-1.00187
(dLV/dLT)p	1.5771	1.4979	1.1869	1.0881	1.0505
Cp, KJ/(KG)(K)	6.2978	5.8743	3.7619	2.9512	2.6124
GAMMAs	1.1298	1.1285	1.1415	1.1583	1.1700
SON VEL,M/SEC	1174.6	1137.9	1033.0	994.8	971.6
MACH NUMBER	0.000	1.000	2.152	2.500	2.695

TRANSPORT PROPERTIES (GASES ONLY)
CONDUCTIVITY IN UNITS OF MILLIWATTS/(CM)(K)

VISC,MILLIPOISE	1.0718	1.0371	0.92348	0.87167	0.83857

WITH EQUILIBRIUM REACTIONS

Cp, KJ/(KG)(K)	6.2978	5.8743	3.7619	2.9512	2.6124
CONDUCTIVITY	12.7689	11.3888	6.2983	4.5286	3.7305
PRANDTL NUMBER	0.5286	0.5349	0.5516	0.5680	0.5872

WITH FROZEN REACTIONS

Cp, KJ/(KG)(K)	2.2071	2.1958	2.1500	2.1236	2.1048
CONDUCTIVITY	3.5388	3.3820	2.8860	2.6707	2.5364
PRANDTL NUMBER	0.6685	0.6733	0.6880	0.6931	0.6959

PERFORMANCE PARAMETERS

Ae/At	1.0000	2.4136	3.9443	5.3061
CSTAR, M/SEC	1742.1	1742.1	1742.1	1742.1
CF	0.6532	1.2762	1.4273	1.5031
Ivac, M/SEC	2146.1	2643.7	2830.1	2926.6
Isp, M/SEC	1137.9	2223.2	2486.5	2618.5

MOLE FRACTIONS

*CO	0.22709	0.22091	0.20243	0.19657	0.19330
*CO2	0.15087	0.16166	0.19224	0.20098	0.20530
COOH	0.00001	0.00000	0.00000	0.00000	0.00000
*H	0.02065	0.01741	0.00789	0.00463	0.00307
HCO	0.00001	0.00000	0.00000	0.00000	0.00000
HO2	0.00005	0.00003	0.00000	0.00000	0.00000
*H2	0.08422	0.08204	0.07984	0.08234	0.08492
H2O	0.44786	0.46329	0.50157	0.50860	0.50976
H2O2	0.00001	0.00000	0.00000	0.00000	0.00000
*O	0.00659	0.00467	0.00077	0.00021	0.00007
*OH	0.04905	0.03965	0.01331	0.00615	0.00338
*O2	0.01360	0.01033	0.00195	0.00053	0.00019

* THERMODYNAMIC PROPERTIES FITTED TO 20000.K

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

*C	*CH	CH2	CH3	CH2OH
CH3O	CH4	CH3OH	CH3OOH	*C2
C2H	C2H2,acetylene	C2H2,vinylidene	CH2CO,ketene	O(CH)2O
HO(CO)2OH	C2H3,vinyl	CH3CO,acetyl	C2H4	C2H4O,ethylen-o
CH3CHO,ethanal	CH3COOH	OHCH2COOH	C2H5	C2H6
C2H5OH	CH3OCH3	CH3O2CH3	C2O	*C3
C3H3,1-propynl	C3H3,2-propynl	C3H4,allene	C3H4,propyne	C3H4,cyclo-
C3H5,allyl	C3H6,propylene	C3H6,cyclo-	C3H6O,propylox	C3H6O,acetone
C3H6O,propanal	C3H7,n-propyl	C3H7,i-propyl	C3H8	C3H8O,1propanol
C3H8O,2propanol	C3O2	*C4	C4H2,butadiyne	C4H4,1,3-cyclo-
C4H6,butadiene	C4H6,1butyne	C4H6,2butyne	C4H6,cyclo-	C4H8,1-butene
C4H8,cis2-buten	C4H8,tr2-butene	C4H8,isobutene	C4H8,cyclo-	(CH3COOH)2
C4H9,n-butyl	C4H9,i-butyl	C4H9,s-butyl	C4H9,t-butyl	C4H10,n-butane
C4H10,isobutane	*C5	C5H6,1,3cyclo-	C5H8,cyclo-	C5H10,1-pentene
C5H10,cyclo-	C5H11,pentyl	C5H11,t-pentyl	C5H12,n-pentane	C5H12,i-pentane
CH3C(CH3)2CH3	C6H2	C6H5,phenyl	C6H5O,phenoxy	C6H6
C6H5OH,phenol	C6H10,cyclo-	C6H12,1-hexene	C6H12,cyclo-	C6H13,n-hexyl
C6H14,n-hexane	C7H7,benzyl	C7H8	C7H8O,cresol-mx	C7H14,1-heptene
C7H15,n-heptyl	C7H16,n-heptane	C7H16,2-methylh	C8H8,styrene	C8H10,ethylbenz
C8H16,1-octene	C8H17,n-octyl	C8H18,n-octane	C8H18,isooctane	C9H19,n-nonyl
C10H8,naphthale	C10H21,n-decyl	C12H9,o-bipheny	C12H10,biphenyl	HCCO
HCHO,formaldehy	HCOOH	(HCOOH)2	O3	C(gr)
H2O(cr)	H2O(L)			

O/F =   1.800000

ENTHALPY	EFFECTIVE FUEL h(2)/R	EFFECTIVE OXIDANT h(1)/R	MIXTURE h0/R
(KG-MOL)(K)/KG	-0.72450014E+03	-0.48137850E-07	-0.25875005E+03

KG-FORM.WT./KG	bi(2)	bi(1)	b0i
*C	0.43413669E-01	0.00000000E+00	0.15504882E-01
*H	0.13024101E+00	0.00000000E+00	0.46514645E-01
*O	0.21706834E-01	0.62502344E-01	0.47932519E-01

POINT	ITN	T	C	H	O
1	5	3238.147	-17.105	-10.775	-15.776
Pinf/Pt = 1.722113					
2	3	3101.069	-17.470	-10.994	-16.015
Pinf/Pt = 1.719897					
2	2	3101.383	-17.469	-10.993	-16.015
3	4	2707.165	-18.626	-11.715	-16.903
4	4	2565.222	-19.048	-11.999	-17.325
5	3	2483.256	-19.273	-12.162	-17.604

THEORETICAL ROCKET PERFORMANCE ASSUMING EQUILIBRIUM

COMPOSITION DURING EXPANSION FROM INFINITE AREA COMBUSTOR

Pin = 145.0 PSIA
CASE = Ethanol

REACTANT		MOLES	ENERGY KJ/KG-MOL	TEMP K
FUEL	C2H5OH(L)	1.0000000	-277510.001	298.150
OXIDANT	O2	1.0000000	0.000	298.150

O/F= 1.80000 %FUEL= 35.714286 R,EQ.RATIO= 1.132156 PHI,EQ.RATIO= 1.157654

	CHAMBER	THROAT	EXIT	EXIT	EXIT
Pinf/P	1.0000	1.7199	10.000	20.000	30.000
P, BAR	10.000	5.8143	1.0000	0.50000	0.33333
T, K	3238.15	3101.38	2707.17	2565.22	2483.26
RHO, KG/CU M	8.6172-1	5.3043-1	1.0894-1	5.8319-2	4.0478-2
H, KJ/KG	-2151.38	-2762.98	-4529.73	-5144.77	-5485.50
U, KJ/KG	-3311.85	-3859.14	-5447.70	-6002.12	-6309.00
G, KJ/KG	-40993.1	-39964.2	-37002.3	-35914.7	-35272.2
S, KJ/(KG)(K)	11.9950	11.9950	11.9950	11.9950	11.9950
M, (1/n)	23.201	23.525	24.520	24.877	25.072
(dLV/dLP)t	-1.04534	-1.04111	-1.02659	-1.02044	-1.01673
(dLV/dLT)p	1.8862	1.8413	1.6287	1.5115	1.4330
Cp, KJ/(KG)(K)	8.3979	8.2653	7.1823	6.4024	5.8302
GAMMAs	1.1192	1.1159	1.1094	1.1097	1.1112
SON VEL,M/SEC	1139.6	1106.0	1009.2	975.4	956.6
MACH NUMBER	0.000	1.000	2.161	2.509	2.699

TRANSPORT PROPERTIES (GASES ONLY)
CONDUCTIVITY IN UNITS OF MILLIWATTS/(CM)(K)

VISC,MILLIPOISE	1.0610	1.0325	0.94881	0.91742	0.89875

WITH EQUILIBRIUM REACTIONS

Cp, KJ/(KG)(K)	8.3979	8.2653	7.1823	6.4024	5.8302
CONDUCTIVITY	17.3104	16.3380	12.3292	10.3640	9.1131
PRANDTL NUMBER	0.5147	0.5223	0.5527	0.5667	0.5750

