FileEditor:ethanol-engine-6-equilibrium.out

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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

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 prob
 o/f=1.5 rocket equilibrium p,bar=20 pi/pe=22.222
 react
   fuel=C2H5OH(L) wt=100 t,k=297
   oxid=O2 wt=100
 end

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

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

 Pc,BAR =    20.000000

 Pc/P =    22.2220

 SUBSONIC AREA RATIOS =

 SUPERSONIC AREA RATIOS =

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

    REACTANT          WT.FRAC   (ENERGY/R),K   TEMP,K  DENSITY
        EXPLODED FORMULA
 F: C2H5OH(L)        1.000000  -0.333921E+05   297.00  0.0000
          C  2.00000  H  6.00000  O  1.00000
 O: O2               1.000000   0.000000E+00     0.00  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
  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
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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)				

O/F = 1.500000

	EFFECTIVE FUEL	EFFECTIVE OXIDANT	MIXTURE
ENTHALPY	h(2)/R	h(1)/R	h0/R
(KG-MOL)(K)/KG	-0.72483648E+03	0.00000000E+00	-0.28993459E+03

KG-FORM.WT./KG	bi(2)	bi(1)	b0i
*C	0.43413669E-01	0.00000000E+00	0.17365468E-01
*H	0.13024101E+00	0.00000000E+00	0.52096403E-01
*O	0.21706834E-01	0.62502344E-01	0.46184140E-01

POINT	ITN	T	C	H	O
1	22	3232.250	-15.733	-10.195	-16.220
Pinf/Pt = 1.730587					
2	4	3064.794	-15.961	-10.379	-16.584
Pinf/Pt = 1.731234					
2	2	3064.681	-15.961	-10.379	-16.584
3	5	2256.369	-16.047	-11.080	-19.573

THEORETICAL ROCKET PERFORMANCE ASSUMING EQUILIBRIUM

COMPOSITION DURING EXPANSION FROM INFINITE AREA COMBUSTOR

Pin = 290.1 PSIA
CASE =

	REACTANT	WT FRACTION (SEE NOTE)	ENERGY KJ/KG-MOL	TEMP K
FUEL	C2H5OH(L)	1.0000000	-277638.832	297.000
OXIDANT	O2	1.0000000	0.000	0.000

O/F= 1.50000 %FUEL= 40.000000 R,EQ.RATIO= 1.316017 PHI,EQ.RATIO= 1.389185

	CHAMBER	THROAT	EXIT
Pinf/P	1.0000	1.7312	22.222
P, BAR	20.000	11.552	0.90001
T, K	3232.25	3064.68	2256.37
RHO, KG/CU M	1.6399 0	1.0104 0	1.1023-1
H, KJ/KG	-2410.66	-3058.90	-5556.22
U, KJ/KG	-3630.26	-4202.27	-6372.68
G, KJ/KG	-41747.5	-40356.4	-33016.4
S, KJ/(KG)(K)	12.1701	12.1701	12.1701
M, (1/n)	22.036	22.286	22.978
(dLV/dLP)t	-1.02474	-1.01881	-1.00126
(dLV/dLT)p	1.4837	1.3885	1.0339
Cp, KJ/(KG)(K)	5.8444	5.2543	2.4928
GAMMAs	1.1330	1.1339	1.1819
SON VEL,M/SEC	1175.5	1138.6	982.3
MACH NUMBER	0.000	1.000	2.553

PERFORMANCE PARAMETERS

Ae/At	1.0000	4.1609
CSTAR, M/SEC	1738.5	1738.5
CF	0.6550	1.4428
Ivac, M/SEC	2142.8	2833.7
Isp, M/SEC	1138.6	2508.2

MOLE FRACTIONS

*CO	0.24774	0.24309	0.22294
*CO2	0.13490	0.14392	0.17609
COOH	0.00001	0.00000	0.00000
*H	0.02202	0.01804	0.00272
HCO	0.00001	0.00000	0.00000
HO2	0.00002	0.00001	0.00000
*H2	0.10302	0.10191	0.11219
H2O	0.44009	0.45440	0.48400
*O	0.00468	0.00301	0.00003
*OH	0.03970	0.03034	0.00198
*O2	0.00780	0.00528	0.00005

* THERMODYNAMIC PROPERTIES FITTED TO 20000.K

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

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*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)		

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