Apogee Components

PEAK OF FLIGHT

NEWSLETTER

In This Issue

How to Achieve Extreme Altitude Deployment

Cover Photor:Two version of Mad Cow Rocketry's Black Brant rockets.
Get your own kit at: www.ApogeeRockets.com/Madcow_4in_Black_Brant_FG.asp

Apogee Components, Inc. — Your Source For Rocket Supplies That Will Take You To The "Peak-of-Flight"
3355 Fillmore Ridge Heights
Colorado Springs, Colorado 80907-9024 USA
www.ApogeeRockets.com e-mail: orders@apogeerockets.com

ISSUE 286 MAY 10, 2011

How to Achieve Extreme Altitude Deployment

By Joel Schiff & Martin Aspell

When a rocket is launched on low- or medium-power motors, little consideration is given to the effectiveness of black powder to blow the rocket apart and deploy its parachute(s). This is because at the altitudes reached by these rockets, the atmosphere has enough oxygen molecules for the black powder to detonate properly. But this is not the case as we go increasingly higher into the atmosphere with high-power motors. As Table 1 and Figure 1 (altitude in feet, pressure in pounds per square inch) indicate, the air pressure at 20,000 ft is less than half that at ground level.

This means that there is less than half the necessary air available for heat conduction between the burning BP particles in your ejection canisters. This can lead to incomplete combustion with some of the BP left unburnt, with a consequent loss of pressure to blow the chute at apogee — either drogue or main, whatever is being deployed.

0	14.696
500	14.43
1,000	14.16
1,500	13.91
2,000	13.66
2,500	13.41
3,000	13.17
3,500	12.93
4,000	12.69
4,500	12.46
5,000	12.23
6,000	11.78
7,000	11.34
8,000	10.91
9,000	10.5
10,000	10.1
15,000	8.29
20,000	6.76
25,000	5.46
30,000	4.37
35,000	3.47
40,000	2.73
45,000	2.15
50,000	1.69
55,000	1.33
60,000	1.05
70,000	0.65
80,000	0.41
90,000	0.26
100,000	0.16

Table 1: The left-column shows altitude in feet, and the right side shows the atmospheric pressure as measured in pounds per square inch.

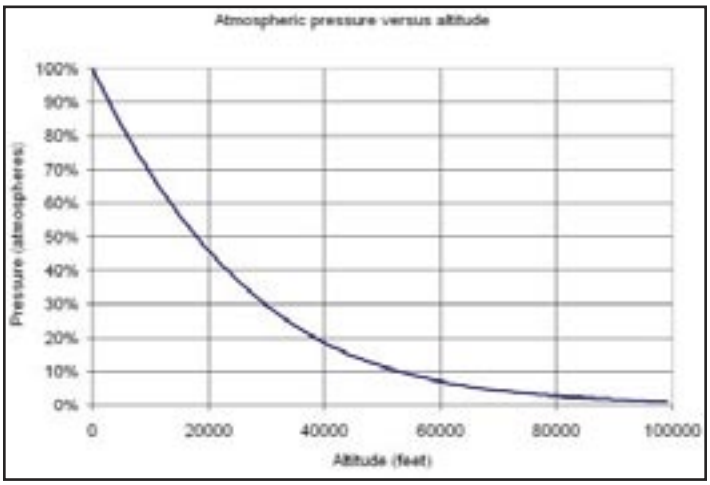

Figure 1: The atmospheric pressure drops off dramatically as the altitude increases.

From Table 1, it is clear that as one goes ever higher, the air pressure is going ever lower, until at 100,000 ft the air pressure is virtually nil — actually 0.16 psi vs 14.7 psi at sea level.

Recently, the authors have been working on a carbon fiber, unmodified, Mongoose 98 and after preliminary test flights with a K458 and then L952, we wanted to go for broke (almost literally) and purchased an Aerotech N1000. With its whopping 14,000 N-s total impulse it would according to RockSim models, boost the rocket to about 33,000 ft AGL.

As others had succeeded in reaching over 40,000 ft with some modifications to the Mongoose 98, we used this altitude as our 'best case' scenario. At 40,000 ft however, the atmospheric pressure is 19% that at sea level (2.73 psi) and therefore there is too little air available for conduction to simply use our aluminum ejection canisters as in the successful K and L flights. Something entirely new would have to be done to ensure the complete burn-

Figure 2: The ejection canister set-up for the K and L flights with no consideration given to diminishing air density. These are at the bottom end of the avionics bay for deployment of the drogue chute at apogee. A tapered red plastic plug with paper wadding retains the 1.2 g of BP. (An aluminum unpainted ejection canister has been added to the original kit as a safety backup).

