

FileEditor:LMP103S0907.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 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=CH4(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: CH4(L)	1.000000	-0.107322E+05	111.64	0.0000
C 1.00000	H 4.00000			

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

FileEditor:LMP103S0907.out

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	-0.66898729E+03	-0.16844346E+03	-0.33529141E+03
KG-FORM.WT./KG	bi(2)	bi(1)	b0i

FileEditor:LMP103S0907.out

*H	0.24933832E+00	0.13733597E+00	0.17467009E+00
*O	0.00000000E+00	0.28905870E-01	0.19270580E-01
*C	0.62334580E-01	0.10403058E-01	0.27713565E-01
*N	0.00000000E+00	0.19572704E-01	0.13048470E-01

POINT	ITN	T	H	O	C	N
1	21	1058.260	-7.704	-36.293	-1.587	-12.277

ADD	C(gr)	T	H	O	C	N
1	2	1058.105	-7.701	-36.291	-1.604	-12.277

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	CH4 (L)	1.0000000	-89233.000	111.643

O/F= 2.00000 %FUEL= 33.333333 R,EQ.RATIO= 7.408297 PHI,EQ.RATIO=-2.058326

	CHAMBER	THROAT
Pinf/P	1.0000	1.8012
P, BAR	20.000	11.104
T, K	1058.10	943.73
RHO, KG/CU M	2.7609 0	1.7186 0
H, KJ/KG	-2787.78	-3190.73
U, KJ/KG	-3512.18	-3836.82
G, KJ/KG	-19787.8	-18353.1
S, KJ/(KG) (K)	16.0665	16.0665

M, (1/n)	12.145	12.145
MW, MOL WT	12.110	12.110
Cp, KJ/(KG) (K)	3.5910	3.4527
GAMMA _s	1.2356	1.2473
SON VEL, M/SEC	946.1	897.7
MACH NUMBER	0.000	1.000

PERFORMANCE PARAMETERS

Ae/At	1.0000
CSTAR, M/SEC	1296.3
CF	0.6925
Ivac, M/SEC	1617.4
Isp, M/SEC	897.7

MOLE FRACTIONS

FileEditor:LMP103S0907.out

CH4	0.23567	*CO	0.07577	*CO2	0.02121
C2H6	0.00003	*H2	0.46988	H2O	0.11517
NH3	0.00073	*N2	0.07864	C(gr)	0.00288

* 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	1072.348	-7.620	-35.903	-1.624	-12.180

REMOVE	C(gr)	T	H	O	C	N
1	2	1072.094	-7.616	-35.899	-1.653	-12.180

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	CH4(L)	1.0000000	-89233.000	111.643

O/F= 2.00000 %FUEL= 33.333333 R,EQ.RATIO= 7.408297 PHI,EQ.RATIO=-2.058326

	CHAMBER	THROAT
Pinf/P	1.0000	1.7993
P, BAR	25.000	13.894
T, K	1072.09	957.49
RHO, KG/CU M	3.4274 0	2.1329 0
H, KJ/KG	-2787.78	-3193.06
U, KJ/KG	-3517.19	-3844.50
G, KJ/KG	-19849.3	-18430.7
S, KJ/(KG) (K)	15.9142	15.9142
M, (1/n)	12.221	12.221
MW, MOL WT	12.221	12.221

FileEditor:LMP103S0907.out

Cp, KJ/(KG) (K)	3.6045	3.4658
GAMMAS	1.2327	1.2443
SON VEL,M/SEC	948.2	900.3
MACH NUMBER	0.000	1.000

PERFORMANCE PARAMETERS

Ae/At	1.0000
CSTAR, M/SEC	1301.9
CF	0.6915
Ivac, M/SEC	1623.9
Isp, M/SEC	900.3

MOLE FRACTIONS

CH4	0.24235	*CO	0.07533	*CO2	0.02091
C2H6	0.00004	*H2	0.46287	H2O	0.11835
NH3	0.00083	*N2	0.07931		

* 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	1083.565	-7.544	-35.579	-1.708	-12.101

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	CH4 (L)	1.0000000	-89233.000	111.643

