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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=LMP130S o/f=2,4,6,8,10,
  rocket frozen nfz=1
  p,bar=20,25,30,
react
  oxid=H2O(L) wt=100
  oxid=CH3OH(L) wt=100
  oxid=NH3(L) wt=100
  fuel=C2H5OH(L) 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=T EQL=F 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 25.000000 30.000000

Pc/P =

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				
O: H2O(L)	0.333333	0.000000E+00	0.00	0.0000
H 2.00000	O 1.00000			
O: CH3OH(L)	0.333333	0.000000E+00	0.00	0.0000
C 1.00000	H 4.00000	O 1.00000		
O: NH3(L)	0.333333	-0.860604E+04	239.72	0.0000
N 1.00000	H 3.00000			
F: C2H5OH(L)	1.000000	0.000000E+00	0.00	0.0000
C 2.00000	H 6.00000	O 1.00000		

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
g 8/99 *CN	g12/99 CNN	tpis79 *CO
g 9/99 *CO2	tpis91 COOH	tpis91 *C2
g 6/01 C2H	g 1/91 C2H2,acetylene	g 5/01 C2H2,vinylidene

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g 4/02	CH2CO, ketene	g 3/02	O(CH)2O	srd 01	HO(CO)2OH
g 7/01	C2H3, vinyl	g 9/00	CH3CN	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	CH3N2CH3	g 8/88	C2H5OH
g 7/00	CH3OCH3	srd 01	CH3O2CH3	g 7/00	CCN
tpis91	CNC	srd 01	OCCN	tpis79	C2N2
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
srd 01	CNCOCN	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 6/01	C4N2	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 6/01	HCN	g 1/01	HCO
tpis89	HCCN	g 6/01	HCCO	g 6/01	HNC
g 7/00	HNCO	g10/01	HNO	tpis89	HNO2
g 5/99	HNO3	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	*N
g 6/01	NCO	g 4/99	*NH	g 3/01	NH2
tpis89	NH3	tpis89	NH2OH	tpis89	*NO
g 4/99	NO2	j12/64	NO3	tpis78	*N2
g 6/01	NCN	g 5/99	N2H2	tpis89	NH2NO2
g 4/99	N2H4	g 4/99	N2O	g 4/99	N2O3
tpis89	N2O4	g 4/99	N2O5	tpis89	N3
g 4/99	N3H	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 = 2.000000

	EFFECTIVE FUEL	EFFECTIVE OXIDANT	MIXTURE
ENTHALPY	h(2)/R	h(1)/R	h0/R
(KG-MOL) (K) /KG	0.00000000E+00	-0.16844346E+03	-0.11229564E+03
KG-FORM.WT./KG	bi(2)	bi(1)	b0i

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*H	0.13024101E+00	0.13733597E+00	0.13497098E+00
*O	0.21706834E-01	0.28905870E-01	0.26506191E-01
*C	0.43413669E-01	0.10403058E-01	0.21406595E-01
*N	0.00000000E+00	0.19572704E-01	0.13048470E-01

POINT	ITN	T	H	O	C	N
1	18	1327.205	-7.854	-31.829	-3.168	-12.650

THEORETICAL ROCKET PERFORMANCE ASSUMING FROZEN COMPOSITION

Pin = 290.1 PSIA
CASE = LMP130S

	REACTANT	WT FRACTION (SEE NOTE)	ENERGY KJ/KG-MOL	TEMP K
OXIDANT	H2O (L)	0.3333333	0.000	0.000
OXIDANT	CH3OH (L)	0.3333333	0.000	0.000
OXIDANT	NH3 (L)	0.3333333	-71555.000	239.720
FUEL	C2H5OH (L)	1.0000000	0.000	0.000

O/F= 2.00000 %FUEL= 33.333333 R,EQ.RATIO= 4.161242 PHI,EQ.RATIO=-1.075159

	CHAMBER	THROAT
Pinf/P	1.0000	1.8523
P, BAR	20.000	10.797
T, K	1327.21	1140.89
RHO, KG/CU M	1.9621 0	1.2322 0
H, KJ/KG	-933.68	-1517.03
U, KJ/KG	-1953.01	-2393.27
G, KJ/KG	-23577.7	-20982.3
S, KJ/(KG) (K)	17.0614	17.0614
M, (1/n)	10.826	10.826
Cp, KJ/(KG) (K)	3.1763	3.0849
GAMMAS	1.3189	1.3315
SON VEL,M/SEC	1159.5	1080.1
MACH NUMBER	0.000	1.000

