

NAU Rocket Propulsion Capstone Team #3 Prototypes

Shannon Comstock, Remy
Dasher, Andrew King, Grace
Morris



Virtual Prototype

- How does our formulation compare to current formulations?
- Is this safe to manufacturer?

The image shows a screenshot of the ProPep software interface, split into two windows: 'ProPepMain' and 'Results'.

ProPepMain Window:

- Ingredients:**

Name	Weight (gr)
AMMONIUM PERCHLORATE	73.00
ALUMINUM (PURE CRYSTALLINE)	12.00
HTPB (R-45M)	10.00
IDP (B. LEE)	5.00
	0.00
	0.00
	0.00
	0.00
	0.00
	0.00
	0.00
	0.00
	0.00
	0.00
	0.00
Total Wt (grams)	100.00
- Operating Conditions:**
 - Temp. of Ingredients (K): 298
 - Chamber Pressure (PSI): 1000
 - Exhaust Pressure (PSI): 14.70
 - Boost Velocity and Nozzle Design
- Buttons:** Calculate, Display Results, Display Nozzle Graphs
- Output:**
 - Isp*: 194.7704
 - C*: 5053.193
 - Density: 0.0614266
 - Molecular Wt: 24.72115
 - Chamber CP/CV: 1.18984
 - Chamber Temp: 3093.635

Results Window:

```
Copy Results to a File  Copy Results to Clipboard

0 ALUMINUM (PURE CRYSTALLINE)  12.000  0  0.09750  1 AL
0 HTPB (R-45M)  10.000  -367  0.03250  200 C  302 H  2 O
0 IDP (B. LEE)  5.000  -908  0.03120  38 H  19 C  2 O

THE PROPELLANT DENSITY IS  0.06143 LB/CU-IN OR  1.7003 GM/CC
THE TOTAL PROPELLANT WEIGHT IS  100.0000 GRAMS

NUMBER OF GRAM ATOMS OF EACH ELEMENT PRESENT IN INGREDIENTS

  4.224405 H
  1.048540 C
  0.621293 N
  2.525972 O
  0.444774 AL
  0.621293 CL

*****CHAMBER RESULTS FOLLOW *****
T(K)  T(F)  P(ATM)  P(PSI)  ENTHALPY  ENTROPY  CP/CV  GAS  RT/V
3094  5109   68.02  1000.00  -52.08   234.66  1.1898  3.826  17.778

SPECIFIC HEAT (MOLAR) OF GAS AND TOTAL =    9.820  11.781
NUMBER MOLS GAS AND CONDENSED =    3.826  0.219

1.065679e+000 H2      9.614733e-001 CO      7.176855e-001 H2O      5.926929e-001 HCl
3.101899e-001 N2     2.187286e-001 Al2O3*  8.696948e-002 CO2     5.115809e-002 H
1.920726e-002 Cl    1.256985e-002 HO     2.754679e-003 AlCl    1.728771e-003 AlCl2
1.390152e-003 AlOCl  7.469057e-004 NO     5.590536e-004 AlHO2   5.265781e-004 AlCl3
3.610584e-004 O     2.617696e-004 AlHO   9.690391e-005 O2     7.283463e-005 NH3
6.040830e-005 CH0   5.264860e-005 Cl2    4.264156e-005 AlO    3.132671e-005 COCl
2.538110e-005 CNH   1.629680e-005 Al     1.486980e-005 HOC1   1.225854e-005 NH2
1.028697e-005 CH2O  6.932781e-006 OCl    4.210823e-006 AlH    3.29670e-006 N
3.178272e-006 Al2O  2.801911e-006 NH     2.789011e-006 CNHO   1.510172e-006 NHO
1.30781E-06 HO2

THE MOLECULAR WEIGHT OF THE MIXTURE IS  24.721

*****EXHAUST RESULTS FOLLOW *****
T(K)  T(F)  P(ATM)  P(PSI)  ENTHALPY  ENTROPY  CP/CV  GAS  RT/V
1696  2576   1.00   14.70  -127.08   234.66  1.2215  3.782  0.264

SPECIFIC HEAT (MOLAR) OF GAS AND TOTAL =    9.074  10.351
```

BurnSim - C:\Users\gm600\Documents\prot1.bsx

File Action Settings View Help

Grains

Grain Type: BATES
 Propellant: Prot1
 Length: 2.25 inches
 Diameter: 1.26 inches
 Core Diameter: 0.4375 inches
 Core Offset: inches
 # of Points: inches
 Fin Length: inches
 Inhibited Ends: 0 (0-2)

#	Length	Diameter	Core	Inhib.	Type	Prop.
1	2.25	1.26	0.4375	0	BATES	Prot1
2	2.25	1.26	0.4375	0	BATES	Prot1
3	2.25	1.26	0.4375	0	BATES	Prot1

Motor Cross-Section

Bottom Grain Is Nozzle End

Add Delete Apply Up Down

Nozzle & Thrust | Propellants | Startup

Nozzle Throat Dia: 0.485 inches Area
 Use Nozzle Calculations
 Nozzle Exit Dia: 1.25 inches
 Expansion Ratio: 6.64
 Ambient Pressure: 14.7 psi
 Efficiency: 85
 Nozzle Dia Erosion: 0 in / sec
 Use Thrust Coefficient
 Thrust Coefficient: 0

Graph | Notes

Sim Results | Graph Lines | Test Data

- Kn
- Pressure psi
- Imported Pressure
- Thrust lbf
- Thrust From Imported Pc
- Mass Flux 500
- Mass Flow 0