O/F= 2.00000 %FUEL= 33.333333 R,EQ.RATIO= 7.408297 PHI,EQ.RATIO=-2.058326

CHAMBER THROAT

FileEditor:LMP103S0907.out

Pinf/P	1.0000	1.7978
P, BAR	30.000	16.687
T, K	1083.56	968.76
RHO, KG/CU M	4.0885 0	2.5437 0
H, KJ/KG	-2787.78	-3195.11
U, KJ/KG	-3521.54	-3851.12
G, KJ/KG	-19897.8	-18492.3
S, KJ/(KG) (K)	15.7905	15.7905

M, (1/n)	12.278	12.278
MW, MOL WT	12.278	12.278
Cp, KJ/(KG) (K)	3.6163	3.4776
GAMMAS	1.2304	1.2418
SON VEL,M/SEC	950.2	902.6
MACH NUMBER	0.000	1.000

PERFORMANCE PARAMETERS

Ae/At	1.0000
CSTAR, M/SEC	1306.7
CF	0.6907
Ivac, M/SEC	1629.4
Isp, M/SEC	902.6

MOLE FRACTIONS

CH4	0.24579	*CO	0.07388	*CO2	0.02050
C2H6	0.00005	*H2	0.45748	H2O	0.12174
NH3	0.00092	*N2	0.07965		

* 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	EFFECTIVE OXIDANT	MIXTURE
ENTHALPY	h(2)/R	h(1)/R	h0/R
(KG-MOL) (K) /KG	-0.66898729E+03	-0.16844346E+03	-0.26855223E+03
KG-FORM.WT./KG	bi(2)	bi(1)	b0i
*H	0.24933832E+00	0.13733597E+00	0.15973644E+00
*O	0.00000000E+00	0.28905870E-01	0.23124696E-01
*C	0.62334580E-01	0.10403058E-01	0.20789362E-01
*N	0.00000000E+00	0.19572704E-01	0.15658164E-01

POINT ITN	T	H	O	C	N
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1 5 1140.361 -7.701 -34.608 -2.212 -12.331

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	CH4 (L)	1.0000000	-89233.000	111.643

O/F= 4.00000 %FUEL= 20.000000 R,EQ.RATIO= 5.251829 PHI,EQ.RATIO=-1.029163

	CHAMBER	THROAT
Pinf/P	1.0000	1.8281
P, BAR	20.000	10.940
T, K	1140.36	997.47
RHO, KG/CU M	2.3424 0	1.4649 0
H, KJ/KG	-2232.88	-2715.17
U, KJ/KG	-3086.72	-3462.01
G, KJ/KG	-21518.8	-19584.5
S, KJ/(KG) (K)	16.9121	16.9121

M, (1/n)	11.105	11.105
MW, MOL WT	11.105	11.105
Cp, KJ/(KG) (K)	3.4326	3.3171
GAMMA _s	1.2790	1.2915
SON VEL,M/SEC	1045.0	982.1
MACH NUMBER	0.000	1.000

PERFORMANCE PARAMETERS

Ae/At	1.0000
CSTAR, M/SEC	1390.1
CF	0.7065
Ivac, M/SEC	1742.6
Isp, M/SEC	982.1

MOLE FRACTIONS

CH4	0.10200	*CO	0.11050	*CO2	0.01833
C2H6	0.00001	HCN	0.00001	*H2	0.57225
H2O	0.10964	NH3	0.00066	*N2	0.08661

* 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	1156.537	-7.613	-34.216	-2.272	-12.236

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	CH4 (L)	1.0000000	-89233.000	111.643

O/F= 4.00000 %FUEL= 20.000000 R,EQ.RATIO= 5.251829 PHI,EQ.RATIO=-1.029163

	CHAMBER	THROAT
Pinf/P	1.0000	1.8261
P, BAR	25.000	13.690
T, K	1156.54	1013.06
RHO, KG/CU M	2.9034 0	1.8151 0
H, KJ/KG	-2232.88	-2718.70
U, KJ/KG	-3093.93	-3472.94
G, KJ/KG	-21599.7	-19683.0
S, KJ/(KG) (K)	16.7455	16.7455
M, (1/n)	11.168	11.168
MW, MOL WT	11.168	11.168
Cp, KJ/(KG) (K)	3.4441	3.3274
GAMMAS	1.2758	1.2882
SON VEL,M/SEC	1048.1	985.7
MACH NUMBER	0.000	1.000