PERFORMANCE PARAMETERS

Ae/At	1.0000
CSTAR, M/SEC	1502.6
CF	0.7188
Ivac, M/SEC	1891.4
Isp, M/SEC	1080.1

MOLE FRACTIONS

CH4	0.01632	*CO	0.20491	*CO2	0.01049
HCN	0.00002	*H2	0.63643	H2O	0.06105
NH3	0.00030	*N2	0.07047		

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* THERMODYNAMIC PROPERTIES FITTED TO 20000.K

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

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

POINT	ITN	T	H	O	C	N
1	3	1342.807	-7.762	-31.536	-3.164	-12.554

THEORETICAL ROCKET PERFORMANCE ASSUMING FROZEN COMPOSITION

Pin = 362.6 PSIA
CASE = LMP130S

	REACTANT	WT FRACTION (SEE NOTE)	ENERGY KJ/KG-MOL	TEMP K
OXIDANT	H2O (L)	0.3333333	0.000	0.000
OXIDANT	CH3OH (L)	0.3333333	0.000	0.000
OXIDANT	NH3 (L)	0.3333333	-71555.000	239.720
FUEL	C2H5OH (L)	1.0000000	0.000	0.000

O/F= 2.00000 %FUEL= 33.333333 R,EQ.RATIO= 4.161242 PHI,EQ.RATIO=-1.075159

	CHAMBER	THROAT
Pinf/P	1.0000	1.8505
P, BAR	25.000	13.510
T, K	1342.81	1155.84
RHO, KG/CU M	2.4357 0	1.5292 0
H, KJ/KG	-933.68	-1520.49
U, KJ/KG	-1960.07	-2403.96
G, KJ/KG	-23614.3	-21043.0
S, KJ/(KG) (K)	16.8904	16.8904
M, (1/n)	10.878	10.878
Cp, KJ/(KG) (K)	3.1843	3.0917
GAMMA _s	1.3159	1.3284
SON VEL,M/SEC	1162.1	1083.3
MACH NUMBER	0.000	1.000

PERFORMANCE PARAMETERS

Ae/At 1.0000

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CSTAR, M/SEC	1509.1
CF	0.7179
Ivac, M/SEC	1898.8
Isp, M/SEC	1083.3

MOLE FRACTIONS

CH4	0.01876	*CO	0.20348	*CO2	0.01058
HCN	0.00002	*H2	0.63233	H2O	0.06369
NH3	0.00035	*N2	0.07078		

* THERMODYNAMIC PROPERTIES FITTED TO 20000.K

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

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

POINT	ITN	T	H	O	C	N
1	3	1356.169	-7.687	-31.290	-3.165	-12.475

THEORETICAL ROCKET PERFORMANCE ASSUMING FROZEN COMPOSITION

Pin = 435.1 PSIA
CASE = LMP130S

	REACTANT	WT FRACTION (SEE NOTE)	ENERGY KJ/KG-MOL	TEMP K
OXIDANT	H2O (L)	0.3333333	0.000	0.000
OXIDANT	CH3OH (L)	0.3333333	0.000	0.000
OXIDANT	NH3 (L)	0.3333333	-71555.000	239.720
FUEL	C2H5OH (L)	1.0000000	0.000	0.000

O/F= 2.00000 %FUEL= 33.333333 R,EQ.RATIO= 4.161242 PHI,EQ.RATIO=-1.075159

	CHAMBER	THROAT
Pinf/P	1.0000	1.8489
P, BAR	30.000	16.226
T, K	1356.17	1168.66
RHO, KG/CU M	2.9061 0	1.8240 0
H, KJ/KG	-933.68	-1523.39
U, KJ/KG	-1966.01	-2412.98
G, KJ/KG	-23651.3	-21100.1
S, KJ/(KG) (K)	16.7513	16.7513

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M, (1/n)	10.923	10.923
Cp, KJ/(KG) (K)	3.1911	3.0978
GAMMAS	1.3133	1.3258
SON VEL,M/SEC	1164.3	1086.0
MACH NUMBER	0.000	1.000

