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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
       hp   p,bar=30,45,70,  t,k=3800
 react
   fuel=AL(cr) wt=18  t,k=300
   oxid=NH4CLO4(I) wt=68  t,k=300
   fuel=HTPB  wt=14  t,k=300
     h,kj/mol=-58  H 10.65 C 7.075 O 0.223 N 0.063
 output  massf short transport
 end


 WARNING!!  MAXIMUM ALLOWED NO. OF SPECIES 40 WAS USED IN
 TRANSPORT PROPERTY CALCULATIONS FOR POINT  1(TRANIN))

 WARNING!!  MAXIMUM ALLOWED NO. OF SPECIES 40 WAS USED IN
 TRANSPORT PROPERTY CALCULATIONS FOR POINT  2(TRANIN))

 WARNING!!  MAXIMUM ALLOWED NO. OF SPECIES 40 WAS USED IN
 TRANSPORT PROPERTY CALCULATIONS FOR POINT  3(TRANIN))



         THERMODYNAMIC EQUILIBRIUM COMBUSTION PROPERTIES AT ASSIGNED

                                  PRESSURES

 CASE =

             REACTANT                    WT FRACTION      ENERGY      TEMP
                                          (SEE NOTE)     KJ/KG-MOL      K
 FUEL        AL(cr)                       0.5625000        44.802    300.000
 OXIDANT     NH4CLO4(I)                   1.0000000   -295529.716    300.000
 FUEL        HTPB                         0.4375000    -58000.000    300.000

 O/F=    2.12500  %FUEL= 32.000000  R,EQ.RATIO= 1.851663  PHI,EQ.RATIO= 2.551340

 THERMODYNAMIC PROPERTIES

 P, BAR             30.000   45.000   70.000
 T, K              3333.74  3368.27  3404.10
 RHO, KG/CU M    2.9979 0 4.4685 0 6.9066 0
 H, KJ/KG         -1791.23 -1791.23 -1791.23
 U, KJ/KG         -2791.92 -2798.29 -2804.75
 G, KJ/KG         -34280.6 -34208.1 -34104.1
 S, KJ/(KG)(K)      9.7456   9.6242   9.4923
```

Fit on this pressure the data

M, (1/n)	27.699	27.809	27.926
MW, MOL WT	25.574	25.663	25.758
(dLV/dLP)t	-1.01930	-1.01761	-1.01590
(dLV/dLT)p	1.3593	1.3228	1.2853
Cp, KJ/(KG)(K)	4.1331	3.9026	3.6712
GAMMAs	1.1298	1.1318	1.1339
SON VEL,M/SEC	1063.3	1067.6	1072.0

Use this molar mass

This Cp is wrong and the Gammas is not the specific heat ratio

TRANSPORT PROPERTIES (GASES ONLY)
CONDUCTIVITY IN UNITS OF MILLIWATTS/(CM)(K)

VISC,MILLIPOISE	0.97395	0.98099	0.98830

WITH EQUILIBRIUM REACTIONS

Do not use parameters from this section

Cp, KJ/(KG)(K)	4.0461	3.8175	3.5969
CONDUCTIVITY	12.7040	11.7546	10.8120
PRANDTL NUMBER	0.3102	0.3186	0.3288

WITH FROZEN REACTIONS

Use parameters from this section

Cp, KJ/(KG)(K)	2.0456	2.0486	2.0519
CONDUCTIVITY	4.0952	4.1238	4.1545
PRANDTL NUMBER	0.4865	0.4873	0.4881

Use Cp for gamma computation via Mayer relation

MASS FRACTIONS

*AL	0.00021	0.00018	0.00015
ALCL	0.01975	0.01872	0.01746
ALCL2	0.00194	0.00219	0.00248
ALCL3	0.00077	0.00099	0.00128
ALH	0.00005	0.00005	0.00005
ALHCL	0.00006	0.00008	0.00009
ALHCL2	0.00015	0.00020	0.00027
ALH2CL	0.00000	0.00000	0.00001
*ALO	0.00039	0.00033	0.00027
ALOCL	0.00139	0.00132	0.00123
ALOCL2	0.00001	0.00001	0.00001
ALOH	0.00947	0.00900	0.00841
ALOHCL	0.00192	0.00217	0.00247
ALOHCL2	0.00281	0.00359	0.00468
AL(OH)2	0.00036	0.00041	0.00047
AL(OH)2CL	0.00066	0.00084	0.00111
AL(OH)3	0.00013	0.00017	0.00022
AL2O	0.00030	0.00026	0.00023
AL2O2	0.00009	0.00008	0.00007
*CO	0.26679	0.26689	0.26699
*CO2	0.01599	0.01581	0.01562
*CL	0.01459	0.01298	0.01133
CLO	0.00001	0.00001	0.00001
CL2	0.00004	0.00004	0.00005
*H	0.00152	0.00135	0.00118
HALO	0.00001	0.00001	0.00001
HALO2	0.00003	0.00003	0.00003
HCN	0.00001	0.00001	0.00002
HCO	0.00002	0.00003	0.00003

HCL	0.17864	0.17984	0.18086
HOCL	0.00001	0.00001	0.00001
*H2	0.02402	0.02416	0.02430
H2O	0.06565	0.06574	0.06577
NH2	0.00000	0.00000	0.00001
NH3	0.00001	0.00001	0.00001
*NO	0.00036	0.00033	0.00030
*N2	0.08212	0.08212	0.08213
*O	0.00023	0.00018	0.00014
*OH	0.00352	0.00319	0.00283
*O2	0.00005	0.00004	0.00003
AL2O3(L)	0.30592	0.30661	0.30736

* THERMODYNAMIC PROPERTIES FITTED TO 20000.K

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