WITH FROZEN REACTIONS

Cp, KJ/(KG)(K)	2.1367	2.1278	2.0968	2.0827	2.0735
CONDUCTIVITY	3.3609	3.2337	2.8636	2.7272	2.6472
PRANDTL NUMBER	0.6745	0.6794	0.6947	0.7006	0.7040

PERFORMANCE PARAMETERS

Ae/At	1.0000	2.4692	4.1112	5.6125
CSTAR, M/SEC	1704.6	1704.6	1704.6	1704.6
CF	0.6488	1.2795	1.4354	1.5149
Ivac, M/SEC	2097.1	2601.9	2797.2	2901.2
Isp, M/SEC	1106.0	2181.0	2446.8	2582.3

MOLE FRACTIONS

*CO	0.19585	0.18765	0.15883	0.14725	0.14068
*CO2	0.16386	0.17709	0.22135	0.23847	0.24807
*H	0.02512	0.02204	0.01340	0.01048	0.00887
HO2	0.00007	0.00004	0.00001	0.00000	0.00000
*H2	0.06498	0.06183	0.05252	0.04947	0.04797
H2O	0.42704	0.44364	0.49331	0.51063	0.51995
H2O2	0.00001	0.00000	0.00000	0.00000	0.00000
*O	0.01492	0.01217	0.00524	0.00330	0.00237
*OH	0.06994	0.06121	0.03547	0.02648	0.02154
*O2	0.03822	0.03432	0.01987	0.01391	0.01056

* THERMODYNAMIC PROPERTIES FITTED TO 20000.K

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

*C	*CH	CH2	CH3	CH2OH
CH3O	CH4	CH3OH	CH3OOH	COOH
*C2	C2H	C2H2,acetylene	C2H2,vinylidene	CH2CO,ketene
O(CH)2O	HO(CO)2OH	C2H3,vinyl	CH3CO,acetyl	C2H4
C2H4O,ethylen-o	CH3CHO,ethanal	CH3COOH	OHCH2COOH	C2H5
C2H6	C2H5OH	CH3OCH3	CH3O2CH3	C2O
*C3	C3H3,1-propynl	C3H3,2-propynl	C3H4,allene	C3H4,propyne
C3H4,cyclo-	C3H5,allyl	C3H6,propylene	C3H6,cyclo-	C3H6O,propylox
C3H6O,acetone	C3H6O,propanal	C3H7,n-propyl	C3H7,i-propyl	C3H8
C3H8O,1propanol	C3H8O,2propanol	C3O2	*C4	C4H2,butadiyne
C4H4,1,3-cyclo-	C4H6,butadiene	C4H6,1butyne	C4H6,2butyne	C4H6,cyclo-
C4H8,1-butene	C4H8,cis2-buten	C4H8,tr2-butene	C4H8,isobutene	C4H8,cyclo-
(CH3COOH)2	C4H9,n-butyl	C4H9,i-butyl	C4H9,s-butyl	C4H9,t-butyl
C4H10,n-butane	C4H10,isobutane	*C5	C5H6,1,3cyclo-	C5H8,cyclo-
C5H10,1-pentene	C5H10,cyclo-	C5H11,pentyl	C5H11,t-pentyl	C5H12,n-pentane
C5H12,i-pentane	CH3C(CH3)2CH3	C6H2	C6H5,phenyl	C6H5O,phenoxy
C6H6	C6H5OH,phenol	C6H10,cyclo-	C6H12,1-hexene	C6H12,cyclo-
C6H13,n-hexyl	C6H14,n-hexane	C7H7,benzyl	C7H8	C7H8O,cresol-mx
C7H14,1-heptene	C7H15,n-heptyl	C7H16,n-heptane	C7H16,2-methylh	C8H8,styrene
C8H10,ethylbenz	C8H16,1-octene	C8H17,n-octyl	C8H18,n-octane	C8H18,isooctane
C9H19,n-nonyl	C10H8,naphthale	C10H21,n-decyl	C12H9,o-bipheny	C12H10,biphenyl
HCO	HCCO	HCHO,formaldehy	HCOOH	(HCOOH)2
O3	C(gr)	H2O(cr)	H2O(L)	

POINT	ITN	T	C	H	O
1	3	3323.678	-16.676	-10.498	-15.520
Pinf/Pt = 1.724049					
2	3	3177.178	-17.037	-10.714	-15.761
Pinf/Pt = 1.721823					
2	2	3177.515	-17.036	-10.714	-15.761
3	4	2757.222	-18.166	-11.425	-16.669
4	4	2604.843	-18.566	-11.702	-17.113
5	3	2516.169	-18.771	-11.859	-17.412

THEORETICAL ROCKET PERFORMANCE ASSUMING EQUILIBRIUM

COMPOSITION DURING EXPANSION FROM INFINITE AREA COMBUSTOR

Pin = 290.1 PSIA
CASE = Ethanol

	REACTANT	MOLES	ENERGY KJ/KG-MOL	TEMP K
FUEL	C2H5OH(L)	1.0000000	-277510.001	298.150
OXIDANT	O2	1.0000000	0.000	298.150

O/F= 1.80000 %FUEL= 35.714286 R,EQ.RATIO= 1.132156 PHI,EQ.RATIO= 1.157654

	CHAMBER	THROAT	EXIT	EXIT	EXIT
Pinf/P	1.0000	1.7218	10.000	20.000	30.000
P, BAR	20.000	11.616	2.0000	1.0000	0.66667
T, K	3323.68	3177.51	2757.22	2604.84	2516.17
RHO, KG/CU M	1.6930 0	1.0425 0	2.1533-1	1.1554-1	8.0329-2
H, KJ/KG	-2151.38	-2774.79	-4565.57	-5187.19	-5530.87
U, KJ/KG	-3332.68	-3888.97	-5494.37	-6052.65	-6360.79
G, KJ/KG	-41196.8	-40103.1	-36956.5	-35788.0	-35090.0
S, KJ/(KG)(K)	11.7477	11.7477	11.7477	11.7477	11.7477
M, (1/n)	23.393	23.712	24.682	25.025	25.208
(dLV/dLP)t	-1.04222	-1.03805	-1.02363	-1.01750	-1.01383
(dLV/dLT)p	1.8072	1.7630	1.5508	1.4330	1.3548
Cp, KJ/(KG)(K)	7.6755	7.5451	6.4661	5.6837	5.1144
GAMMAs	1.1223	1.1191	1.1132	1.1143	1.1167
SON VEL,M/SEC	1151.4	1116.6	1016.8	982.0	962.7
MACH NUMBER	0.000	1.000	2.161	2.509	2.701

TRANSPORT PROPERTIES (GASES ONLY)
CONDUCTIVITY IN UNITS OF MILLIWATTS/(CM)(K)

VISC,MILLIPOISE	1.0830	1.0527	0.96339	0.92945	0.90901

WITH EQUILIBRIUM REACTIONS

Cp, KJ/(KG)(K)	7.6755	7.5451	6.4661	5.6837	5.1144
CONDUCTIVITY	15.7485	14.8196	10.9695	9.0756	7.8789
PRANDTL NUMBER	0.5278	0.5359	0.5679	0.5821	0.5901

WITH FROZEN REACTIONS

Cp, KJ/(KG)(K)	2.1439	2.1349	2.1030	2.0882	2.0785
CONDUCTIVITY	3.4328	3.2998	2.9119	2.7669	2.6808
PRANDTL NUMBER	0.6763	0.6810	0.6958	0.7015	0.7048

PERFORMANCE PARAMETERS

Ae/At	1.0000	2.4603	4.0887	5.5741

CSTAR, M/SEC	1718.1	1718.1	1718.1	1718.1
CF	0.6499	1.2790	1.4342	1.5132
Ivac, M/SEC	2114.4	2620.0	2815.3	2919.0
Isp, M/SEC	1116.6	2197.4	2464.1	2599.8

MOLE FRACTIONS

*CO	0.19308	0.18463	0.15546	0.14401	0.13766
*CO2	0.16963	0.18302	0.22724	0.24399	0.25319
COOH	0.00001	0.00000	0.00000	0.00000	0.00000
*H	0.02165	0.01887	0.01113	0.00852	0.00710
HO2	0.00009	0.00006	0.00001	0.00000	0.00000
*H2	0.06217	0.05905	0.05005	0.04724	0.04595
H2O	0.43704	0.45343	0.50197	0.51857	0.52731
H2O2	0.00001	0.00001	0.00000	0.00000	0.00000
*O	0.01298	0.01046	0.00422	0.00252	0.00173
*OH	0.06796	0.05904	0.03292	0.02386	0.01892
*O2	0.03540	0.03142	0.01701	0.01127	0.00814