PERFORMANCE PARAMETERS

Ae/At	1.0000
CSTAR, M/SEC	1514.5
CF	0.7171
IvaC, M/SEC	1905.1
Isp, M/SEC	1086.0

MOLE FRACTIONS

CH4	0.02089	*CO	0.20224	*CO2	0.01066
HCN	0.00003	*H2	0.62877	H2O	0.06597
NH3	0.00040	*N2	0.07105		

* THERMODYNAMIC PROPERTIES FITTED TO 20000.K

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

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

O/F = 4.000000

	EFFECTIVE FUEL h(2)/R	EFFECTIVE OXIDANT h(1)/R	MIXTURE h0/R
ENTHALPY (KG-MOL) (K) /KG	0.00000000E+00	-0.16844346E+03	-0.13475477E+03
KG-FORM.WT./KG	bi(2)	bi(1)	b0i
*H	0.13024101E+00	0.13733597E+00	0.13591698E+00
*O	0.21706834E-01	0.28905870E-01	0.27466063E-01
*C	0.43413669E-01	0.10403058E-01	0.17005180E-01
*N	0.00000000E+00	0.19572704E-01	0.15658164E-01

POINT	ITN	T	H	O	C	N
1	5	1439.245	-7.975	-29.662	-4.985	-12.680

THEORETICAL ROCKET PERFORMANCE ASSUMING FROZEN COMPOSITION

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Pin = 290.1 PSIA
CASE = LMP130S

	REACTANT	WT FRACTION (SEE NOTE)	ENERGY KJ/KG-MOL	TEMP K
OXIDANT	H2O (L)	0.3333333	0.000	0.000
OXIDANT	CH3OH (L)	0.3333333	0.000	0.000
OXIDANT	NH3 (L)	0.3333333	-71555.000	239.720
FUEL	C2H5OH (L)	1.0000000	0.000	0.000

O/F= 4.00000 %FUEL= 20.000000 R,EQ.RATIO= 3.712540 PHI,EQ.RATIO=-0.537580

	CHAMBER	THROAT
Pinf/P	1.0000	1.8501
P, BAR	20.000	10.810
T, K	1439.24	1239.14
RHO, KG/CU M	1.8072 0	1.1346 0
H, KJ/KG	-1120.42	-1753.02
U, KJ/KG	-2227.08	-2705.82
G, KJ/KG	-26110.3	-23268.5
S, KJ/(KG) (K)	17.3632	17.3632

M, (1/n)	10.813	10.813
Cp, KJ/(KG) (K)	3.2073	3.1141
GAMMA _s	1.3153	1.3279
SON VEL, M/SEC	1206.5	1124.8
MACH NUMBER	0.000	1.000

PERFORMANCE PARAMETERS

Ae/At	1.0000
CSTAR, M/SEC	1567.2
CF	0.7177
Ivac, M/SEC	1971.9
Isp, M/SEC	1124.8

MOLE FRACTIONS

CH4	0.00158	*CO	0.17036	*CO2	0.01193
HCN	0.00001	*H2	0.62858	H2O	0.10277
NH3	0.00022	*N2	0.08454		

* THERMODYNAMIC PROPERTIES FITTED TO 20000.K

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

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

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POINT	ITN	T	H	O	C	N
1	3	1443.865	-7.869	-29.590	-4.817	-12.573

THEORETICAL ROCKET PERFORMANCE ASSUMING FROZEN COMPOSITION

Pin = 362.6 PSIA
CASE = LMP130S

	REACTANT	WT FRACTION (SEE NOTE)	ENERGY KJ/KG-MOL	TEMP K
OXIDANT	H2O (L)	0.3333333	0.000	0.000
OXIDANT	CH3OH (L)	0.3333333	0.000	0.000
OXIDANT	NH3 (L)	0.3333333	-71555.000	239.720
FUEL	C2H5OH (L)	1.0000000	0.000	0.000

O/F= 4.00000 %FUEL= 20.000000 R,EQ.RATIO= 3.712540 PHI,EQ.RATIO=-0.537580

	CHAMBER	THROAT
Pinf/P	1.0000	1.8496
P, BAR	25.000	13.517
T, K	1443.86	1243.61
RHO, KG/CU M	2.2551 0	1.4156 0
H, KJ/KG	-1120.42	-1753.93
U, KJ/KG	-2229.02	-2708.78
G, KJ/KG	-25942.9	-23133.8
S, KJ/(KG) (K)	17.1917	17.1917

M, (1/n)	10.829	10.829
Cp, KJ/(KG) (K)	3.2097	3.1162
GAMMA _s	1.3144	1.3269
SON VEL, M/SEC	1207.1	1125.6
MACH NUMBER	0.000	1.000

