

FileEditor:MethaneOx.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

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rocket fac ac/at=3.0 tcest,k=3800
p,bar=100,
sup,ae/at=1000,
react
fuel=CH4 moles=1.0 t,k=298.15
oxid=O2 moles=2.0 t,k=298.15
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				
F: CH4	1.000000	-0.897227E+04	298.15	0.0000
C 1.00000	H 4.00000			
O: O2	2.000000	-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
g 7/00 C2H6	g 8/88 C2H5OH	g 7/00 CH3OCH3
srd 01 CH3O2CH3	g 8/00 C2O	tpis79 *C3

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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 = 3.989263

ENTHALPY	EFFECTIVE FUEL	EFFECTIVE OXIDANT	MIXTURE
(KG-MOL)(K)/KG	h(2)/R	h(1)/R	h0/R
	-0.55928246E+03	-0.48137850E-07	-0.11209720E+03

KG-FORM.WT./KG	bi(2)	bi(1)	b0i
*C	0.62334580E-01	0.00000000E+00	0.12493744E-01
*H	0.24933832E+00	0.00000000E+00	0.49974975E-01
*O	0.00000000E+00	0.62502344E-01	0.49974975E-01

POINT	ITN	T	C	H	O
1	22	3680.166	-16.311	-9.973	-14.606
2	2	3673.417	-16.336	-9.991	-14.623
Pinf/Pt = 1.728726					
3	3	3500.561	-16.742	-10.212	-14.819
Pinf/Pt = 1.725874					
3	2	3501.062	-16.741	-10.212	-14.818
4	2	3666.888	-16.351	-9.999	-14.630
4	2	3665.860	-16.353	-10.000	-14.631
4	2	3665.772	-16.354	-10.000	-14.632
2	2	3676.886	-16.323	-9.982	-14.614
Pinf/Pt = 1.728786					
3	3	3503.649	-16.729	-10.203	-14.809

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Pinf/Pt = 1.725934

3	2	3504.152	-16.728	-10.203	-14.809
4	2	3670.342	-16.338	-9.990	-14.621
4	2	3669.313	-16.340	-9.991	-14.622
4	2	3669.224	-16.340	-9.991	-14.622
END OF CHAMBER ITERATIONS					
4	7	1217.975	-31.833	-17.120	-21.775
4	5	1463.068	-28.147	-15.667	-20.238
4	2	1461.940	-28.161	-15.673	-20.244

THEORETICAL ROCKET PERFORMANCE ASSUMING EQUILIBRIUM

COMPOSITION DURING EXPANSION FROM FINITE AREA COMBUSTOR

Pin = 1450.4 PSIA

Ac/At = 3.0000 Pinj/Pinf = 1.022564

CASE =

	REACTANT	MOLES	ENERGY KJ/KG-MOL	TEMP K
FUEL	CH4	1.0000000	-74600.000	298.150
OXIDANT	O2	2.0000000	0.000	298.150

O/F= 3.98926 %FUEL= 20.043038 R,EQ.RATIO= 1.000000 PHI,EQ.RATIO= 1.000000

	INJECTOR	COMB END	THROAT	EXIT
Pinj/P	1.0000	1.0467	1.7649	16490.8
P, BAR	100.00	95.540	56.661	0.00606
T, K	3680.17	3669.22	3504.15	1461.94
RHO, KG/CU M	7.4634 0	7.1538 0	4.5014 0	1.3303-3
H, KJ/KG	-932.03	-963.20	-1640.61	-9045.29
U, KJ/KG	-2271.91	-2298.73	-2899.34	-9501.13
G, KJ/KG	-43821.1	-43754.6	-42506.9	-26094.8
S, KJ/(KG)(K)	11.6541	11.6622	11.6622	11.6622
M, (1/n)	22.837	22.843	23.147	26.666
(dLV/dLP)t	-1.04656	-1.04651	-1.04311	-1.00018
(dLV/dLT)p	1.8037	1.8053	1.7840	1.0079
Cp, KJ/(KG)(K)	7.3240	7.3472	7.3799	2.0085
GAMMAS	1.1302	1.1299	1.1259	1.1870
SON VEL, M/SEC	1230.6	1228.4	1190.4	735.6
MACH NUMBER	0.000	0.203	1.000	5.476

PERFORMANCE PARAMETERS

Ae/At	3.0001	1.0000	1000.00
CSTAR, M/SEC	1824.9	1824.9	1824.9
CF	0.1368	0.6523	2.2073
Ivac, M/SEC	5598.6	2247.8	4141.4
Isp, M/SEC	249.7	1190.4	4028.2

MOLE FRACTIONS

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*CO	0.13951	0.13930	0.13135	0.00054
*CO2	0.14578	0.14606	0.15782	0.33262
COOH	0.00002	0.00002	0.00001	0.00000
*H	0.01983	0.01983	0.01739	0.00000
HCO	0.00001	0.00001	0.00001	0.00000
HO2	0.00034	0.00033	0.00023	0.00000
*H2	0.05172	0.05168	0.04808	0.00045
H2O	0.46104	0.46143	0.47867	0.66580
H2O2	0.00005	0.00005	0.00003	0.00000
*O	0.01961	0.01956	0.01675	0.00000
*OH	0.09544	0.09509	0.08554	0.00013
*O2	0.06664	0.06664	0.06412	0.00046

* 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)			