* THERMODYNAMIC PROPERTIES FITTED TO 20000.K

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

*C	*CH	CH2	CH3	CH2OH
CH3O	CH4	CH3OH	CH3OOH	*C2
C2H	C2H2,acetylene	C2H2,vinylidene	CH2CO,ketene	O(CH)2O
HO(CO)2OH	C2H3,vinyl	CH3CO,acetyl	C2H4	C2H4O,ethylen-o
CH3CHO,ethanal	CH3COOH	OHCH2COOH	C2H5	C2H6
C2H5OH	CH3OCH3	CH3O2CH3	C2O	*C3
C3H3,1-propynl	C3H3,2-propynl	C3H4,allene	C3H4,propyne	C3H4,cyclo-
C3H5,allyl	C3H6,propylene	C3H6,cyclo-	C3H6O,propylox	C3H6O,acetone
C3H6O,propanal	C3H7,n-propyl	C3H7,i-propyl	C3H8	C3H8O,1propanol
C3H8O,2propanol	C3O2	*C4	C4H2,butadiyne	C4H4,1,3-cyclo-
C4H6,butadiene	C4H6,1butyne	C4H6,2butyne	C4H6,cyclo-	C4H8,1-butene
C4H8,cis2-buten	C4H8,tr2-butene	C4H8,isobutene	C4H8,cyclo-	(CH3COOH)2
C4H9,n-butyl	C4H9,i-butyl	C4H9,s-butyl	C4H9,t-butyl	C4H10,n-butane
C4H10,isobutane	*C5	C5H6,1,3cyclo-	C5H8,cyclo-	C5H10,1-pentene
C5H10,cyclo-	C5H11,pentyl	C5H11,t-pentyl	C5H12,n-pentane	C5H12,i-pentane
CH3C(CH3)2CH3	C6H2	C6H5,phenyl	C6H5O,phenoxy	C6H6
C6H5OH,phenol	C6H10,cyclo-	C6H12,1-hexene	C6H12,cyclo-	C6H13,n-hexyl
C6H14,n-hexane	C7H7,benzyl	C7H8	C7H8O,cresol-mx	C7H14,1-heptene
C7H15,n-heptyl	C7H16,n-heptane	C7H16,2-methylh	C8H8,styrene	C8H10,ethylbenz
C8H16,1-octene	C8H17,n-octyl	C8H18,n-octane	C8H18,isooctane	C9H19,n-nonyl
C10H8,naphthale	C10H21,n-decyl	C12H9,o-bipheny	C12H10,biphenyl	HCO
HCCO	HCHO,formaldehy	HCOOH	(HCOOH)2	O3
C(gr)	H2O(cr)	H2O(L)		

POINT	ITN	T	C	H	O
1	3	3374.205	-16.426	-10.337	-15.372

Pinf/Pt = 1.725186

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  2    3    3221.913     -16.783     -10.551     -15.616
Pinf/Pt = 1.722966
  2    2    3222.261     -16.782     -10.551     -15.615
  3    4    2785.792     -17.894     -11.254     -16.538
  4    4    2626.760     -18.278     -11.527     -16.996
  5    3    2533.730     -18.468     -11.680     -17.310
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THEORETICAL ROCKET PERFORMANCE ASSUMING EQUILIBRIUM

COMPOSITION DURING EXPANSION FROM INFINITE AREA COMBUSTOR

Pin = 435.1 PSIA
CASE = Ethanol

REACTANT		MOLES	ENERGY KJ/KG-MOL	TEMP K
FUEL	C2H5OH(L)	1.0000000	-277510.001	298.150
OXIDANT	O2	1.0000000	0.000	298.150

O/F= 1.80000 %FUEL= 35.714286 R,EQ.RATIO= 1.132156 PHI,EQ.RATIO= 1.157654

	CHAMBER	THROAT	EXIT	EXIT	EXIT
Pinf/P	1.0000	1.7230	10.000	20.000	30.000
P, BAR	30.000	17.412	3.0000	1.5000	1.0000
T, K	3374.20	3222.26	2785.79	2626.76	2533.73
RHO, KG/CU M	2.5139 0	1.5483 0	3.2090-1	1.7244-1	1.2001-1
H, KJ/KG	-2151.38	-2781.66	-4586.17	-5211.43	-5556.68
U, KJ/KG	-3344.77	-3906.25	-5521.05	-6081.29	-6389.93
G, KJ/KG	-41305.3	-40172.4	-36912.2	-35692.1	-34957.8
S, KJ/(KG)(K)	11.6039	11.6039	11.6039	11.6039	11.6039
M, (1/n)	23.509	23.823	24.776	25.108	25.283
(dLV/dLP)t	-1.04040	-1.03626	-1.02190	-1.01579	-1.01218
(dLV/dLT)p	1.7624	1.7185	1.5064	1.3885	1.3111
Cp, KJ/(KG)(K)	7.2815	7.1514	6.0713	5.2884	4.7246
GAMMAs	1.1242	1.1209	1.1155	1.1172	1.1204
SON VEL,M/SEC	1158.3	1122.8	1021.2	985.8	966.2
MACH NUMBER	0.000	1.000	2.161	2.509	2.701

TRANSPORT PROPERTIES (GASES ONLY)
CONDUCTIVITY IN UNITS OF MILLIWATTS/(CM)(K)

VISC,MILLIPOISE	1.0960	1.0645	0.97175	0.93615	0.91453

WITH EQUILIBRIUM REACTIONS

Cp, KJ/(KG)(K)	7.2815	7.1514	6.0713	5.2884	4.7246
CONDUCTIVITY	14.8934	13.9891	10.2288	8.3787	7.2190
PRANDTL NUMBER	0.5358	0.5442	0.5768	0.5909	0.5985

WITH FROZEN REACTIONS

Cp, KJ/(KG)(K)	2.1481	2.1390	2.1066	2.0913	2.0811

CONDUCTIVITY	3.4756	3.3391	2.9399	2.7892	2.6990
PRANDTL NUMBER	0.6774	0.6819	0.6963	0.7019	0.7052

PERFORMANCE PARAMETERS

Ae/At	1.0000	2.4548	4.0749	5.5503
CSTAR, M/SEC	1725.8	1725.8	1725.8	1725.8
CF	0.6506	1.2787	1.4335	1.5122
Ivac, M/SEC	2124.4	2630.4	2825.5	2929.0
Isp, M/SEC	1122.8	2206.7	2473.9	2609.7

MOLE FRACTIONS

*CO	0.19122	0.18265	0.15338	0.14210	0.13594
*CO2	0.17327	0.18672	0.23076	0.24719	0.25607
COOH	0.00001	0.00000	0.00000	0.00000	0.00000
*H	0.01976	0.01715	0.00992	0.00750	0.00618
HCO	0.00001	0.00000	0.00000	0.00000	0.00000
HO2	0.00010	0.00006	0.00001	0.00001	0.00000
*H2	0.06048	0.05740	0.04863	0.04600	0.04486
H2O	0.44304	0.45927	0.50697	0.52306	0.53139
H2O2	0.00001	0.00001	0.00000	0.00000	0.00000
*O	0.01188	0.00950	0.00367	0.00212	0.00141
*OH	0.06656	0.05756	0.03130	0.02224	0.01732
*O2	0.03367	0.02967	0.01535	0.00978	0.00683

* THERMODYNAMIC PROPERTIES FITTED TO 20000.K

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

*C	*CH	CH2	CH3	CH2OH
CH3O	CH4	CH3OH	CH3OOH	*C2
C2H	C2H2,acetylene	C2H2,vinylidene	CH2CO,ketene	O(CH)2O
HO(CO)2OH	C2H3,vinyl	CH3CO,acetyl	C2H4	C2H4O,ethylen-o
CH3CHO,ethanal	CH3COOH	OHCH2COOH	C2H5	C2H6
C2H5OH	CH3OCH3	CH3O2CH3	C2O	*C3
C3H3,1-propynl	C3H3,2-propynl	C3H4,allene	C3H4,propyne	C3H4,cyclo-
C3H5,allyl	C3H6,propylene	C3H6,cyclo-	C3H6O,propylox	C3H6O,acetone
C3H6O,propanal	C3H7,n-propyl	C3H7,i-propyl	C3H8	C3H8O,1propanol
C3H8O,2propanol	C3O2	*C4	C4H2,butadiyne	C4H4,1,3-cyclo-
C4H6,butadiene	C4H6,1butyne	C4H6,2butyne	C4H6,cyclo-	C4H8,1-butene
C4H8,cis2-buten	C4H8,tr2-butene	C4H8,isobutene	C4H8,cyclo-	(CH3COOH)2
C4H9,n-butyl	C4H9,i-butyl	C4H9,s-butyl	C4H9,t-butyl	C4H10,n-butane
C4H10,isobutane	*C5	C5H6,1,3cyclo-	C5H8,cyclo-	C5H10,1-pentene
C5H10,cyclo-	C5H11,pentyl	C5H11,t-pentyl	C5H12,n-pentane	C5H12,i-pentane
CH3C(CH3)2CH3	C6H2	C6H5,phenyl	C6H5O,phenoxy	C6H6
C6H5OH,phenol	C6H10,cyclo-	C6H12,1-hexene	C6H12,cyclo-	C6H13,n-hexyl
C6H14,n-hexane	C7H7,benzyl	C7H8	C7H8O,cresol-mx	C7H14,1-heptene
C7H15,n-heptyl	C7H16,n-heptane	C7H16,2-methylh	C8H8,styrene	C8H10,ethylbenz
C8H16,1-octene	C8H17,n-octyl	C8H18,n-octane	C8H18,isooctane	C9H19,n-nonyl
C10H8,naphthale	C10H21,n-decyl	C12H9,o-bipheny	C12H10,biphenyl	HCCO
HCHO,formaldehy	HCOOH	(HCOOH)2	O3	C(gr)
H2O(cr)	H2O(L)			