PERFORMANCE PARAMETERS

Ae/At	1.0000
CSTAR, M/SEC	1569.0
CF	0.7174
Ivac, M/SEC	1973.9
Isp, M/SEC	1125.6

MOLE FRACTIONS

CH4	0.00228	*CO	0.16992	*CO2	0.01193
HCN	0.00001	*H2	0.62729	H2O	0.10365
NH3	0.00027	*N2	0.08464		

* THERMODYNAMIC PROPERTIES FITTED TO 20000.K

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

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

POINT	ITN	T	H	O	C	N
1	3	1448.742	-7.784	-29.514	-4.693	-12.486

THEORETICAL ROCKET PERFORMANCE ASSUMING FROZEN COMPOSITION

Pin = 435.1 PSIA
CASE = LMP130S

	REACTANT	WT FRACTION (SEE NOTE)	ENERGY KJ/KG-MOL	TEMP K
OXIDANT	H2O (L)	0.3333333	0.000	0.000
OXIDANT	CH3OH (L)	0.3333333	0.000	0.000
OXIDANT	NH3 (L)	0.3333333	-71555.000	239.720
FUEL	C2H5OH (L)	1.0000000	0.000	0.000

O/F= 4.00000 %FUEL= 20.000000 R,EQ.RATIO= 3.712540 PHI,EQ.RATIO=-0.537580

	CHAMBER	THROAT
Pinf/P	1.0000	1.8490
P, BAR	30.000	16.225
T, K	1448.74	1248.34
RHO, KG/CU M	2.7011 0	1.6954 0
H, KJ/KG	-1120.42	-1754.90
U, KJ/KG	-2231.06	-2711.90
G, KJ/KG	-25824.1	-23041.4
S, KJ/(KG) (K)	17.0518	17.0518
M, (1/n)	10.846	10.846
Cp, KJ/(KG) (K)	3.2121	3.1185
GAMMAS	1.3135	1.3260
SON VEL,M/SEC	1207.8	1126.5
MACH NUMBER	0.000	1.000

PERFORMANCE PARAMETERS

Ae/At	1.0000
CSTAR, M/SEC	1570.8
CF	0.7171
Ivac, M/SEC	1976.0
Isp, M/SEC	1126.5

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MOLE FRACTIONS

CH4	0.00303	*CO	0.16946	*CO2	0.01193
HCN	0.00002	*H2	0.62593	H2O	0.10458
NH3	0.00032	*N2	0.08475		

* THERMODYNAMIC PROPERTIES FITTED TO 20000.K

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

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

O/F = 6.000000

ENTHALPY (KG-MOL) (K) /KG	EFFECTIVE FUEL h(2) /R	EFFECTIVE OXIDANT h(1) /R	MIXTURE h0/R
	0.00000000E+00	-0.16844346E+03	-0.14438011E+03

KG-FORM.WT./KG	bi(2)	bi(1)	b0i
*H	0.13024101E+00	0.13733597E+00	0.13632240E+00
*O	0.21706834E-01	0.28905870E-01	0.27877436E-01
*C	0.43413669E-01	0.10403058E-01	0.15118860E-01
*N	0.00000000E+00	0.19572704E-01	0.16776604E-01

POINT	ITN	T	H	O	C	N
1	4	1519.498	-8.064	-28.407	-6.030	-12.724

THEORETICAL ROCKET PERFORMANCE ASSUMING FROZEN COMPOSITION

Pin = 290.1 PSIA
CASE = LMP130S

	REACTANT	WT FRACTION (SEE NOTE)	ENERGY KJ/KG-MOL	TEMP K
OXIDANT	H2O (L)	0.3333333	0.000	0.000
OXIDANT	CH3OH (L)	0.3333333	0.000	0.000
OXIDANT	NH3 (L)	0.3333333	-71555.000	239.720
FUEL	C2H5OH (L)	1.0000000	0.000	0.000

O/F= 6.00000 %FUEL= 14.285714 R,EQ.RATIO= 3.529698 PHI,EQ.RATIO=-0.358386

	CHAMBER	THROAT
Pinf/P	1.0000	1.8454

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P, BAR	20.000	10.838
T, K	1519.50	1312.64
RHO, KG/CU M	1.7286 0	1.0843 0
H, KJ/KG	-1200.45	-1860.13
U, KJ/KG	-2357.46	-2859.63
G, KJ/KG	-27741.7	-24788.2
S, KJ/(KG) (K)	17.4671	17.4671

M, (1/n)	10.919	10.919
Cp, KJ/(KG) (K)	3.2357	3.1407
GAMMAS	1.3077	1.3200
SON VEL,M/SEC	1230.1	1148.6
MACH NUMBER	0.000	1.000