PERFORMANCE PARAMETERS

Ae/At	1.0000
CSTAR, M/SEC	1397.3
CF	0.7055
Ivac, M/SEC	1750.9
Isp, M/SEC	985.7

FileEditor:LMP103S0907.out

MOLE FRACTIONS

CH4	0.10537	*CO	0.10879	*CO2	0.01797
C2H6	0.00001	HCN	0.00001	*H2	0.56652
H2O	0.11352	NH3	0.00074	*N2	0.08706

* 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	1170.014	-7.542	-33.899	-2.321	-12.159

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	CH4 (L)	1.0000000	-89233.000	111.643

O/F= 4.00000 %FUEL= 20.000000 R,EQ.RATIO= 5.251829 PHI,EQ.RATIO=-1.029163

	CHAMBER	THROAT
Pinf/P	1.0000	1.8244
P, BAR	30.000	16.443
T, K	1170.01	1026.09
RHO, KG/CU M	3.4604 0	2.1627 0
H, KJ/KG	-2232.88	-2721.58
U, KJ/KG	-3099.83	-3481.88
G, KJ/KG	-21666.9	-19765.0
S, KJ/(KG) (K)	16.6101	16.6101
M, (1/n)	11.221	11.221
MW, MOL WT	11.221	11.221
Cp, KJ/(KG) (K)	3.4539	3.3362

FileEditor:LMP103S0907.out

GAMMAS	1.2731	1.2855
SON VEL,M/SEC	1050.6	988.6
MACH NUMBER	0.000	1.000

PERFORMANCE PARAMETERS

Ae/At	1.0000
CSTAR, M/SEC	1403.1
CF	0.7046
IvaC, M/SEC	1757.7
Isp, M/SEC	988.6

MOLE FRACTIONS

CH4	0.10822	*CO	0.10734	*CO2	0.01768
C2H6	0.00001	HCN	0.00001	*H2	0.56169
H2O	0.11679	NH3	0.00083	*N2	0.08743

* 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
	-0.66898729E+03	-0.16844346E+03	-0.23994972E+03
KG-FORM.WT./KG	bi(2)	bi(1)	b0i
*H	0.24933832E+00	0.13733597E+00	0.15333630E+00
*O	0.00000000E+00	0.28905870E-01	0.24776460E-01
*C	0.62334580E-01	0.10403058E-01	0.17821847E-01
*N	0.00000000E+00	0.19572704E-01	0.16776604E-01

POINT	ITN	T	H	O	C	N
1	4	1187.695	-7.725	-33.677	-2.689	-12.370

THEORETICAL ROCKET PERFORMANCE ASSUMING FROZEN COMPOSITION

Pin = 290.1 PSIA
CASE = LMP130S

FileEditor:LMP103S0907.out

	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	CH4 (L)	1.0000000	-89233.000	111.643

O/F= 6.00000 %FUEL= 14.285714 R,EQ.RATIO= 4.533006 PHI,EQ.RATIO=-0.686109

	CHAMBER	THROAT
Pinf/P	1.0000	1.8409
P, BAR	20.000	10.864
T, K	1187.69	1029.36
RHO, KG/CU M	2.1754 0	1.3635 0
H, KJ/KG	-1995.06	-2518.02
U, KJ/KG	-2914.45	-3314.85
G, KJ/KG	-22459.7	-20254.4
S, KJ/(KG) (K)	17.2305	17.2305

M, (1/n)	10.741	10.741
MW, MOL WT	10.741	10.741
Cp, KJ/(KG) (K)	3.3550	3.2503
GAMMAS	1.2999	1.3126
SON VEL,M/SEC	1093.2	1022.7
MACH NUMBER	0.000	1.000

PERFORMANCE PARAMETERS

Ae/At	1.0000
CSTAR, M/SEC	1434.3
CF	0.7130
Ivac, M/SEC	1801.8
Isp, M/SEC	1022.7

MOLE FRACTIONS

CH4	0.05220	*CO	0.12248	*CO2	0.01672
HCN	0.00001	*H2	0.60800	H2O	0.11020
NH3	0.00058	*N2	0.08981		

* 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
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FileEditor:LMP103S0907.out

1 3 1204.393 -7.637 -33.307 -2.735 -12.275

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	CH4 (L)	1.0000000	-89233.000	111.643