O/F = 2.000000

ENTHALPY	EFFECTIVE FUEL h(2)/R	EFFECTIVE OXIDANT h(1)/R	MIXTURE h0/R
(KG-MOL)(K)/KG	-0.72450014E+03	-0.48137850E-07	-0.24150005E+03

KG-FORM.WT./KG	bi(2)	bi(1)	b0i
*C	0.43413669E-01	0.00000000E+00	0.14471223E-01
*H	0.13024101E+00	0.00000000E+00	0.43413669E-01
*O	0.21706834E-01	0.62502344E-01	0.48903841E-01

POINT	ITN	T	C	H	O
1	4	3246.029	-17.510	-10.908	-15.522
Pinf/Pt = 1.721171					
2	3	3111.708	-17.911	-11.136	-15.738
Pinf/Pt = 1.718759					
2	2	3112.043	-17.910	-11.135	-15.737
3	4	2730.708	-19.257	-11.904	-16.496
4	4	2598.036	-19.807	-12.219	-16.822
5	3	2523.788	-20.134	-12.406	-17.022

THEORETICAL ROCKET PERFORMANCE ASSUMING EQUILIBRIUM

COMPOSITION DURING EXPANSION FROM INFINITE AREA COMBUSTOR

Pin = 145.0 PSIA
CASE = Ethanol

	REACTANT	MOLES	ENERGY KJ/KG-MOL	TEMP K
FUEL	C2H5OH(L)	1.0000000	-277510.001	298.150
OXIDANT	O2	1.0000000	0.000	298.150

O/F= 2.00000 %FUEL= 33.333333 R,EQ.RATIO= 1.035691 PHI,EQ.RATIO= 1.041889

	CHAMBER	THROAT	EXIT	EXIT	EXIT
Pinf/P	1.0000	1.7188	10.000	20.000	30.000
P, BAR	10.000	5.8182	1.0000	0.50000	0.33333
T, K	3246.03	3112.04	2730.71	2598.04	2523.79
RHO, KG/CU M	8.8584-1	5.4521-1	1.1147-1	5.9496-2	4.1188-2
H, KJ/KG	-2007.95	-2602.40	-4325.78	-4927.68	-5262.07
U, KJ/KG	-3136.82	-3669.55	-5222.91	-5768.07	-6071.37
G, KJ/KG	-40107.5	-39129.3	-36376.8	-35421.5	-34884.5
S, KJ/(KG)(K)	11.7373	11.7373	11.7373	11.7373	11.7373
M, (1/n)	23.908	24.247	25.308	25.704	25.929
(dLV/dLP)t	-1.04855	-1.04487	-1.03290	-1.02823	-1.02552
(dLV/dLT)p	1.9492	1.9177	1.7732	1.6994	1.6520
Cp, KJ/(KG)(K)	8.5905	8.5618	8.0617	7.6815	7.4083

GAMMAs	1.1176	1.1141	1.1053	1.1030	1.1021
SON VEL,M/SEC	1123.2	1090.4	995.8	962.8	944.4
MACH NUMBER	0.000	1.000	2.162	2.510	2.701

TRANSPORT PROPERTIES (GASES ONLY)
CONDUCTIVITY IN UNITS OF MILLIWATTS/(CM)(K)

VISC,MILLIPOISE	1.0703	1.0424	0.96193	0.93330	0.91703

WITH EQUILIBRIUM REACTIONS

Cp, KJ/(KG)(K)	8.5905	8.5618	8.0617	7.6815	7.4083
CONDUCTIVITY	17.9139	17.1856	14.2745	12.9189	12.0763
PRANDTL NUMBER	0.5133	0.5193	0.5433	0.5549	0.5626

WITH FROZEN REACTIONS

Cp, KJ/(KG)(K)	2.0823	2.0742	2.0464	2.0346	2.0273
CONDUCTIVITY	3.2742	3.1555	2.8151	2.6946	2.6263
PRANDTL NUMBER	0.6807	0.6852	0.6993	0.7047	0.7079

PERFORMANCE PARAMETERS

Ae/At	1.0000	2.4770	4.1348	5.6576
CSTAR, M/SEC	1682.2	1682.2	1682.2	1682.2
CF	0.6482	1.2799	1.4365	1.5166
Ivac, M/SEC	2069.1	2569.7	2764.3	2868.4
Isp, M/SEC	1090.4	2153.1	2416.5	2551.1

MOLE FRACTIONS

*CO	0.16820	0.15883	0.12558	0.11171	0.10350
*CO2	0.17778	0.19205	0.24066	0.26026	0.27172
*H	0.02254	0.01982	0.01229	0.00984	0.00853
HO2	0.00010	0.00007	0.00002	0.00001	0.00001
*H2	0.05020	0.04705	0.03708	0.03328	0.03109
H2O	0.41753	0.43371	0.48306	0.50099	0.51105
H2O2	0.00001	0.00001	0.00000	0.00000	0.00000
*O	0.01976	0.01672	0.00884	0.00651	0.00534
*OH	0.07982	0.07122	0.04611	0.03752	0.03285
*O2	0.06406	0.06052	0.04636	0.03988	0.03591

* THERMODYNAMIC PROPERTIES FITTED TO 20000.K

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

*C	*CH	CH2	CH3	CH2OH
CH3O	CH4	CH3OH	CH3OOH	COOH
*C2	C2H	C2H2,acetylene	C2H2,vinylidene	CH2CO,ketene
O(CH)2O	HO(CO)2OH	C2H3,vinyl	CH3CO,acetyl	C2H4
C2H4O,ethylen-o	CH3CHO,ethanal	CH3COOH	OHCH2COOH	C2H5
C2H6	C2H5OH	CH3OCH3	CH3O2CH3	C2O
*C3	C3H3,1-propynl	C3H3,2-propynl	C3H4,allene	C3H4,propyne
C3H4,cyclo-	C3H5,allyl	C3H6,propylene	C3H6,cyclo-	C3H6O,propylox
C3H6O,acetone	C3H6O,propanal	C3H7,n-propyl	C3H7,i-propyl	C3H8

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C3H8O,1propanol	C3H8O,2propanol	C3O2	*C4	C4H2,butadiyne
C4H4,1,3-cyclo-	C4H6,butadiene	C4H6,1butyne	C4H6,2butyne	C4H6,cyclo-
C4H8,1-butene	C4H8,cis2-buten	C4H8,tr2-butene	C4H8,isobutene	C4H8,cyclo-
(CH3COOH)2	C4H9,n-butyl	C4H9,i-butyl	C4H9,s-butyl	C4H9,t-butyl
C4H10,n-butane	C4H10,isobutane	*C5	C5H6,1,3cyclo-	C5H8,cyclo-
C5H10,1-pentene	C5H10,cyclo-	C5H11,pentyl	C5H11,t-pentyl	C5H12,n-pentane
C5H12,i-pentane	CH3C(CH3)2CH3	C6H2	C6H5,phenyl	C6H5O,phenoxy
C6H6	C6H5OH,phenol	C6H10,cyclo-	C6H12,1-hexene	C6H12,cyclo-
C6H13,n-hexyl	C6H14,n-hexane	C7H7,benzyl	C7H8	C7H8O,cresol-mx
C7H14,1-heptene	C7H15,n-heptyl	C7H16,n-heptane	C7H16,2-methylh	C8H8,styrene
C8H10,ethylbenz	C8H16,1-octene	C8H17,n-octyl	C8H18,n-octane	C8H18,isooctane
C9H19,n-nonyl	C10H8,naphthale	C10H21,n-decyl	C12H9,o-bipheny	C12H10,biphenyl
HCO	HCCO	HCHO,formaldehy	HCOOH	(HCOOH)2
O3	C(gr)	H2O(cr)	H2O(L)	

POINT	ITN	T	C	H	O
1	3	3333.357	-17.105	-10.639	-15.251
Pinf/Pt = 1.722988					
2	3	3190.106	-17.507	-10.865	-15.466
Pinf/Pt = 1.720520					
2	2	3190.470	-17.505	-10.864	-15.466
3	4	2785.804	-18.852	-11.629	-16.225
4	4	2645.108	-19.403	-11.943	-16.554
5	3	2566.349	-19.731	-12.129	-16.757

