FileEditor:paraffin.out

```
 ******************************************************************************

        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
       rocket  fac   ac/at=3.0  tcest,k=3800
   p,bar=100,
   sup,ae/at=1000,
 react
   name=O2 moles=48.5  t,k=298.15
   name=paraffin  moles=1.0  t,k=298.15
     h,kj/mol=-698.52  C 32 H 66
 end

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

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

 Pc,BAR =   100.000000

 Pc/P =

 SUBSONIC AREA RATIOS =

 SUPERSONIC AREA RATIOS =  1000.0000

 NFZ=  1  Mdot/Ac= 0.000000E+00  Ac/At= 3.000000E+00

    REACTANT           MOLES    (ENERGY/R),K   TEMP,K  DENSITY
       EXPLODED FORMULA
 N: O2              48.500000  -0.154035E-05   298.15  0.0000
          O  2.00000
 N: paraffin         1.000000  -0.840122E+05   298.15  0.0000
          C 32.00000  H 66.00000

  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
```

FileEditor:paraffin.out

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)				

O/F = 0.000000

ENTHALPY (KG-MOL)(K)/KG	EFFECTIVE FUEL h(2)/R	EFFECTIVE OXIDANT h(1)/R	MIXTURE h0/R
	-0.41947184E+02	0.00000000E+00	-0.41947184E+02

KG-FORM.WT./KG	bi(2)	bi(1)	b0i
*O	0.48431996E-01	0.00000000E+00	0.48431996E-01
*C	0.15977566E-01	0.00000000E+00	0.15977566E-01
*H	0.32953729E-01	0.00000000E+00	0.32953729E-01

POINT	ITN	T	O	C	H
1	23	3791.059	-14.519	-16.005	-10.170
2	2	3783.596	-14.537	-16.031	-10.187

Pinf/Pt = 1.730097

3	3	3606.245	-14.727	-16.426	-10.401

Pinf/Pt = 1.726762

3	2	3606.844	-14.726	-16.424	-10.401
4	2	3776.880	-14.544	-16.045	-10.195
4	2	3775.821	-14.545	-16.047	-10.196
4	2	3775.730	-14.545	-16.047	-10.196
2	2	3787.427	-14.528	-16.018	-10.178

Pinf/Pt = 1.730159

```
  3    3    3609.677     -14.718     -16.412     -10.393
 Pinf/Pt = 1.726822
  3    2    3610.276     -14.717     -16.411     -10.392
  4    2    3780.695     -14.534     -16.032     -10.186
  4    2    3779.634     -14.535     -16.034     -10.187
  4    2    3779.543     -14.536     -16.034     -10.187
 END OF CHAMBER ITERATIONS
  4    7    1497.085     -20.427     -27.874     -16.085
  4    5    1752.346     -19.228     -25.254     -14.972
  4    2    1749.419     -19.241     -25.280     -14.984
```

THEORETICAL ROCKET PERFORMANCE ASSUMING EQUILIBRIUM

COMPOSITION DURING EXPANSION FROM FINITE AREA COMBUSTOR

Pin = 1450.4 PSIA
Ac/At = 3.0000 Pinj/Pinf = 1.022590
CASE =

REACTANT		MOLES	ENERGY KJ/KG-MOL	TEMP K
NAME	O2	48.5000000	0.000	298.150
NAME	paraffin	1.0000000	-698520.000	298.150

O/F= 0.00000 %FUEL= 0.000000 R,EQ.RATIO= 1.000000 PHI,EQ.RATIO= 0.000000

	INJECTOR	COMB END	THROAT	EXIT
Pinj/P	1.0000	1.0467	1.7658	14746.0
P, BAR	100.00	95.535	56.631	0.00678
T, K	3791.06	3779.54	3610.28	1749.42
RHO, KG/CU M	8.0239 0	7.6913 0	4.8413 0	1.4270-3
H, KJ/KG	-348.77	-377.80	-1008.14	-7937.79
U, KJ/KG	-1595.05	-1619.92	-2177.88	-8413.01
G, KJ/KG	-40788.9	-40722.9	-39546.4	-26612.1
S, KJ/(KG)(K)	10.6672	10.6746	10.6746	10.6746
M, (1/n)	25.292	25.299	25.662	30.608
(dLV/dLP)t	-1.05498	-1.05494	-1.05186	-1.00224
(dLV/dLT)p	1.9212	1.9234	1.9155	1.0845
Cp, KJ/(KG)(K)	7.0584	7.0846	7.2112	2.6397
GAMMAs	1.1324	1.1321	1.1274	1.1348
SON VEL,M/SEC	1188.0	1185.8	1148.4	734.4
MACH NUMBER	0.000	0.203	1.000	5.305

PERFORMANCE PARAMETERS

Ae/At	3.0001	1.0000	1000.00
CSTAR, M/SEC	1759.0	1759.0	1759.0
CF	0.1370	0.6529	2.2149
Ivac, M/SEC	5396.3	2167.0	4017.9
Isp, M/SEC	240.9	1148.4	3895.9

FileEditor:paraffin.out

MOLE FRACTIONS

*CO	0.20864	0.20839	0.19846	0.00935
*CO2	0.19542	0.19579	0.21153	0.47970
COOH	0.00003	0.00003	0.00002	0.00000
*H	0.02149	0.02150	0.01922	0.00015
HCO	0.00002	0.00002	0.00001	0.00000
HO2	0.00040	0.00039	0.00028	0.00000
*H2	0.03904	0.03903	0.03682	0.00270
H2O	0.31708	0.31740	0.33113	0.50064
H2O2	0.00004	0.00004	0.00003	0.00000
*O	0.02907	0.02901	0.02530	0.00007
*OH	0.09917	0.09883	0.09016	0.00183
*O2	0.08958	0.08957	0.08704	0.00557

* 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)			