PERFORMANCE PARAMETERS

Ae/At	1.0000
CSTAR, M/SEC	1605.8
CF	0.7153
Ivac, M/SEC	2018.8
Isp, M/SEC	1148.6

MOLE FRACTIONS

CH4	0.00040	*CO	0.15280	*CO2	0.01189
HCN	0.00001	*H2	0.61540	H2O	0.12783
NH3	0.00017	*N2	0.09151		

* THERMODYNAMIC PROPERTIES FITTED TO 20000.K

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

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

POINT	ITN	T	H	O	C	N
1	3	1520.892	-7.954	-28.387	-5.822	-12.613

THEORETICAL ROCKET PERFORMANCE ASSUMING FROZEN COMPOSITION

Pin = 362.6 PSIA
CASE = LMP130S

REACTANT	WT FRACTION	ENERGY	TEMP
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FileEditor:LMP103S0907.out

		(SEE NOTE)	KJ/KG-MOL	K
OXIDANT	H2O (L)	0.3333333	0.000	0.000
OXIDANT	CH3OH (L)	0.3333333	0.000	0.000
OXIDANT	NH3 (L)	0.3333333	-71555.000	239.720
FUEL	C2H5OH (L)	1.0000000	0.000	0.000

O/F= 6.00000 %FUEL= 14.285714 R,EQ.RATIO= 3.529698 PHI,EQ.RATIO=-0.358386

	CHAMBER	THROAT
Pinf/P	1.0000	1.8452
P, BAR	25.000	13.549
T, K	1520.89	1314.00
RHO, KG/CU M	2.1598 0	1.3548 0
H, KJ/KG	-1200.45	-1860.37
U, KJ/KG	-2357.98	-2860.44
G, KJ/KG	-27507.7	-24589.0
S, KJ/(KG) (K)	17.2973	17.2973

M, (1/n)	10.925	10.925
Cp, KJ/(KG) (K)	3.2365	3.1414
GAMMAS	1.3075	1.3197
SON VEL,M/SEC	1230.2	1148.8
MACH NUMBER	0.000	1.000

PERFORMANCE PARAMETERS

Ae/At	1.0000
CSTAR, M/SEC	1606.2
CF	0.7152
IvaC, M/SEC	2019.3
Isp, M/SEC	1148.8

MOLE FRACTIONS

CH4	0.00060	*CO	0.15266	*CO2	0.01189
HCN	0.00001	*H2	0.61498	H2O	0.12811
NH3	0.00021	*N2	0.09153		

* THERMODYNAMIC PROPERTIES FITTED TO 20000.K

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

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

POINT	ITN	T	H	O	C	N
1	3	1522.506	-7.865	-28.364	-5.657	-12.524

THEORETICAL ROCKET PERFORMANCE ASSUMING FROZEN COMPOSITION

Pin = 435.1 PSIA
CASE = LMP130S

	REACTANT	WT FRACTION (SEE NOTE)	ENERGY KJ/KG-MOL	TEMP K
OXIDANT	H2O (L)	0.3333333	0.000	0.000
OXIDANT	CH3OH (L)	0.3333333	0.000	0.000
OXIDANT	NH3 (L)	0.3333333	-71555.000	239.720
FUEL	C2H5OH (L)	1.0000000	0.000	0.000

O/F= 6.00000 %FUEL= 14.285714 R,EQ.RATIO= 3.529698 PHI,EQ.RATIO=-0.358386

	CHAMBER	THROAT
Pinf/P	1.0000	1.8450
P, BAR	30.000	16.260
T, K	1522.51	1315.58
RHO, KG/CU M	2.5904 0	1.6248 0
H, KJ/KG	-1200.45	-1860.65
U, KJ/KG	-2358.59	-2861.39
G, KJ/KG	-27324.4	-24434.1
S, KJ/ (KG) (K)	17.1585	17.1585
M, (1/n)	10.930	10.930
Cp, KJ/ (KG) (K)	3.2373	3.1422
GAMMAS	1.3071	1.3194
SON VEL,M/SEC	1230.4	1149.1
MACH NUMBER	0.000	1.000