THEORETICAL ROCKET PERFORMANCE ASSUMING EQUILIBRIUM

COMPOSITION DURING EXPANSION FROM INFINITE AREA COMBUSTOR

Pin = 290.1 PSIA
CASE = Ethanol

REACTANT		MOLES	ENERGY KJ/KG-MOL	TEMP K
FUEL	C2H5OH(L)	1.0000000	-277510.001	298.150
OXIDANT	O2	1.0000000	0.000	298.150

O/F= 2.00000 %FUEL= 33.333333 R,EQ.RATIO= 1.035691 PHI,EQ.RATIO= 1.041889

	CHAMBER	THROAT	EXIT	EXIT	EXIT
Pinf/P	1.0000	1.7205	10.000	20.000	30.000
P, BAR	20.000	11.624	2.0000	1.0000	0.66667
T, K	3333.36	3190.47	2785.80	2645.11	2566.35
RHO, KG/CU M	1.7400 0	1.0713 0	2.2010-1	1.1767-1	8.1542-2
H, KJ/KG	-2007.95	-2613.97	-4362.01	-4971.17	-5309.15
U, KJ/KG	-3157.41	-3699.09	-5270.68	-5820.99	-6126.73
G, KJ/KG	-40332.3	-39295.6	-36391.1	-35382.6	-34815.1
S, KJ/(KG)(K)	11.4972	11.4972	11.4972	11.4972	11.4972

M, (1/n)	24.112	24.446	25.491	25.879	26.099
(dLV/dLP)t	-1.04568	-1.04209	-1.03042	-1.02585	-1.02321
(dLV/dLT)p	1.8728	1.8427	1.7032	1.6314	1.5853
Cp, KJ/(KG)(K)	7.8892	7.8656	7.3951	7.0312	6.7688
GAMMAs	1.1206	1.1170	1.1081	1.1059	1.1051
SON VEL,M/SEC	1134.9	1100.9	1003.4	969.4	950.5
MACH NUMBER	0.000	1.000	2.162	2.511	2.703

TRANSPORT PROPERTIES (GASES ONLY)
CONDUCTIVITY IN UNITS OF MILLIWATTS/(CM)(K)

VISC,MILLIPOISE	1.0928	1.0632	0.97805	0.94766	0.93035

WITH EQUILIBRIUM REACTIONS

Cp, KJ/(KG)(K)	7.8892	7.8656	7.3951	7.0312	6.7688
CONDUCTIVITY	16.3947	15.7106	12.9711	11.6911	10.8948
PRANDTL NUMBER	0.5259	0.5323	0.5576	0.5699	0.5780

WITH FROZEN REACTIONS

Cp, KJ/(KG)(K)	2.0896	2.0814	2.0532	2.0410	2.0335
CONDUCTIVITY	3.3473	3.2236	2.8690	2.7428	2.6711
PRANDTL NUMBER	0.6822	0.6864	0.6999	0.7052	0.7083

PERFORMANCE PARAMETERS

Ae/At	1.0000	2.4695	4.1170	5.6289
CSTAR, M/SEC	1695.8	1695.8	1695.8	1695.8
CF	0.6492	1.2795	1.4356	1.5152
Ivac, M/SEC	2086.6	2588.6	2783.5	2887.7
Isp, M/SEC	1100.9	2169.8	2434.4	2569.5

MOLE FRACTIONS

*CO	0.16435	0.15467	0.12065	0.10657	0.09829
*CO2	0.18457	0.19909	0.24823	0.26793	0.27939
COOH	0.00001	0.00000	0.00000	0.00000	0.00000
*H	0.01938	0.01693	0.01023	0.00808	0.00694
HO2	0.00013	0.00009	0.00002	0.00001	0.00001
*H2	0.04742	0.04430	0.03448	0.03076	0.02863
H2O	0.42702	0.44305	0.49164	0.50920	0.51901
H2O2	0.00001	0.00001	0.00000	0.00000	0.00000
*O	0.01753	0.01472	0.00753	0.00544	0.00440
*OH	0.07834	0.06957	0.04415	0.03550	0.03082
*O2	0.06123	0.05756	0.04306	0.03650	0.03251

* THERMODYNAMIC PROPERTIES FITTED TO 20000.K

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

*C	*CH	CH2	CH3	CH2OH
CH3O	CH4	CH3OH	CH3OOH	*C2
C2H	C2H2,acetylene	C2H2,vinylidene	CH2CO,ketene	O(CH)2O

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 HO(CO)2OH       C2H3,vinyl      CH3CO,acetyl    C2H4            C2H4O,ethylen-o
 CH3CHO,ethanal  CH3COOH         OHCH2COOH       C2H5            C2H6
 C2H5OH          CH3OCH3         CH3O2CH3        C2O             *C3
 C3H3,1-propynl  C3H3,2-propynl  C3H4,allene     C3H4,propyne    C3H4,cyclo-
 C3H5,allyl      C3H6,propylene  C3H6,cyclo-     C3H6O,propylox  C3H6O,acetone
 C3H6O,propanal  C3H7,n-propyl   C3H7,i-propyl   C3H8            C3H8O,1propanol
 C3H8O,2propanol C3O2            *C4             C4H2,butadiyne  C4H4,1,3-cyclo-
 C4H6,butadiene  C4H6,1butyne    C4H6,2butyne    C4H6,cyclo-     C4H8,1-butene
 C4H8,cis2-buten C4H8,tr2-butene C4H8,isobutene  C4H8,cyclo-     (CH3COOH)2
 C4H9,n-butyl    C4H9,i-butyl    C4H9,s-butyl    C4H9,t-butyl    C4H10,n-butane
 C4H10,isobutane *C5             C5H6,1,3cyclo-  C5H8,cyclo-     C5H10,1-pentene
 C5H10,cyclo-    C5H11,pentyl    C5H11,t-pentyl  C5H12,n-pentane C5H12,i-pentane
 CH3C(CH3)2CH3   C6H2            C6H5,phenyl     C6H5O,phenoxy   C6H6
 C6H5OH,phenol   C6H10,cyclo-    C6H12,1-hexene  C6H12,cyclo-    C6H13,n-hexyl
 C6H14,n-hexane  C7H7,benzyl     C7H8            C7H8O,cresol-mx C7H14,1-heptene
 C7H15,n-heptyl  C7H16,n-heptane C7H16,2-methylh C8H8,styrene    C8H10,ethylbenz
 C8H16,1-octene  C8H17,n-octyl   C8H18,n-octane  C8H18,isooctane C9H19,n-nonyl
 C10H8,naphthale C10H21,n-decyl  C12H9,o-bipheny C12H10,biphenyl HCO
 HCCO            HCHO,formaldehy HCOOH           (HCOOH)2        O3
 C(gr)           H2O(cr)         H2O(L)
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POINT	ITN	T	C	H	O
1	3	3385.171	-16.870	-10.482	-15.094
Pinf/Pt = 1.724044					
2	3	3236.463	-17.272	-10.708	-15.309
Pinf/Pt = 1.721551					
2	2	3236.844	-17.271	-10.707	-15.308
3	4	2817.935	-18.618	-11.469	-16.068
4	4	2672.323	-19.169	-11.782	-16.399
5	3	2590.792	-19.497	-11.968	-16.605

THEORETICAL ROCKET PERFORMANCE ASSUMING EQUILIBRIUM

COMPOSITION DURING EXPANSION FROM INFINITE AREA COMBUSTOR

Pin = 435.1 PSIA
CASE = Ethanol

	REACTANT	MOLES	ENERGY KJ/KG-MOL	TEMP K
FUEL	C2H5OH(L)	1.0000000	-277510.001	298.150
OXIDANT	O2	1.0000000	0.000	298.150

O/F= 2.00000 %FUEL= 33.333333 R,EQ.RATIO= 1.035691 PHI,EQ.RATIO= 1.041889

	CHAMBER	THROAT	EXIT	EXIT	EXIT
Pinf/P	1.0000	1.7216	10.000	20.000	30.000
P, BAR	30.000	17.426	3.0000	1.5000	1.0000

T, K	3385.17	3236.84	2817.94	2672.32	2590.79
RHO, KG/CU M	2.5830 0	1.5906 0	3.2777-1	1.7540-1	1.2162-1
H, KJ/KG	-2007.95	-2620.72	-4383.00	-4996.30	-5336.33
U, KJ/KG	-3169.39	-3716.27	-5298.29	-5851.49	-6158.58
G, KJ/KG	-40455.9	-39384.0	-36388.5	-35347.9	-34761.9
S, KJ/(KG)(K)	11.3578	11.3578	11.3578	11.3578	11.3578
M, (1/n)	24.234	24.566	25.598	25.981	26.198
(dLV/dLP)t	-1.04402	-1.04049	-1.02899	-1.02449	-1.02189
(dLV/dLT)p	1.8299	1.8005	1.6639	1.5933	1.5479
Cp, KJ/(KG)(K)	7.5078	7.4866	7.0313	6.6764	6.4198
GAMMAs	1.1223	1.1187	1.1098	1.1077	1.1069
SON VEL,M/SEC	1141.7	1107.0	1007.8	973.3	954.0
MACH NUMBER	0.000	1.000	2.163	2.512	2.704

