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APOGEE PEAK OF FLIGHT NEWSLETTER

Building a Hybrid in RockSim

By Bob Fortune

With the resurgence in HyperTek hybrid enthusiasm I'll bet some people are considering building rockets for the HyperTek L and M motors. It's a great piece of hardware that I highly recommend.

Hybrids, from my experience, are funny things in that they have a liquid oxidizer that is carried above the motor and are depleted as the motor burns. The center of gravity changes as the rocket flies because the weight moves aft in a way different from a solid. A solid simply gets lighter through the length of the motor as the motor burns. On a hybrid, the aft end gets heavier as it burns because the nitrous moves aft. A lot depends on where the tank is in relation to the CG. This is a bit simplistic but it's the best way I can think of describing it. But it's easy to model in RockSim and that's why RockSim is such a cool program.

Worst case scenario is not when a hybrid is fully loaded and ready to go, rather when there is very little nitrous in the tank. Nitrous weighs about .028 pounds per cubic inch at 700 PSI. You can plug that value into the RockSim database for future use. If it won't take lb/cu.in. then you can do the multiplication to get cubic feet.

What I do is build the whole tank and motor system using aluminum, PVC or ABS, and nitrous. Build the tank and bulkheads of aluminum with bulkheads being 1/2" thick and the tank walls at .25" thick. This is probably heavy but it's pretty close. Model the injector in aluminum, the motor case and closures in aluminum (or PVC/ABS in the case of HT), and the nozzle of G10. G10 is pretty close in weight to what is currently in use, if you have a graphite spec this works too. These would all be body tubes or bulkheads or whatever works.

The neat part is that you can build a body tube to fit inside your tank and combustion chamber that mimics nitrous. The OD would be the ID of the tank, the ID would be zero. The length would be whatever you choose dependent on the fill state of the tank you wish to model.

Like I said earlier, worst case is a short filled or depleted tank and a combustion chamber full of nitrous. You can model this by filling the bore of the combustion chamber with nitrous and leaving the tank empty. If it's stable in this configuration then you are all set. Granted, a combustion chamber might never be full of liquid nitrous but this is worst case scenario we're talking about. Then model the tank as 1/4 full, 1/2 full, and completely full and see what happens to the CP/CG relationship. If you want to get really technical you can model the motor to regress at the rate of about .06" per second but that's pretty nebulous.

Hope you enjoy this little dissertation but if something is out of whack or incorrectly stated, lemme know. I'm avoiding doing my real work this morning, which is all nightmarish paperwork, but I suppose I'll have to get back to it now. Talking and reading about rockets is much more fun.

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