PERFORMANCE PARAMETERS

Ae/At	1.0000
CSTAR, M/SEC	1606.8
CF	0.7151
Ivac, M/SEC	2020.0
Isp, M/SEC	1149.1

MOLE FRACTIONS

CH4	0.00085	*CO	0.15251	*CO2	0.01188
HCN	0.00001	*H2	0.61450	H2O	0.12843
NH3	0.00025	*N2	0.09155		

* THERMODYNAMIC PROPERTIES FITTED TO 20000.K

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

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

O/F = 8.000000

	EFFECTIVE FUEL	EFFECTIVE OXIDANT	MIXTURE
ENTHALPY	h(2)/R	h(1)/R	h0/R
(KG-MOL) (K) /KG	0.00000000E+00	-0.16844346E+03	-0.14972752E+03
KG-FORM.WT./KG	bi(2)	bi(1)	b0i
*H	0.13024101E+00	0.13733597E+00	0.13654764E+00
*O	0.21706834E-01	0.28905870E-01	0.28105977E-01
*C	0.43413669E-01	0.10403058E-01	0.14070904E-01
*N	0.00000000E+00	0.19572704E-01	0.17397959E-01

POINT	ITN	T	H	O	C	N
1	3	1566.595	-8.116	-27.737	-6.601	-12.750

THEORETICAL ROCKET PERFORMANCE ASSUMING FROZEN COMPOSITION

Pin = 290.1 PSIA
CASE = LMP130S

	REACTANT	WT FRACTION	ENERGY	TEMP
		(SEE NOTE)	KJ/KG-MOL	K
OXIDANT	H2O (L)	0.3333333	0.000	0.000
OXIDANT	CH3OH (L)	0.3333333	0.000	0.000
OXIDANT	NH3 (L)	0.3333333	-71555.000	239.720
FUEL	C2H5OH (L)	1.0000000	0.000	0.000

O/F= 8.00000 %FUEL= 11.111111 R,EQ.RATIO= 3.430431 PHI,EQ.RATIO=-0.268790

	CHAMBER	THROAT
Pinf/P	1.0000	1.8424
P, BAR	20.000	10.855
T, K	1566.60	1356.13
RHO, KG/CU M	1.6874 0	1.0580 0
H, KJ/KG	-1244.91	-1919.62
U, KJ/KG	-2430.17	-2945.65
G, KJ/KG	-28687.8	-25675.7
S, KJ/(KG) (K)	17.5176	17.5176
M, (1/n)	10.990	10.990
Cp, KJ/(KG) (K)	3.2528	3.1570
GAMMA	1.3031	1.3152
SON VEL,M/SEC	1242.8	1161.6
MACH NUMBER	0.000	1.000

PERFORMANCE PARAMETERS

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Ae/At	1.0000
CSTAR, M/SEC	1627.3
CF	0.7138
Ivac, M/SEC	2044.9
Isp, M/SEC	1161.6

MOLE FRACTIONS

CH4	0.00019	*CO	0.14273	*CO2	0.01171
*H	0.00001	HCN	0.00001	*H2	0.60697
H2O	0.14272	NH3	0.00015	*N2	0.09552

* THERMODYNAMIC PROPERTIES FITTED TO 20000.K

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

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

POINT	ITN	T	H	O	C	N
1	3	1567.293	-8.005	-27.728	-6.385	-12.639

THEORETICAL ROCKET PERFORMANCE ASSUMING FROZEN COMPOSITION

Pin = 362.6 PSIA
CASE = LMP130S

	REACTANT	WT FRACTION (SEE NOTE)	ENERGY KJ/KG-MOL	TEMP K
OXIDANT	H2O (L)	0.3333333	0.000	0.000
OXIDANT	CH3OH (L)	0.3333333	0.000	0.000
OXIDANT	NH3 (L)	0.3333333	-71555.000	239.720
FUEL	C2H5OH (L)	1.0000000	0.000	0.000

O/F= 8.00000 %FUEL= 11.111111 R,EQ.RATIO= 3.430431 PHI,EQ.RATIO=-0.268790

	CHAMBER	THROAT
Pinf/P	1.0000	1.8423
P, BAR	25.000	13.570
T, K	1567.29	1356.82
RHO, KG/CU M	2.1088 0	1.3222 0
H, KJ/KG	-1244.91	-1919.73
U, KJ/KG	-2430.41	-2946.03

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G, KJ/KG	-28435.5	-25458.8
S, KJ/(KG) (K)	17.3488	17.3488
M, (1/n)	10.992	10.992
Cp, KJ/(KG) (K)	3.2531	3.1573
GAMMAS	1.3030	1.3150
SON VEL,M/SEC	1242.8	1161.7
MACH NUMBER	0.000	1.000

