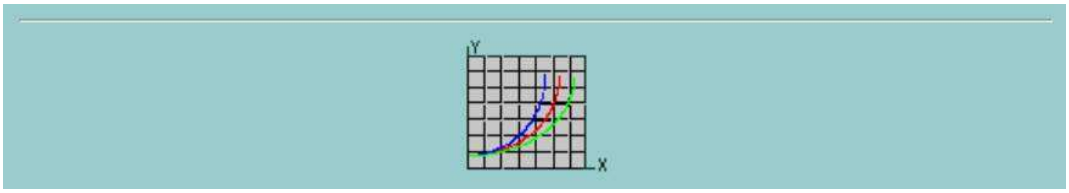
Richard Nakka's *Experimental Rocketry* Web Site



Technical Notepad – KNSU Ideal Performance Calculations

Potassium Nitrate-Sucrose 65/35 O/F ratio @ 1000 psi chamber pressure

From Propep results, for 100 gram mixture:

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Potassium Nitrate-Sucrose  65/35 O/F ratio  Run using June 1988 Version of PEP,
Case  1 of  1      6 Nov 1999 at  4:17: 0.93 pm

  CODE                                WEIGHT    D-H  DENS      COMPOSITION
   821 POTASSIUM NITRATE              65.000  -1169  0.07670    1N   30   1K
   897 SUCROSE (TABLE SUGAR)          35.000  -1550  0.05740   22H  12C  11O

THE PROPELLANT DENSITY IS 0.06862 LB/CU-IN OR  1.8995 GM/CC
THE TOTAL PROPELLANT WEIGHT IS  100.0000 GRAMS

NUMBER OF GRAM ATOMS OF EACH ELEMENT PRESENT IN INGREDIENTS

   2.249436 H     1.226965 C     0.642877 N     3.053349 O
   0.642877 K

****************************CHAMBER RESULTS FOLLOW*****************************

 T(K)  T(F)  P(ATM)   P(PSI) ENTHALPY  ENTROPY   CP/CV     GAS   RT/V
1720. 2636.   68.02  1000.00  -130.24   165.92  1.1331  2.382   28.559

SPECIFIC HEAT (MOLAR) OF GAS AND TOTAL=   10.505   14.984
NUMBER MOLS GAS AND CONDENSED=   2.3819   0.3066

  0.79693 H2O        0.53225 CO         0.38810 CO2        0.32136 N2
  0.31344 H2         0.30654 K2CO3*     0.02797 KHO        0.00147 K
 1.54E-04 K2H2O2    1.01E-04 NH3       1.86E-05 H         1.31E-05 KH
 1.04E-05 KCN       6.92E-06 CH4       3.48E-06 CH2O      3.33E-06 CNH
 2.63E-06 HO

THE MOLECULAR WEIGHT OF THE MIXTURE IS   37.196


**********PERFORMANCE:  FROZEN ON FIRST LINE, SHIFTING ON SECOND LINE**********

IMPULSE   IS EX      T*      P*      C*    ISP*  OPT-EX  D-ISP      A*M   EX-T
  153.2  1.1380   1609.   39.24  3005.5           10.10  291.0  0.09344  1031.
  155.0  1.1101   1633.   39.63  3066.8   116.0   10.69  294.4  0.09534  1142.
```

Mole fractions and mass fractions for each significant combustion product are calculated in the table below:

Phase	Product	MW g/mole	moles	mole fraction	mass grams	mass fraction gas/cond.	mass fraction mixture
condensed	K2CO3	138.21	0.3065	1.000	42.367	1.000	0.424
gas	KOH	56.11	0.028	0.0118	1.569	0.0273	0.0157
gas	CO	28.01	0.5322	0.2236	14.908	0.2590	0.1491
gas	CO2	44.01	0.3881	0.1631	17.080	0.2968	0.1708
gas	H2	2.02	0.3134	0.1317	0.633	0.0110	0.0063
gas	H2O	18.02	0.7969	0.3348	14.361	0.2495	0.1436
gas	N2	28.02	0.3214	0.1350	9.004	0.1564	0.0900
	total (gas) =		2.38	1.0000	-	-	1.00
	total (mix) =		2.6866		42.367	<= total mass condensed	
					57.556	<= total mass gases	

The specific heat at constant pressure for gas products (Cp) and for condensed-phase products (Cs) are shown in the table below. From these, the specific heats are calculated for gas-only products and for the gas/condensed-phase mixture.

To (K)	Cp						Cp	Cs	Cs	Cp_mix	
	KOH	CO	CO2	H2	H2O	N2	gases	K2CO3	condensed	(g+c)	Units
1720	57.86	35.75	59.394	32.419	49.102	35.422	43.853	209.2	209.2	70.7974	J/mol-K
	1.031	1.276	1.350	16.049	2.725	1.264	1.813	1.514	1.514	1.68501	J/g-K
							1813.4		**1513.6**	1685.0	J/kg-K

The table below provides a summary of the thermochemical properties and ideal performance characteristics:

Specific heat ratio, mixture	k_{mix}	1.133	
Specific heat ratio, gases	k_{gas}	1.234	
Specific heat ratio, 2-ph flow	k″	1.133	
Condensed fraction	X	0.424	
Molecular mass, 2-ph mixture	M″	42.02	*kg/kmol*
Molecular mass, gases	M	24.18	*kg/kmol*
Specific gas constant, 2-ph mixture	R″	197.89	*J/kg-K*
Specific gas constant, gases	R	343.82	*J/kg-K*
Pressure ratio exponent, 2-ph mixture	m	0.1174	
Characteristic velocity	C*	918.5	*m/sec.*
Specific Impulse	Isp	153.5	*sec.*

Note: calculation details for all thermochemical properties and performance parameters shown above are found in the Theory, 2-phase Flow web page.

Originally posted March 8, 2023

Last updated March 8, 2023

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