TRANSPORT PROPERTIES (GASES ONLY)
CONDUCTIVITY IN UNITS OF MILLIWATTS/(CM)(K)

VISC,MILLIPOISE	1.1061	1.0755	0.98749	0.95601	0.93805

WITH EQUILIBRIUM REACTIONS

Cp, KJ/(KG)(K)	7.5078	7.4866	7.0313	6.6764	6.4198
CONDUCTIVITY	15.5654	14.9067	12.2650	11.0278	10.2577
PRANDTL NUMBER	0.5335	0.5401	0.5661	0.5788	0.5871

WITH FROZEN REACTIONS

Cp, KJ/(KG)(K)	2.0939	2.0856	2.0571	2.0447	2.0371
CONDUCTIVITY	3.3912	3.2644	2.9009	2.7712	2.6974
PRANDTL NUMBER	0.6830	0.6871	0.7002	0.7054	0.7084

PERFORMANCE PARAMETERS

Ae/At	1.0000	2.4650	4.1065	5.6119
CSTAR, M/SEC	1703.7	1703.7	1703.7	1703.7
CF	0.6498	1.2793	1.4350	1.5144
Ivac, M/SEC	2096.7	2599.4	2794.5	2898.8
Isp, M/SEC	1107.0	2179.5	2444.7	2580.1

MOLE FRACTIONS

*CO	0.16181	0.15197	0.11757	0.10342	0.09512
*CO2	0.18887	0.20352	0.25287	0.27257	0.28399
COOH	0.00001	0.00000	0.00000	0.00000	0.00000
*H	0.01765	0.01537	0.00915	0.00716	0.00611
HO2	0.00015	0.00010	0.00003	0.00001	0.00001
*H2	0.04576	0.04266	0.03297	0.02931	0.02722
H2O	0.43274	0.44863	0.49667	0.51397	0.52361
H2O2	0.00002	0.00001	0.00000	0.00000	0.00000
*O	0.01626	0.01359	0.00681	0.00486	0.00389
*OH	0.07725	0.06840	0.04287	0.03422	0.02955
*O2	0.05949	0.05574	0.04107	0.03448	0.03049

* THERMODYNAMIC PROPERTIES FITTED TO 20000.K

FileEditor:KAL-Eta-p.out

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

*C	*CH	CH2	CH3	CH2OH
CH3O	CH4	CH3OH	CH3OOH	*C2
C2H	C2H2,acetylene	C2H2,vinylidene	CH2CO,ketene	O(CH)2O
HO(CO)2OH	C2H3,vinyl	CH3CO,acetyl	C2H4	C2H4O,ethylen-o
CH3CHO,ethanal	CH3COOH	OHCH2COOH	C2H5	C2H6
C2H5OH	CH3OCH3	CH3O2CH3	C2O	*C3
C3H3,1-propynl	C3H3,2-propynl	C3H4,allene	C3H4,propyne	C3H4,cyclo-
C3H5,allyl	C3H6,propylene	C3H6,cyclo-	C3H6O,propylox	C3H6O,acetone
C3H6O,propanal	C3H7,n-propyl	C3H7,i-propyl	C3H8	C3H8O,1propanol
C3H8O,2propanol	C3O2	*C4	C4H2,butadiyne	C4H4,1,3-cyclo-
C4H6,butadiene	C4H6,1butyne	C4H6,2butyne	C4H6,cyclo-	C4H8,1-butene
C4H8,cis2-buten	C4H8,tr2-butene	C4H8,isobutene	C4H8,cyclo-	(CH3COOH)2
C4H9,n-butyl	C4H9,i-butyl	C4H9,s-butyl	C4H9,t-butyl	C4H10,n-butane
C4H10,isobutane	*C5	C5H6,1,3cyclo-	C5H8,cyclo-	C5H10,1-pentene
C5H10,cyclo-	C5H11,pentyl	C5H11,t-pentyl	C5H12,n-pentane	C5H12,i-pentane
CH3C(CH3)2CH3	C6H2	C6H5,phenyl	C6H5O,phenoxy	C6H6
C6H5OH,phenol	C6H10,cyclo-	C6H12,1-hexene	C6H12,cyclo-	C6H13,n-hexyl
C6H14,n-hexane	C7H7,benzyl	C7H8	C7H8O,cresol-mx	C7H14,1-heptene
C7H15,n-heptyl	C7H16,n-heptane	C7H16,2-methylh	C8H8,styrene	C8H10,ethylbenz
C8H16,1-octene	C8H17,n-octyl	C8H18,n-octane	C8H18,isooctane	C9H19,n-nonyl
C10H8,naphthale	C10H21,n-decyl	C12H9,o-bipheny	C12H10,biphenyl	HCO
HCCO	HCHO,formaldehy	HCOOH	(HCOOH)2	O3
C(gr)	H2O(cr)	H2O(L)		

O/F =   2.200000

	EFFECTIVE FUEL	EFFECTIVE OXIDANT	MIXTURE
ENTHALPY	h(2)/R	h(1)/R	h0/R
(KG-MOL)(K)/KG	-0.72450014E+03	-0.48137850E-07	-0.22640629E+03

KG-FORM.WT./KG	bi(2)	bi(1)	b0i
*C	0.43413669E-01	0.00000000E+00	0.13566772E-01
*H	0.13024101E+00	0.00000000E+00	0.40700315E-01
*O	0.21706834E-01	0.62502344E-01	0.49753747E-01

POINT	ITN	T	C	H	O
1	4	3239.589	-17.845	-11.019	-15.336
Pinf/Pt = 1.720877					
2	3	3106.076	-18.273	-11.253	-15.539
Pinf/Pt = 1.718483					
2	2	3106.407	-18.272	-11.252	-15.539
3	4	2727.057	-19.744	-12.051	-16.237
4	4	2595.033	-20.370	-12.385	-16.526
5	3	2521.139	-20.752	-12.585	-16.699

THEORETICAL ROCKET PERFORMANCE ASSUMING EQUILIBRIUM

COMPOSITION DURING EXPANSION FROM INFINITE AREA COMBUSTOR

Pin = 145.0 PSIA
CASE = Ethanol

REACTANT		MOLES	ENERGY KJ/KG-MOL	TEMP K
FUEL	C2H5OH(L)	1.0000000	-277510.001	298.150
OXIDANT	O2	1.0000000	0.000	298.150

O/F= 2.20000 %FUEL= 31.250000 R,EQ.RATIO= 0.954374 PHI,EQ.RATIO= 0.947172

	CHAMBER	THROAT	EXIT	EXIT	EXIT
Pinf/P	1.0000	1.7185	10.000	20.000	30.000
P, BAR	10.000	5.8191	1.0000	0.50000	0.33333
T, K	3239.59	3106.41	2727.06	2595.03	2521.14
RHO, KG/CU M	9.1059-1	5.6040-1	1.1449-1	6.1097-2	4.2291-2
H, KJ/KG	-1882.46	-2460.65	-4138.19	-4724.26	-5049.92
U, KJ/KG	-2980.65	-3499.02	-5011.64	-5542.64	-5838.12
G, KJ/KG	-39152.9	-38198.9	-35512.1	-34579.3	-34054.8
S, KJ/(KG)(K)	11.5047	11.5047	11.5047	11.5047	11.5047
M, (1/n)	24.527	24.874	25.959	26.365	26.595
(dLV/dLP)t	-1.04828	-1.04465	-1.03279	-1.02815	-1.02546
(dLV/dLT)p	1.9484	1.9173	1.7738	1.7002	1.6530
Cp, KJ/(KG)(K)	8.4026	8.3762	7.8909	7.5201	7.2541
GAMMAs	1.1172	1.1136	1.1049	1.1026	1.1017
SON VEL,M/SEC	1107.6	1075.4	982.4	949.9	931.9
MACH NUMBER	0.000	1.000	2.162	2.510	2.701

TRANSPORT PROPERTIES (GASES ONLY)
CONDUCTIVITY IN UNITS OF MILLIWATTS/(CM)(K)

VISC,MILLIPOISE	1.0735	1.0454	0.96451	0.93571	0.91934

WITH EQUILIBRIUM REACTIONS

Cp, KJ/(KG)(K)	8.4026	8.3762	7.8909	7.5201	7.2541
CONDUCTIVITY	17.6337	16.9681	14.2821	13.0230	12.2390
PRANDTL NUMBER	0.5115	0.5161	0.5329	0.5403	0.5449

WITH FROZEN REACTIONS

Cp, KJ/(KG)(K)	2.0334	2.0255	1.9988	1.9873	1.9803
CONDUCTIVITY	3.1856	3.0720	2.7451	2.6290	2.5631
PRANDTL NUMBER	0.6852	0.6893	0.7023	0.7073	0.7103

PERFORMANCE PARAMETERS

Ae/At	1.0000	2.4781	4.1373	5.6615
CSTAR, M/SEC	1659.4	1659.4	1659.4	1659.4
CF	0.6480	1.2800	1.4367	1.5168
Ivac, M/SEC	2041.0	2535.2	2727.3	2830.1
Isp, M/SEC	1075.3	2124.0	2384.0	2516.9