O/F= 6.00000 %FUEL= 14.285714 R,EQ.RATIO= 4.533006 PHI,EQ.RATIO=-0.686109

	CHAMBER	THROAT
Pinf/P	1.0000	1.8389
P, BAR	25.000	13.595
T, K	1204.39	1045.34
RHO, KG/CU M	2.6963 0	1.6894 0
H, KJ/KG	-1995.06	-2521.90
U, KJ/KG	-2922.26	-3326.64
G, KJ/KG	-22539.9	-20353.5
S, KJ/ (KG) (K)	17.0583	17.0583

M, (1/n)	10.800	10.800
MW, MOL WT	10.800	10.800
Cp, KJ/ (KG) (K)	3.3651	3.2588
GAMMAS	1.2966	1.3093
SON VEL,M/SEC	1096.5	1026.5
MACH NUMBER	0.000	1.000

PERFORMANCE PARAMETERS

Ae/At	1.0000
CSTAR, M/SEC	1441.7
CF	0.7120
Ivac, M/SEC	1810.5
Isp, M/SEC	1026.5

MOLE FRACTIONS

CH4	0.05521	*CO	0.12083	*CO2	0.01642
HCN	0.00001	*H2	0.60269	H2O	0.11392
NH3	0.00066	*N2	0.09026		

* 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	1218.346	-7.565	-33.004	-2.773	-12.198

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	CH4 (L)	1.0000000	-89233.000	111.643

O/F= 6.00000 %FUEL= 14.285714 R,EQ.RATIO= 4.533006 PHI,EQ.RATIO=-0.686109

	CHAMBER	THROAT
Pinf/P	1.0000	1.8372
P, BAR	30.000	16.329
T, K	1218.35	1058.73
RHO, KG/CU M	3.2134 0	2.0128 0
H, KJ/KG	-1995.06	-2525.05
U, KJ/KG	-2928.67	-3336.34
G, KJ/KG	-22607.3	-20436.8
S, KJ/(KG) (K)	16.9182	16.9182
M, (1/n)	10.850	10.850
MW, MOL WT	10.850	10.850
Cp, KJ/(KG) (K)	3.3737	3.2661
GAMMAS	1.2939	1.3065
SON VEL,M/SEC	1099.1	1029.5
MACH NUMBER	0.000	1.000

PERFORMANCE PARAMETERS

Ae/At	1.0000
CSTAR, M/SEC	1447.7
CF	0.7112
Ivac, M/SEC	1817.6
Isp, M/SEC	1029.6

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MOLE FRACTIONS

CH4	0.05775	*CO	0.11942	*CO2	0.01618
HCN	0.00001	*H2	0.59820	H2O	0.11705
NH3	0.00074	*N2	0.09064		

* 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

ENTHALPY (KG-MOL) (K) /KG	EFFECTIVE FUEL h(2) /R	EFFECTIVE OXIDANT h(1) /R	MIXTURE h0/R
	-0.66898729E+03	-0.16844346E+03	-0.22405944E+03

KG-FORM.WT./KG	bi(2)	bi(1)	b0i
*H	0.24933832E+00	0.13733597E+00	0.14978067E+00
*O	0.00000000E+00	0.28905870E-01	0.25694107E-01
*C	0.62334580E-01	0.10403058E-01	0.16173227E-01
*N	0.00000000E+00	0.19572704E-01	0.17397959E-01

POINT	ITN	T	H	O	C	N
1	4	1226.456	-7.756	-32.929	-3.133	-12.404

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	CH4 (L)	1.0000000	-89233.000	111.643

O/F= 8.00000 %FUEL= 11.111111 R,EQ.RATIO= 4.173595 PHI,EQ.RATIO=-0.514581

	CHAMBER	THROAT
Pinf/P	1.0000	1.8474

FileEditor:LMP103S0907.out

P, BAR	20.000	10.826
T, K	1226.46	1058.00
RHO, KG/CU M	2.0763 0	1.3028 0
H, KJ/KG	-1862.94	-2412.78
U, KJ/KG	-2826.20	-3243.72
G, KJ/KG	-23190.9	-20811.3
S, KJ/(KG) (K)	17.3899	17.3899

M, (1/n)	10.586	10.586
MW, MOL WT	10.586	10.586
Cp, KJ/(KG) (K)	3.3135	3.2141
GAMMA _s	1.3107	1.3234
SON VEL, M/SEC	1123.6	1048.6
MACH NUMBER	0.000	1.000

