

FileEditor:paraffin.out

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

problem

```
rocket fac ac/at=3.0 tcest,k=3800
p,bar=100,
sup,ae/at=100000,
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 =100000.0000

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

REACTANT	MOLES	(ENERGY/R),K	TEMP,K	DENSITY
EXPLODED FORMULA				
N: O2	48.500000	-0.154035E-05	298.15	0.0000
O	2.000000			
N: paraffin	1.000000	-0.840122E+05	298.15	0.0000
C	32.000000			
H	66.000000			

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

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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

	EFFECTIVE FUEL	EFFECTIVE OXIDANT	MIXTURE
ENTHALPY	h(2)/R	h(1)/R	h0/R
(KG-MOL)(K)/KG	-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					

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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	8	467.797	-28.105	-84.461	-35.239
4	7	708.909	-33.777	-37.659	-21.212
4	2	705.690	-31.965	-41.597	-22.218

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 =

NAME	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	4094994.
P, BAR	100.00	95.535	56.631	0.00002
T, K	3791.06	3779.54	3610.28	705.69
RHO, KG/CU M	8.0239 0	7.6913 0	4.8413 0	1.2824-5
H, KJ/KG	-348.77	-377.80	-1008.14	-9746.30
U, KJ/KG	-1595.05	-1619.92	-2177.88	-9936.72
G, KJ/KG	-40788.9	-40722.9	-39546.4	-17279.3
S, KJ/(KG)(K)	10.6672	10.6746	10.6746	10.6746
M, (1/n)	25.292	25.299	25.662	30.812
(dLV/dLP)t	-1.05498	-1.05494	-1.05186	-1.00000
(dLV/dLT)p	1.9212	1.9234	1.9155	1.0000
Cp, KJ/(KG)(K)	7.0584	7.0846	7.2112	1.4127
GAMMAS	1.1324	1.1321	1.1274	1.2361
SON VEL, M/SEC	1188.0	1185.8	1148.4	485.2
MACH NUMBER	0.000	0.203	1.000	8.936

PERFORMANCE PARAMETERS

Ae/At	3.0001	1.0000	100000.0
CSTAR, M/SEC	1759.0	1759.0	1759.0
CF	0.1370	0.6529	2.4647
Ivac, M/SEC	5396.3	2167.0	4379.2
Isp, M/SEC	240.9	1148.4	4335.3

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MOLE FRACTIONS

*CO	0.20864	0.20839	0.19846	0.00000
*CO2	0.19542	0.19579	0.21153	0.49231
COOH	0.00003	0.00003	0.00002	0.00000
*H	0.02149	0.02150	0.01922	0.00000
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	0.00000
H2O	0.31708	0.31740	0.33113	0.50769
H2O2	0.00004	0.00004	0.00003	0.00000
*O	0.02907	0.02901	0.02530	0.00000
*OH	0.09917	0.09883	0.09016	0.00000
*O2	0.08958	0.08957	0.08704	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,isoctane	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)			