MOLE FRACTIONS

*CO	0.14505	0.13509	0.10013	0.08572	0.07724
*CO2	0.18770	0.20237	0.25206	0.27197	0.28357
*H	0.01978	0.01730	0.01044	0.00822	0.00704
HO2	0.00013	0.00009	0.00003	0.00002	0.00001
*H2	0.03998	0.03702	0.02750	0.02380	0.02166
H2O	0.40655	0.42217	0.46993	0.48735	0.49716
H2O2	0.00001	0.00001	0.00000	0.00000	0.00000
*O	0.02327	0.01996	0.01125	0.00862	0.00727
*OH	0.08528	0.07660	0.05122	0.04250	0.03775
*O2	0.09225	0.08941	0.07744	0.07180	0.06831

* THERMODYNAMIC PROPERTIES FITTED TO 20000.K

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

*C	*CH	CH2	CH3	CH2OH
CH3O	CH4	CH3OH	CH3OOH	COOH
*C2	C2H	C2H2,acetylene	C2H2,vinylidene	CH2CO,ketene
O(CH)2O	HO(CO)2OH	C2H3,vinyl	CH3CO,acetyl	C2H4
C2H4O,ethylen-o	CH3CHO,ethanal	CH3COOH	OHCH2COOH	C2H5
C2H6	C2H5OH	CH3OCH3	CH3O2CH3	C2O
*C3	C3H3,1-propynl	C3H3,2-propynl	C3H4,allene	C3H4,propyne
C3H4,cyclo-	C3H5,allyl	C3H6,propylene	C3H6,cyclo-	C3H6O,propylox
C3H6O,acetone	C3H6O,propanal	C3H7,n-propyl	C3H7,i-propyl	C3H8
C3H8O,1propanol	C3H8O,2propanol	C3O2	*C4	C4H2,butadiyne
C4H4,1,3-cyclo-	C4H6,butadiene	C4H6,1butyne	C4H6,2butyne	C4H6,cyclo-
C4H8,1-butene	C4H8,cis2-buten	C4H8,tr2-butene	C4H8,isobutene	C4H8,cyclo-
(CH3COOH)2	C4H9,n-butyl	C4H9,i-butyl	C4H9,s-butyl	C4H9,t-butyl
C4H10,n-butane	C4H10,isobutane	*C5	C5H6,1,3cyclo-	C5H8,cyclo-
C5H10,1-pentene	C5H10,cyclo-	C5H11,pentyl	C5H11,t-pentyl	C5H12,n-pentane
C5H12,i-pentane	CH3C(CH3)2CH3	C6H2	C6H5,phenyl	C6H5O,phenoxy
C6H6	C6H5OH,phenol	C6H10,cyclo-	C6H12,1-hexene	C6H12,cyclo-
C6H13,n-hexyl	C6H14,n-hexane	C7H7,benzyl	C7H8	C7H8O,cresol-mx
C7H14,1-heptene	C7H15,n-heptyl	C7H16,n-heptane	C7H16,2-methylh	C8H8,styrene
C8H10,ethylbenz	C8H16,1-octene	C8H17,n-octyl	C8H18,n-octane	C8H18,isooctane
C9H19,n-nonyl	C10H8,naphthale	C10H21,n-decyl	C12H9,o-bipheny	C12H10,biphenyl
HCO	HCCO	HCHO,formaldehy	HCOOH	(HCOOH)2
O3	C(gr)	H2O(cr)	H2O(L)	

POINT	ITN	T	C	H	O
1	3	3326.378	-17.457	-10.754	-15.056
Pinf/Pt = 1.722677					
2	3	3184.032	-17.888	-10.987	-15.257
Pinf/Pt = 1.720229					
2	2	3184.392	-17.887	-10.986	-15.257
3	4	2781.925	-19.374	-11.785	-15.948
4	4	2641.945	-20.010	-12.120	-16.236
5	3	2563.577	-20.401	-12.322	-16.407

THEORETICAL ROCKET PERFORMANCE ASSUMING EQUILIBRIUM

COMPOSITION DURING EXPANSION FROM INFINITE AREA COMBUSTOR

Pin = 290.1 PSIA
CASE = Ethanol

REACTANT		MOLES	ENERGY KJ/KG-MOL	TEMP K
FUEL	C2H5OH(L)	1.0000000	-277510.001	298.150
OXIDANT	O2	1.0000000	0.000	298.150

O/F= 2.20000 %FUEL= 31.250000 R,EQ.RATIO= 0.954374 PHI,EQ.RATIO= 0.947172

	CHAMBER	THROAT	EXIT	EXIT	EXIT
Pinf/P	1.0000	1.7202	10.000	20.000	30.000
P, BAR	20.000	11.626	2.0000	1.0000	0.66667
T, K	3326.38	3184.39	2781.92	2641.94	2563.58
RHO, KG/CU M	1.7887 0	1.1012 0	2.2607-1	1.2084-1	8.3724-2
H, KJ/KG	-1882.46	-2471.86	-4173.38	-4766.51	-5095.66
U, KJ/KG	-3000.61	-3527.67	-5058.04	-5594.07	-5891.93
G, KJ/KG	-39373.1	-38362.2	-35527.6	-34543.1	-33989.0
S, KJ/(KG)(K)	11.2707	11.2707	11.2707	11.2707	11.2707
M, (1/n)	24.735	25.077	26.146	26.544	26.769
(dLV/dLP)t	-1.04547	-1.04192	-1.03034	-1.02580	-1.02318
(dLV/dLT)p	1.8729	1.8431	1.7042	1.6327	1.5868
Cp, KJ/(KG)(K)	7.7217	7.6999	7.2417	6.8867	6.6313
GAMMAs	1.1201	1.1165	1.1077	1.1055	1.1047
SON VEL,M/SEC	1119.1	1085.7	989.9	956.5	937.9
MACH NUMBER	0.000	1.000	2.162	2.511	2.703

TRANSPORT PROPERTIES (GASES ONLY)
CONDUCTIVITY IN UNITS OF MILLIWATTS/(CM)(K)

VISC,MILLIPOISE	1.0957	1.0660	0.98041	0.94987	0.93247

WITH EQUILIBRIUM REACTIONS

Cp, KJ/(KG)(K)	7.7217	7.6999	7.2417	6.8867	6.6313
CONDUCTIVITY	16.1542	15.5292	13.0011	11.8122	11.0716
PRANDTL NUMBER	0.5237	0.5285	0.5461	0.5538	0.5585

WITH FROZEN REACTIONS

Cp, KJ/(KG)(K)	2.0406	2.0326	2.0054	1.9937	1.9864
CONDUCTIVITY	3.2577	3.1392	2.7983	2.6767	2.6075
PRANDTL NUMBER	0.6864	0.6902	0.7026	0.7075	0.7103

PERFORMANCE PARAMETERS

Ae/At	1.0000	2.4706	4.1197	5.6331	

CSTAR, M/SEC	1672.8	1672.8	1672.8	1672.8
CF	0.6490	1.2796	1.4357	1.5154
Ivac, M/SEC	2058.2	2553.8	2746.3	2849.1
Isp, M/SEC	1085.7	2140.5	2401.7	2535.0

MOLE FRACTIONS

*CO	0.14054	0.13027	0.09459	0.08001	0.07147
*CO2	0.19502	0.20994	0.26012	0.28010	0.29169
COOH	0.00001	0.00000	0.00000	0.00000	0.00000
*H	0.01691	0.01469	0.00861	0.00667	0.00564
HO2	0.00017	0.00012	0.00003	0.00002	0.00001
*H2	0.03739	0.03446	0.02511	0.02150	0.01941
H2O	0.41541	0.43088	0.47792	0.49500	0.50457
H2O2	0.00002	0.00001	0.00000	0.00000	0.00000
*O	0.02081	0.01774	0.00975	0.00736	0.00615
*OH	0.08399	0.07515	0.04943	0.04064	0.03587
*O2	0.08973	0.08675	0.07443	0.06869	0.06518