PERFORMANCE PARAMETERS

Ae/At	1.0000
CSTAR, M/SEC	1463.9
CF	0.7163
IvaC, M/SEC	1841.0
Isp, M/SEC	1048.6

MOLE FRACTIONS

CH4	0.02780	*CO	0.12772	*CO2	0.01568
HCN	0.00001	*H2	0.62352	H2O	0.11292
NH3	0.00051	*N2	0.09183		

* 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	1242.596	-7.666	-32.593	-3.155	-12.308

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	CH4 (L)	1.0000000	-89233.000	111.643

O/F= 8.00000 %FUEL= 11.111111 R,EQ.RATIO= 4.173595 PHI,EQ.RATIO=-0.514581

	CHAMBER	THROAT
Pinf/P	1.0000	1.8455
P, BAR	25.000	13.547
T, K	1242.60	1073.40
RHO, KG/CU M	2.5749 0	1.6152 0
H, KJ/KG	-1862.94	-2416.58
U, KJ/KG	-2833.85	-3255.28
G, KJ/KG	-23254.4	-20895.3
S, KJ/(KG) (K)	17.2151	17.2151
M, (1/n)	10.641	10.641
MW, MOL WT	10.641	10.641
Cp, KJ/(KG) (K)	3.3225	3.2214
GAMMAS	1.3075	1.3202
SON VEL,M/SEC	1126.7	1052.3
MACH NUMBER	0.000	1.000

PERFORMANCE PARAMETERS

Ae/At	1.0000
CSTAR, M/SEC	1470.9
CF	0.7154
Ivac, M/SEC	1849.3
Isp, M/SEC	1052.3

MOLE FRACTIONS

CH4	0.03049	*CO	0.12615	*CO2	0.01544
HCN	0.00001	*H2	0.61866	H2O	0.11638
NH3	0.00059	*N2	0.09227		

* 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	1256.179	-7.593	-32.318	-3.175	-12.231

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	CH4 (L)	1.0000000	-89233.000	111.643

O/F= 8.00000 %FUEL= 11.111111 R,EQ.RATIO= 4.173595 PHI,EQ.RATIO=-0.514581

	CHAMBER	THROAT
Pinf/P	1.0000	1.8439
P, BAR	30.000	16.270
T, K	1256.18	1086.40
RHO, KG/CU M	3.0699 0	1.9251 0
H, KJ/KG	-1862.94	-2419.70
U, KJ/KG	-2840.17	-3264.85
G, KJ/KG	-23309.7	-20967.8
S, KJ/(KG) (K)	17.0730	17.0730
M, (1/n)	10.688	10.688
MW, MOL WT	10.688	10.688
Cp, KJ/(KG) (K)	3.3302	3.2279
GAMMAS	1.3048	1.3175
SON VEL,M/SEC	1129.2	1055.2
MACH NUMBER	0.000	1.000

PERFORMANCE PARAMETERS

Ae/At	1.0000
CSTAR, M/SEC	1476.8
CF	0.7145
Ivac, M/SEC	1856.1
Isp, M/SEC	1055.2

MOLE FRACTIONS

CH4	0.03279	*CO	0.12481	*CO2	0.01524
HCN	0.00001	*H2	0.61453	H2O	0.11932
NH3	0.00066	*N2	0.09264		

* 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

ENTHALPY		EFFECTIVE FUEL	EFFECTIVE OXIDANT	MIXTURE		
(KG-MOL) (K) /KG		h (2) /R	h (1) /R	h0/R		
		-0.66898729E+03	-0.16844346E+03	-0.21394745E+03		
KG-FORM.WT./KG		bi (2)	bi (1)	b0i		
*H		0.24933832E+00	0.13733597E+00	0.14751800E+00		
*O		0.00000000E+00	0.28905870E-01	0.26278064E-01		
*C		0.62334580E-01	0.10403058E-01	0.15124106E-01		
*N		0.00000000E+00	0.19572704E-01	0.17793368E-01		
POINT	ITN	T	H	O	C	N
1	4	1263.854	-7.792	-32.225	-3.588	-12.438

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	CH4 (L)	1.0000000	-89233.000	111.643