PERFORMANCE PARAMETERS

Ae/At	1.0000
CSTAR, M/SEC	1627.6
CF	0.7138
IvaC, M/SEC	2045.2
Isp, M/SEC	1161.7

MOLE FRACTIONS

CH4	0.00029	*CO	0.14266	*CO2	0.01171
*H	0.00001	HCN	0.00001	*H2	0.60675
H2O	0.14286	NH3	0.00019	*N2	0.09552

* THERMODYNAMIC PROPERTIES FITTED TO 20000.K

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

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

POINT	ITN	T	H	O	C	N
1	3	1568.113	-7.915	-27.717	-6.211	-12.548

THEORETICAL ROCKET PERFORMANCE ASSUMING FROZEN COMPOSITION

Pin = 435.1 PSIA
CASE = LMP130S

	REACTANT	WT FRACTION (SEE NOTE)	ENERGY KJ/KG-MOL	TEMP K
OXIDANT	H2O (L)	0.3333333	0.000	0.000
OXIDANT	CH3OH (L)	0.3333333	0.000	0.000
OXIDANT	NH3 (L)	0.3333333	-71555.000	239.720
FUEL	C2H5OH (L)	1.0000000	0.000	0.000

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O/F= 8.00000 %FUEL= 11.111111 R,EQ.RATIO= 3.430431 PHI,EQ.RATIO=-0.268790

	CHAMBER	THROAT
Pinf/P	1.0000	1.8422
P, BAR	30.000	16.285
T, K	1568.11	1357.63
RHO, KG/CU M	2.5300 0	1.5862 0
H, KJ/KG	-1244.91	-1919.85
U, KJ/KG	-2430.70	-2946.47
G, KJ/KG	-28233.5	-25285.8
S, KJ/(KG) (K)	17.2109	17.2109
M, (1/n)	10.995	10.995
Cp, KJ/(KG) (K)	3.2536	3.1577
GAMMAS	1.3028	1.3149
SON VEL,M/SEC	1242.9	1161.8
MACH NUMBER	0.000	1.000

PERFORMANCE PARAMETERS

Ae/At	1.0000
CSTAR, M/SEC	1627.8
CF	0.7137
Ivac, M/SEC	2045.5
Isp, M/SEC	1161.8

MOLE FRACTIONS

CH4	0.00041	*CO	0.14259	*CO2	0.01171
*H	0.00001	HCN	0.00001	*H2	0.60650
H2O	0.14303	NH3	0.00022	*N2	0.09553

* THERMODYNAMIC PROPERTIES FITTED TO 20000.K

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

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

O/F = 10.000000

	EFFECTIVE FUEL	EFFECTIVE OXIDANT	MIXTURE
ENTHALPY	h(2)/R	h(1)/R	h0/R
(KG-MOL) (K) /KG	0.00000000E+00	-0.16844346E+03	-0.15313042E+03
KG-FORM.WT./KG	bi(2)	bi(1)	b0i
*H	0.13024101E+00	0.13733597E+00	0.13669097E+00
*O	0.21706834E-01	0.28905870E-01	0.28251412E-01
*C	0.43413669E-01	0.10403058E-01	0.13404023E-01

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*N 0.00000000E+00 0.19572704E-01 0.17793368E-01

POINT	ITN	T	H	O	C	N
1	3	1596.826	-8.149	-27.330	-6.954	-12.766

THEORETICAL ROCKET PERFORMANCE ASSUMING FROZEN COMPOSITION

Pin = 290.1 PSIA
CASE = LMP130S

	REACTANT	WT FRACTION (SEE NOTE)	ENERGY KJ/KG-MOL	TEMP K
OXIDANT	H2O (L)	0.3333333	0.000	0.000
OXIDANT	CH3OH (L)	0.3333333	0.000	0.000
OXIDANT	NH3 (L)	0.3333333	-71555.000	239.720
FUEL	C2H5OH (L)	1.0000000	0.000	0.000

O/F= 10.00000 %FUEL= 9.090909 R,EQ.RATIO= 3.368098 PHI,EQ.RATIO=-0.215032

	CHAMBER	THROAT
Pinf/P	1.0000	1.8405
P, BAR	20.000	10.866
T, K	1596.83	1384.14
RHO, KG/CU M	1.6624 0	1.0420 0
H, KJ/KG	-1273.20	-1957.32
U, KJ/KG	-2476.25	-3000.13
G, KJ/KG	-29292.7	-26244.9
S, KJ/(KG) (K)	17.5470	17.5470

M, (1/n)	11.036	11.036
Cp, KJ/(KG) (K)	3.2637	3.1676
GAMMAS	1.3001	1.3121
SON VEL, M/SEC	1250.6	1169.7
MACH NUMBER	0.000	1.000