Continued on page 3

About this Newsletter

You can subscribe to receive this e-zine FREE at the Apogee Components web site (www.ApogeeRockets.com), or by sending an e-mail to: ezine@apogeeRockets.com with "SUBSCRIBE" as the subject line of the message.

Newsletter Staff

Writer: Tim Van Milligan
Layout / Cover Artist: Tim Van Milligan
Proofreader: Michelle Mason

Continued from page 2

Achieving Extreme Altitude Deployment

ing of the 1.2 grams of 4F black powder to eject our drogue chute at apogee. Moreover, the Quest Q2 igniters (www.ApogeeRockets.com/igniters.asp) had to do their job as well in the same environment. Another important consideration here is that the combustion of the BP is not instantaneous and therefore the vessel containing it must hold the explosion intact for complete combustion to occur.

What should we do new to compensate for the lack of air at 40,000 ft? We did a search on the internet on how to overcome the combustion problem at high altitude and one of the solutions was replacing each existing ejection canister with a bladder made of surgical rubber. The bladder idea is based on the notion that it would contain the black powder long enough for complete combustion to occur while at the same time sealing in the 1 atmosphere from ground level.

Now, New Zealand (where I live) is not a place where surgical rubber can be bought right off the shelf. But as we had a vacuum pump, we were able to test various alternatives and 'take them up' to 40,000 ft and check their suitability. We did have a latex glove and proceeded to cut out one of the fingers to use as a bladder. It swelled up like a balloon and eventually ruptured explosively. We tried various fingers, including the thumb, as they were of different sizes, but all with the same result. We definitely did not want latex. Even two layers was useless.

So the bladder idea was starting to look too hard and we began thinking, did we even want a bladder at all? In fact, aren't the ejection canisters a form of non-expanding bladder? Well, yes they are. Since we had the canisters already installed, perhaps we could still use them and save a lot of hassle. But clearly our red plastic plugs were not going to be sufficient on their own as the air pressure differential would soon have them popping off, rendering each canister useless in conditions of 2.73 psi.

Figure 3: An ejection canister with ignition wires entering the bottom of the canister with several turns of teflon tape wrapping. A glue gun is at the ready to seal the black cap and seal up the hole.

The solution was indeed obvious — seal in 1 atmosphere of air pressure in each canister so that the tapered end plugs did not blow out until we blasted them out with black powder at apogee! This was achieved as follows.

For one thing, the back end of the ejection canisters are threaded and come with tight fitting black plastic caps. The wires to the igniters go through a tiny hole in the bottom of

Continued on page 4

Continued from page 3

Achieving Extreme Altitude Deployment

each canister, then several wraps of commonly used teflon plumber's tape are placed around the threads. (Both of the apogee ejection canisters were treated identically although only one is depicted in Figure 3).

Before the cap is put in place, the bottom of the canister is doused with a glue gun so that when the cap is put on firmly, some of the glue goes into the hole and seals it as well. Covering the black cap is a plastic tie wound tightly around the cap itself, as shown in Figure 4.

Figure 4: The bottom sealed end of the ejection canister with the black cap covering the wires and teflon tape, and finally sealed tightly with a plastic tie.

By the end of this process, we were quite confident that not a single molecule could escape the back end of the ejection canister before it had gasified.

Now the top end has to be secured similarly and this was achieved by putting a few wraps of teflon tape onto the tapered red plastic plug used on previous launches, as shown in Figure 5.

Again, with only 2.73 psi in mind, the inserted red plug was sealed with a single wrap of Scotch aluminum foil backed tape that is carefully folded down over the top as seen in Figure 6 on the next page.

The ejection canister now had 1 atmosphere sealed in and was ready for testing.

This was done using a vacuum pump and placing the loaded ejection canister into a metal pipe tightly sealed at both ends so that we could pump out

Figure 5: The top end of the ejection canister with teflon tape covering the red plug about to be inserted.