O/F= 10.00000 %FUEL= 9.090909 R,EQ.RATIO= 3.957948 PHI,EQ.RATIO=-0.411665

	CHAMBER	THROAT
Pinf/P	1.0000	1.8505
P, BAR	20.000	10.808
T, K	1263.85	1087.90
RHO, KG/CU M	2.0040 0	1.2582 0
H, KJ/KG	-1778.87	-2349.45
U, KJ/KG	-2776.85	-3208.49
G, KJ/KG	-23872.6	-21367.4
S, KJ/(KG) (K)	17.4813	17.4813
M, (1/n)	10.530	10.530
MW, MOL WT	10.530	10.530
Cp, KJ/(KG) (K)	3.2913	3.1941
GAMMAS	1.3156	1.3284

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SON VEL,M/SEC 1145.9 1068.3
MACH NUMBER 0.000 1.000

PERFORMANCE PARAMETERS

Ae/At 1.0000
CSTAR, M/SEC 1488.1
CF 0.7179
IvaC, M/SEC 1872.4
Isp, M/SEC 1068.3

MOLE FRACTIONS

CH4	0.01456	*CO	0.12978	*CO2	0.01490
HCN	0.00001	*H2	0.62973	H2O	0.11712
NH3	0.00044	*N2	0.09345		

* 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	1278.271	-7.699	-31.942	-3.572	-12.341

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	CH4 (L)	1.0000000	-89233.000	111.643

O/F= 10.00000 %FUEL= 9.090909 R,EQ.RATIO= 3.957948 PHI,EQ.RATIO=-0.411665

	CHAMBER	THROAT
Pinf/P	1.0000	1.8487
P, BAR	25.000	13.523

FileEditor:LMP103S0907.out

T, K	1278.27	1101.67
RHO, KG/CU M	2.4881 0	1.5616 0
H, KJ/KG	-1778.87	-2352.82
U, KJ/KG	-2783.65	-3218.78
G, KJ/KG	-23899.9	-21417.7
S, KJ/(KG) (K)	17.3055	17.3055

M, (1/n)	10.578	10.578
MW, MOL WT	10.578	10.578
Cp, KJ/(KG) (K)	3.2990	3.2004
GAMMAS	1.3128	1.3256
SON VEL,M/SEC	1148.5	1071.4
MACH NUMBER	0.000	1.000

PERFORMANCE PARAMETERS

Ae/At	1.0000
CSTAR, M/SEC	1494.3
CF	0.7170
Ivac, M/SEC	1879.7
Isp, M/SEC	1071.4

MOLE FRACTIONS

CH4	0.01687	*CO	0.12839	*CO2	0.01471
HCN	0.00001	*H2	0.62550	H2O	0.12016
NH3	0.00052	*N2	0.09384		

* 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	1290.646	-7.624	-31.705	-3.566	-12.262

THEORETICAL ROCKET PERFORMANCE ASSUMING FROZEN COMPOSITION

Pin = 435.1 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	CH4 (L)	1.0000000	-89233.000	111.643

O/F= 10.00000 %FUEL= 9.090909 R,EQ.RATIO= 3.957948 PHI,EQ.RATIO=-0.411665

	CHAMBER	THROAT
Pinf/P	1.0000	1.8473
P, BAR	30.000	16.240
T, K	1290.65	1113.51
RHO, KG/CU M	2.9687 0	1.8628 0
H, KJ/KG	-1778.87	-2355.65
U, KJ/KG	-2789.40	-3227.49
G, KJ/KG	-23929.5	-21466.2
S, KJ/(KG) (K)	17.1624	17.1624

M, (1/n)	10.619	10.619
MW, MOL WT	10.619	10.619
Cp, KJ/(KG) (K)	3.3057	3.2060
GAMMAS	1.3104	1.3231
SON VEL,M/SEC	1150.7	1074.0
MACH NUMBER	0.000	1.000

PERFORMANCE PARAMETERS

Ae/At	1.0000
CSTAR, M/SEC	1499.5
CF	0.7163
Ivac, M/SEC	1885.8
Isp, M/SEC	1074.0

MOLE FRACTIONS

CH4	0.01887	*CO	0.12717	*CO2	0.01455
HCN	0.00001	*H2	0.62184	H2O	0.12279
NH3	0.00058	*N2	0.09418		

* 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