* THERMODYNAMIC PROPERTIES FITTED TO 20000.K

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

*C	*CH	CH2	CH3	CH2OH
CH3O	CH4	CH3OH	CH3OOH	*C2
C2H	C2H2,acetylene	C2H2,vinylidene	CH2CO,ketene	O(CH)2O
HO(CO)2OH	C2H3,vinyl	CH3CO,acetyl	C2H4	C2H4O,ethylen-o
CH3CHO,ethanal	CH3COOH	OHCH2COOH	C2H5	C2H6
C2H5OH	CH3OCH3	CH3O2CH3	C2O	*C3
C3H3,1-propynl	C3H3,2-propynl	C3H4,allene	C3H4,propyne	C3H4,cyclo-
C3H5,allyl	C3H6,propylene	C3H6,cyclo-	C3H6O,propylox	C3H6O,acetone
C3H6O,propanal	C3H7,n-propyl	C3H7,i-propyl	C3H8	C3H8O,1propanol
C3H8O,2propanol	C3O2	*C4	C4H2,butadiyne	C4H4,1,3-cyclo-
C4H6,butadiene	C4H6,1butyne	C4H6,2butyne	C4H6,cyclo-	C4H8,1-butene
C4H8,cis2-buten	C4H8,tr2-butene	C4H8,isobutene	C4H8,cyclo-	(CH3COOH)2
C4H9,n-butyl	C4H9,i-butyl	C4H9,s-butyl	C4H9,t-butyl	C4H10,n-butane
C4H10,isobutane	*C5	C5H6,1,3cyclo-	C5H8,cyclo-	C5H10,1-pentene
C5H10,cyclo-	C5H11,pentyl	C5H11,t-pentyl	C5H12,n-pentane	C5H12,i-pentane
CH3C(CH3)2CH3	C6H2	C6H5,phenyl	C6H5O,phenoxy	C6H6
C6H5OH,phenol	C6H10,cyclo-	C6H12,1-hexene	C6H12,cyclo-	C6H13,n-hexyl
C6H14,n-hexane	C7H7,benzyl	C7H8	C7H8O,cresol-mx	C7H14,1-heptene
C7H15,n-heptyl	C7H16,n-heptane	C7H16,2-methylh	C8H8,styrene	C8H10,ethylbenz
C8H16,1-octene	C8H17,n-octyl	C8H18,n-octane	C8H18,isooctane	C9H19,n-nonyl
C10H8,naphthale	C10H21,n-decyl	C12H9,o-bipheny	C12H10,biphenyl	HCO
HCCO	HCHO,formaldehy	HCOOH	(HCOOH)2	O3
C(gr)	H2O(cr)	H2O(L)		

POINT	ITN	T	C	H	O
1	3	3377.879	-17.233	-10.600	-14.893

Pinf/Pt = 1.723723

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  2    3    3230.136     -17.666     -10.833     -15.093
Pinf/Pt = 1.721251
  2    2    3230.512     -17.665     -10.833     -15.093
  3    4    2813.931     -19.161     -11.630     -15.780
  4    4    2669.076     -19.805     -11.966     -16.066
  5    3    2587.961     -20.202     -12.170     -16.237
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THEORETICAL ROCKET PERFORMANCE ASSUMING EQUILIBRIUM

COMPOSITION DURING EXPANSION FROM INFINITE AREA COMBUSTOR

Pin = 435.1 PSIA
CASE = Ethanol

REACTANT		MOLES	ENERGY KJ/KG-MOL	TEMP K
FUEL	C2H5OH(L)	1.0000000	-277510.001	298.150
OXIDANT	O2	1.0000000	0.000	298.150

O/F= 2.20000 %FUEL= 31.250000 R,EQ.RATIO= 0.954374 PHI,EQ.RATIO= 0.947172

	CHAMBER	THROAT	EXIT	EXIT	EXIT
Pinf/P	1.0000	1.7213	10.000	20.000	30.000
P, BAR	30.000	17.429	3.0000	1.5000	1.0000
T, K	3377.88	3230.51	2813.93	2669.08	2587.96
RHO, KG/CU M	2.6554 0	1.6351 0	3.3666-1	1.8012-1	1.2487-1
H, KJ/KG	-1882.46	-2478.40	-4193.76	-4790.93	-5122.07
U, KJ/KG	-3012.23	-3544.34	-5084.87	-5623.72	-5922.89
G, KJ/KG	-39494.3	-38449.3	-35526.2	-34510.4	-33938.3
S, KJ/(KG)(K)	11.1347	11.1347	11.1347	11.1347	11.1347
M, (1/n)	24.859	25.199	26.256	26.648	26.869
(dLV/dLP)t	-1.04384	-1.04035	-1.02893	-1.02446	-1.02188
(dLV/dLT)p	1.8303	1.8013	1.6651	1.5948	1.5496
Cp, KJ/(KG)(K)	7.3512	7.3313	6.8872	6.5410	6.2916
GAMMAs	1.1218	1.1182	1.1093	1.1072	1.1065
SON VEL,M/SEC	1125.8	1091.7	994.3	960.3	941.3
MACH NUMBER	0.000	1.000	2.162	2.512	2.704

TRANSPORT PROPERTIES (GASES ONLY)
CONDUCTIVITY IN UNITS OF MILLIWATTS/(CM)(K)

VISC,MILLIPOISE	1.1089	1.0781	0.98972	0.95810	0.94006

WITH EQUILIBRIUM REACTIONS

Cp, KJ/(KG)(K)	7.3512	7.3313	6.8872	6.5410	6.2916
CONDUCTIVITY	15.3469	14.7452	12.3069	11.1579	10.4419
PRANDTL NUMBER	0.5312	0.5361	0.5539	0.5617	0.5664

WITH FROZEN REACTIONS

Cp, KJ/(KG)(K)	2.0449	2.0368	2.0092	1.9973	1.9899

CONDUCTIVITY	3.3010	3.1794	2.8299	2.7049	2.6336
PRANDTL NUMBER	0.6869	0.6907	0.7027	0.7075	0.7103

PERFORMANCE PARAMETERS

Ae/At	1.0000	2.4662	4.1092	5.6162
CSTAR, M/SEC	1680.6	1680.6	1680.6	1680.6
CF	0.6496	1.2793	1.4351	1.5146
Ivac, M/SEC	2068.1	2564.5	2757.1	2860.0
Isp, M/SEC	1091.7	2150.0	2411.8	2545.4

MOLE FRACTIONS

*CO	0.13761	0.12718	0.09116	0.07651	0.06797
*CO2	0.19964	0.21468	0.26504	0.28501	0.29656
COOH	0.00001	0.00000	0.00000	0.00000	0.00000
*H	0.01535	0.01328	0.00765	0.00587	0.00493
HO2	0.00020	0.00014	0.00004	0.00002	0.00002
*H2	0.03584	0.03294	0.02373	0.02018	0.01813
H2O	0.42074	0.43608	0.48260	0.49944	0.50885
H2O2	0.00002	0.00001	0.00000	0.00000	0.00000
*O	0.01941	0.01648	0.00892	0.00667	0.00554
*OH	0.08302	0.07410	0.04825	0.03946	0.03468
*O2	0.08816	0.08511	0.07260	0.06684	0.06332

* THERMODYNAMIC PROPERTIES FITTED TO 20000.K

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

*C	*CH	CH2	CH3	CH2OH
CH3O	CH4	CH3OH	CH3OOH	*C2
C2H	C2H2,acetylene	C2H2,vinylidene	CH2CO,ketene	O(CH)2O
HO(CO)2OH	C2H3,vinyl	CH3CO,acetyl	C2H4	C2H4O,ethylen-o
CH3CHO,ethanal	CH3COOH	OHCH2COOH	C2H5	C2H6
C2H5OH	CH3OCH3	CH3O2CH3	C2O	*C3
C3H3,1-propynl	C3H3,2-propynl	C3H4,allene	C3H4,propyne	C3H4,cyclo-
C3H5,allyl	C3H6,propylene	C3H6,cyclo-	C3H6O,propylox	C3H6O,acetone
C3H6O,propanal	C3H7,n-propyl	C3H7,i-propyl	C3H8	C3H8O,1propanol
C3H8O,2propanol	C3O2	*C4	C4H2,butadiyne	C4H4,1,3-cyclo-
C4H6,butadiene	C4H6,1butyne	C4H6,2butyne	C4H6,cyclo-	C4H8,1-butene
C4H8,cis2-buten	C4H8,tr2-butene	C4H8,isobutene	C4H8,cyclo-	(CH3COOH)2
C4H9,n-butyl	C4H9,i-butyl	C4H9,s-butyl	C4H9,t-butyl	C4H10,n-butane
C4H10,isobutane	*C5	C5H6,1,3cyclo-	C5H8,cyclo-	C5H10,1-pentene
C5H10,cyclo-	C5H11,pentyl	C5H11,t-pentyl	C5H12,n-pentane	C5H12,i-pentane
CH3C(CH3)2CH3	C6H2	C6H5,phenyl	C6H5O,phenoxy	C6H6
C6H5OH,phenol	C6H10,cyclo-	C6H12,1-hexene	C6H12,cyclo-	C6H13,n-hexyl
C6H14,n-hexane	C7H7,benzyl	C7H8	C7H8O,cresol-mx	C7H14,1-heptene
C7H15,n-heptyl	C7H16,n-heptane	C7H16,2-methylh	C8H8,styrene	C8H10,ethylbenz
C8H16,1-octene	C8H17,n-octyl	C8H18,n-octane	C8H18,isooctane	C9H19,n-nonyl
C10H8,naphthale	C10H21,n-decyl	C12H9,o-bipheny	C12H10,biphenyl	HCO
HCCO	HCHO,formaldehy	HCOOH	(HCOOH)2	O3
C(gr)	H2O(cr)	H2O(L)		