Continued on page 5

Continued from page 4

Achieving Extreme Altitude Deployment

Figure 6: The final seal over the top of the canister is a single wrap of Scotch aluminum foil backed tape folded over the top.

the air and simulate the conditions of the upper atmosphere. To be on the safe side, rather than just going up to 40,000 ft, we decided to err on the conservative side and took the interior of the pipe up to 100,000 ft — essentially a complete vacuum!

Once the vacuum took us up to the top of the atmosphere (note the dial is maxed out in Figure 7), we placed a heavy blanket over the blue pipe installation to contain the explosion of more than 1 gram of black powder. And detonate it did! An inspection was made of the canister and pipe confirming that all the BP had completely combusted.

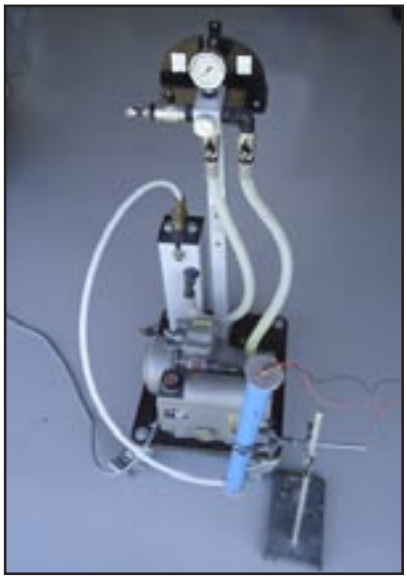

Figure 7: Here is the vacuum pump used in our atmospheric simulation with the loaded ejection canister inside the blue pipe ready for ignition.

The testing phase now over, it was time to give our new knowledge a reality check. The N1000 motor burned for what seemed like an eternity with the rocket reaching apogee of 33,701 ft after 43 seconds. Deployment of the drogue at apogee occurred just like we knew it would.

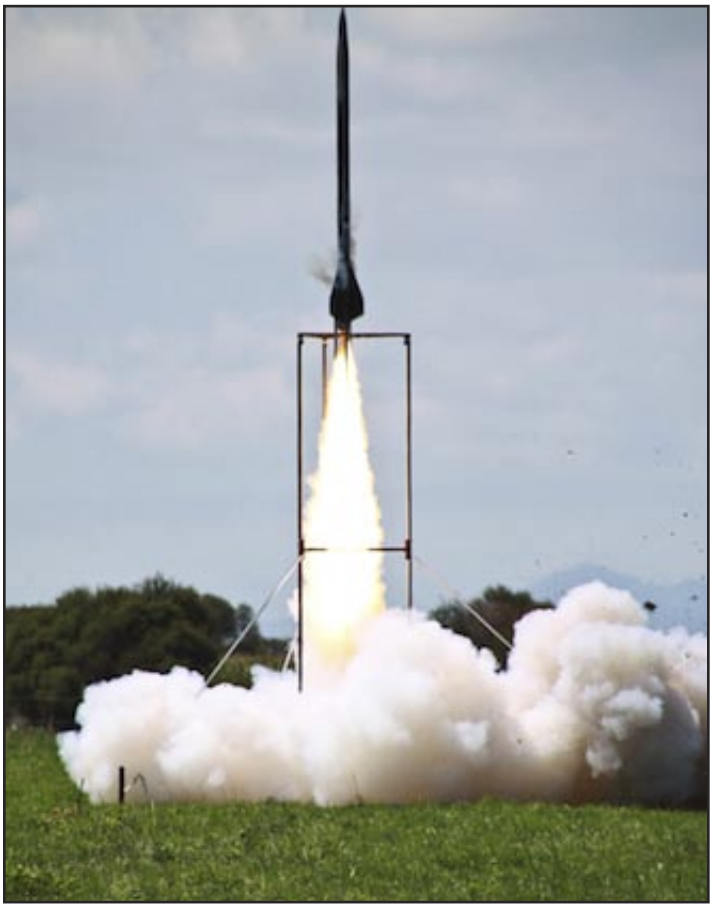

Figure 8: The launch of the Mongoose 98 to an altitude of 33,701 ft with a drogue ejection at apogee.

We're Paying Cash

For Great Articles for This Newsletter

Are you a writer looking for some serious pocket change? We're paying up to $350 for good how-to articles for this newsletter. If you're interested, see our submission guidelines on the Apogee web site.

www.ApogeeRockets.com/Newsletter_Guidelines.asp