PERFORMANCE PARAMETERS

Ae/At	1.00000
CSTAR, M/SEC	1640.8
CF	0.7129
Ivac, M/SEC	2061.2
Isp, M/SEC	1169.7

MOLE FRACTIONS

CH4	0.00012	*CO	0.13626	*CO2	0.01154
*H	0.00001	HCN	0.00001	*H2	0.60138
H2O	0.15243	NH3	0.00014	*N2	0.09811

* THERMODYNAMIC PROPERTIES FITTED TO 20000.K

FileEditor:LMP103S0907.out

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

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

POINT	ITN	T	H	O	C	N
1	3	1597.285	-8.038	-27.324	-6.736	-12.655

THEORETICAL ROCKET PERFORMANCE ASSUMING FROZEN COMPOSITION

Pin = 362.6 PSIA
CASE = LMP130S

	REACTANT	WT FRACTION (SEE NOTE)	ENERGY KJ/KG-MOL	TEMP K
OXIDANT	H2O (L)	0.3333333	0.000	0.000
OXIDANT	CH3OH (L)	0.3333333	0.000	0.000
OXIDANT	NH3 (L)	0.3333333	-71555.000	239.720
FUEL	C2H5OH (L)	1.0000000	0.000	0.000

O/F= 10.00000 %FUEL= 9.090909 R,EQ.RATIO= 3.368098 PHI,EQ.RATIO=-0.215032

	CHAMBER	THROAT
Pinf/P	1.0000	1.8405
P, BAR	25.000	13.584
T, K	1597.28	1384.60
RHO, KG/CU M	2.0778 0	1.3024 0
H, KJ/KG	-1273.20	-1957.39
U, KJ/KG	-2476.40	-3000.36
G, KJ/KG	-29032.3	-26020.2
S, KJ/(KG) (K)	17.3789	17.3789
M, (1/n)	11.038	11.038
Cp, KJ/(KG) (K)	3.2640	3.1678
GAMMAS	1.3000	1.3120
SON VEL,M/SEC	1250.7	1169.8
MACH NUMBER	0.000	1.000

PERFORMANCE PARAMETERS

Ae/At	1.00000
CSTAR, M/SEC	1641.0
CF	0.7129
Ivac, M/SEC	2061.4

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Isp, M/SEC 1169.8

MOLE FRACTIONS

CH4	0.00018	*CO	0.13622	*CO2	0.01154
*H	0.00001	HCN	0.00001	*H2	0.60123
H2O	0.15253	NH3	0.00017	*N2	0.09811

* THERMODYNAMIC PROPERTIES FITTED TO 20000.K

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

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

POINT	ITN	T	H	O	C	N
1	3	1597.823	-7.947	-27.317	-6.559	-12.565

THEORETICAL ROCKET PERFORMANCE ASSUMING FROZEN COMPOSITION

Pin = 435.1 PSIA

CASE = LMP130S

	REACTANT	WT FRACTION (SEE NOTE)	ENERGY KJ/KG-MOL	TEMP K
OXIDANT	H2O (L)	0.3333333	0.000	0.000
OXIDANT	CH3OH (L)	0.3333333	0.000	0.000
OXIDANT	NH3 (L)	0.3333333	-71555.000	239.720
FUEL	C2H5OH (L)	1.0000000	0.000	0.000

O/F= 10.00000 %FUEL= 9.090909 R,EQ.RATIO= 3.368098 PHI,EQ.RATIO=-0.215032

	CHAMBER	THROAT
Pinf/P	1.0000	1.8404
P, BAR	30.000	16.301
T, K	1597.82	1385.13
RHO, KG/CU M	2.4930 0	1.5626 0
H, KJ/KG	-1273.20	-1957.46
U, KJ/KG	-2476.57	-3000.64
G, KJ/KG	-28822.2	-25839.3
S, KJ/(KG) (K)	17.2416	17.2416
M, (1/n)	11.040	11.040
Cp, KJ/(KG) (K)	3.2643	3.1681

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GAMMAS	1.2999	1.3119
SON VEL,M/SEC	1250.7	1169.8
MACH NUMBER	0.000	1.000

PERFORMANCE PARAMETERS

Ae/At	1.0000
CSTAR, M/SEC	1641.1
CF	0.7128
Ivac, M/SEC	2061.6
Isp, M/SEC	1169.8

MOLE FRACTIONS

CH4	0.00026	*CO	0.13617	*CO2	0.01154
*H	0.00001	HCN	0.00001	*H2	0.60106
H2O	0.15264	NH3	0.00021	*N2	0.09811

* THERMODYNAMIC PROPERTIES FITTED TO 20000.K

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

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