EVERCLEAR PROPELLANT

PRESENTED BY BLACK ROCK PROPULSION SYSTEMS

Introduction: Way back in 1994 or 1995, there was a guy named Ron Urinsco who came onto the motor making scene. He made every kind of special effects propellant you can imagine – blue flame, red flame, sparky motors, black smoke, and on and on. But the one that really caught my eye was his translucent flame propellant that he called "Standard." In a large motor, the mach diamonds were very visible, and you could see right through the flame. Jim Hart and Ron teamed up on many projects during this time period, and the large V2 models that they flew looked very much like the real thing.

At the time, I had never seen anyone else build motors with this style of "non-metallized" propellant. Later on, speaking with Gary Rosenfield of AeroTech/RCS, I learned that the original AeroTech motors were made with a similar low metals, low smoke propellant. There was no practical reason to add metals to the hobby motors of that era – they did little for ISP and increased the cost of the propellant. Of course, this was before White Lightning was introduced to compete with the special effects motors by USR and Vulcan Systems.

Our development began in earnest in the fall of 95. The first few couple of prototype fuels were too smoky, so we cut the R45 back and blew up a case. After about a dozen different versions, we came up with this very workable propellant that we have used in all sizes of motors with excellent results.

Well, we must have done a pretty good job at our look-alike propellant. At the BALLS launch this year, right after another rocketeer flew an Everclear motor, I overheard a newbie going on and on about the LOX/alcohol rocket that had just flown. I didn't have the heart to tell him that it was just a low-metals AP motor.

I have always used this propellant in BATES geometry motors, either neutral or progressive, with Kn's between 200 and 260. While we are on the subject of nozzles, let me warn you that this propellant is very erosive to nozzles. A test on an AeroTech style 29/38 nozzle showed that the diameter of the nozzle increased by approximately .018" per second of burn. The erosion of the nozzle and thus the lowering of the Kn (and the pressure) is not a huge problem since Everclear will run smooth even at low pressures. But if you want keep the curve a little flatter and counter the effects of the nozzle erosion, you could certainly make your grains slightly progressive (longer). Of course, burn time is something else to factor in here, as is nozzle type. For example, in a 29 mm motor with a single throat nozzle and a 1 second burn time, erosion isn't a big deal. But if you're making a 54mm with a Medusa nozzle, you'll definitely want to do adjust you grain lengths.

Everclear is a drop in fit for all Kosdon motors…if you keep the grain size, cores, and nozzles all the same, it will run very nicely. This is a simple way to go. Along the same

line of though, the Woody's Pro-X cases with the nozzle properly sized will work well too. But the AeroTech system is a heck of a lot easier to clean!

Density is typically .054-.055 lb/in3. A= .0073, N= .581 according to some quick and dirty test firings. Process at 50 to 110 F.

Enough introduction – Here's the formula:

R45M	12.7%
DOA	2.3%
HX878 Tepanol	0.7%
Mg, Al, or Mg/Al	0.5%
Manganese Dioxide	0.5%
AP 200 micron	53.9%
AP 400 micron	27.4%
Isonate 143L curative	1.7%
IPDI	0.3%

Okay. As with all propellants, you start by mixing the R45, DOA, and HX878. Blend these all together well. Then add the metal powder and manganese dioxide, and mix them very well into the liquids (for five minutes or so). I have often made this propellant with no mixing equipment more complicated than a 2 quart plastic bucket, a nylon rod to stir with, and a spatula. If you are planning on using a mixer, let me inform you now that the propellant will need to be degassed. The mixer definitely puts a whole lot more air into the propellant than the hand mixing method. I will assume for the purposes of this conversation that mixer is not being used, since this material is being presented for beginning to intermediate rocket scientists.

All right, so now you have your premix very homogenous. Now you will measure out your AP 200 into a separate container. Mix it into you premix in three increments, mixing approximately 2 minutes for each addition. Then measure the 400 micron AP and mix it in the same way, only go with two increments instead of three. After the final addition of AP, scrape down the bucket and rod with your spatula. Mix for another 2 minutes, scrape down all propellant into the bucket.

Measure your two curatives into a small plastic cup. Pour them all over the top of your propellant, and mix like a madman. I like to mix for two minutes, scrape, another two minutes, scrape, another two minutes and then scrape and cast.

How to cast: You will, of course, have your cast tubes all set up before you even get the chemicals out. A rod that is approximately 75% the diameter of your cast tube will be ready to pack the fuel into the tube.

Wearing gloves (which you should have been doing this entire process anyhow) grab a bit of propellant, about enough to fill 1" of the cast tube. Roll it up into a ball, working out the air to the extent possible. Drop it into the tube, and tamp it down with moderate

force. Continue this process until your cast tube is full or you run out of propellant, whichever may come first.

Clean up. This is not my favorite part, but is necessary. Use paper towels and DOA to clean everything. Bear in mind that the used paper towels are very flammable! They need to be stored in a safe manner and burned off away from people. Do not throw them in the trash!

The propellant will be fully cured in about two days, and then of course you can cut and drill the grains. I cannot overemphasize the need for caution with the shavings. Think of them as rubbery flashpowder. Scary as hell. Treat them with respect and great caution.

I think that those of you who actually make and use this propellant will find it very user friendly. While not as easy to process as "pourable" propellants, it is simple to make and requires a minimum of equipment, a good thing for those of you just starting out. It ignites easily, runs smooth, and looks great in the air. I think that's what I like best about Everclear – even now, 7 or 8 years since I first flew motors loaded with it, it is still distinctive. Everybody has got a red flame or white flame/heavy smoke propellant, but a clear flame/low smoke propellant is a rarity. Have fun with this, and as always, be careful!

A few notes of varying importance:

This propellant can use magnesium, aluminum, or magnallium. I prefer magnallium, but don't know why. It doesn't matter.

Manganese dioxide is the burn rate catalyst here. It yields a very clean flame. I would not substitute any other catalyst for this one in this particular composition.

I have always used R45M, but R45HT can certainly be used. You will need to adjust the NCO:OH ratio, of course.

Special thanks to Jim G. for naming this stuff. Without his imagination, I'd still be calling it "clear flame".