X Axis Start 0 seconds X Axis End 0 seconds End Sim at 0 % of max thrust

BurnSim Ready

BurnSim - C:\Users\gm600\Documents\cherry test.bsx

File Action Settings View Help

Grains

Grain Type: BATES
 Propellant: Cherry Limeade
 Length: 2.25 inches
 Diameter: 1.26 inches
 Core Diameter: 0.4375 inches
 Core Offset: inches
 # of Points: inches
 Fin Length: inches
 Inhibited Ends: 0 (0-2)

#	Length	Diameter	Core	Inhib.	Type	Prop.
1	2.25	1.26	0.4375	0	BATES	Cherry Limeade
2	2.25	1.26	0.4375	0	BATES	Cherry Limeade
3	2.25	1.26	0.4375	0	BATES	Cherry Limeade

Motor Cross-Section

Bottom Grain Is Nozzle End

Nozzle & Thrust Propellants Startup

Name: Cherry Limeade

Standard Properties Pressure Varied Properties Notes

C*: 7237.57 ft/sec S. Heat Ratio: 1.21
 ISP*: 225 sec Mol. Mass: 0
 BR Coef (a): 0.024986
 BR Exp (n): 0.327392
 Density: 0.061 lb/in^3

Graph Notes

Sim Results Graph Lines Test Data

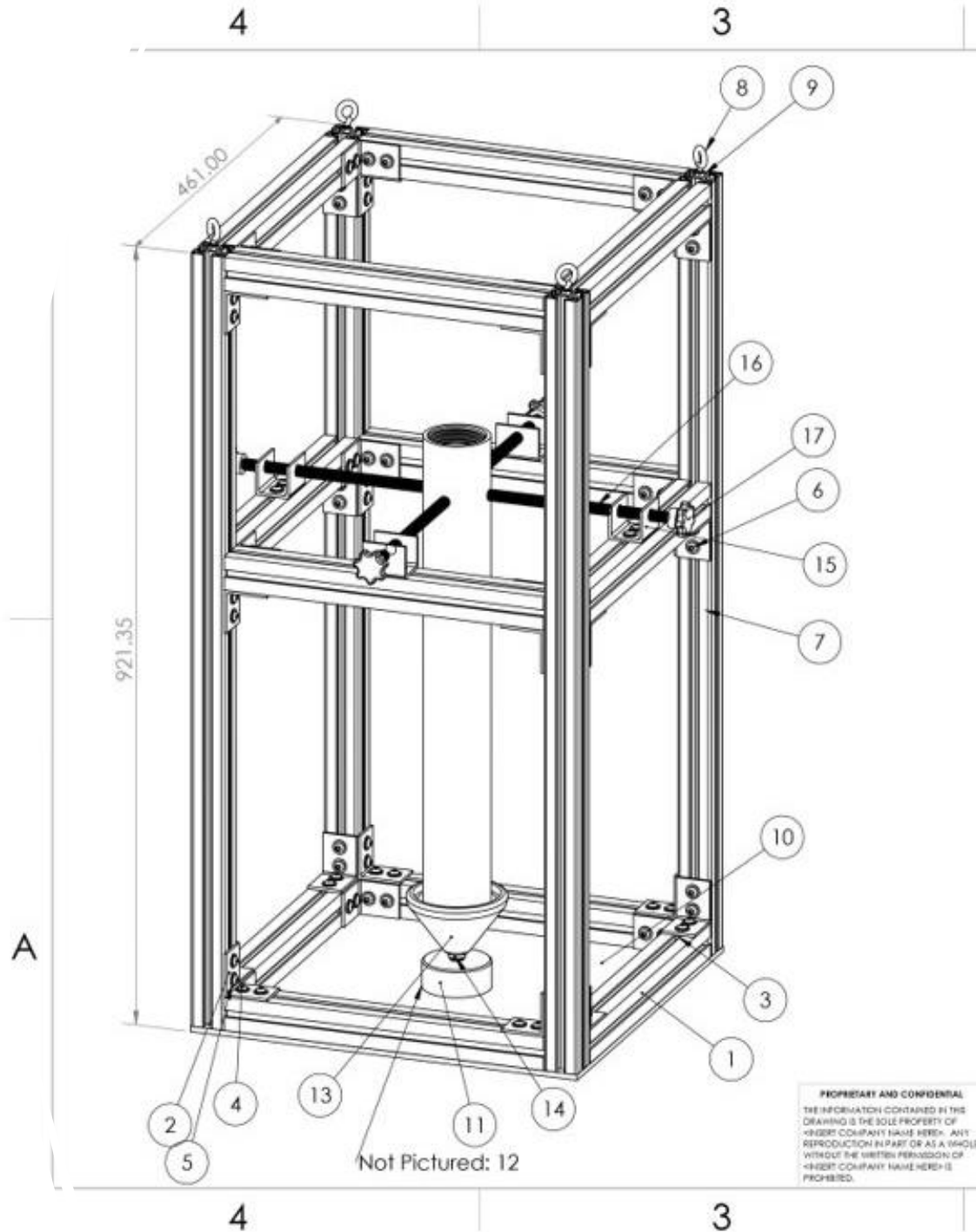
- Kn
- Pressure psi
- Imported Pressure
- Thrust lbf
- Thrust From Imported Pc
- Mass Flux 500
- Mass Flow 0

X Axis Start 0 seconds X Axis End 0 seconds End Sim at 0 % of max thrust

BurnSim Ready

Physical Prototype

- Will the test stand be based on the CAD shown in presentation 3 be the final design?
- Yes



The background features two large, overlapping, curved lines. One is a light green color and the other is a light orange color. They are positioned in the top right and bottom left corners of the slide, framing the central text.

Images of Physical Prototype Test Stand



