

Instructions for Casting Propellant Grains for the 1.75" KNER "I" Class Motor

You will need:

- 1) Presto Multicooker or similar thermostatically controlled heating vessel
- 1) Flat bottomed large plastic spoon
- 1) Covered plastic container for mixing the dry chemicals
- 1) 540 gram propellant reload kit (6 liners {2.5"x5"}, 6 aluminum foil tape wraps {2.5"x5"} and chemicals packs)
- Transparent tape
- 6) 2"x2" pieces of aluminum foil
- 1) Casting stand kit; (2) stand bases, (2) Delrin coring rods, (2) PVC pipe stands and (2) Caps
- Fire extinguisher
- 5 gallon bucket of water

Personal Safety Equipment

Full face shield
Leather gloves
Long sleeve cotton shirt
Long cotton pants and leather shoes

It is highly advisable to work in a safe area, outside, away from any combustibles would be best. Set up a solid work station, such as a sturdy table to work on. Make sure no one has access to your work area, post signs if needed. Make sure no children or pets are allowed in the work area.

Make sure you have everything you need laid out in advance. Start by preheating the Presto Multicooker at a setting of 275 degrees.

Don your safety gear and add the contents of one 540 gram reload kit (one 351 gram bag of KNO₃ and one 189 gram bag of erythritol) to your plastic mixing container. Seal the container and shake the contents well for about 1 minute.

After the Presto Multicooker has been preheating for at least 5 minutes, don your gloves and face shield and add the mixed contents of the plastic mixing container to the Presto Multicooker. Level the mixture in the bottom of the cooker with the spoon or gentle shaking. You may now cover the cooker, or leave it open. Covering retains more heat and speeds the melting process slightly.

Without stirring, leave the contents to melt for about 20 minutes. While the mixture melts, take this time to prep the casting stands.

Roll the 2.5" x 4.25" card stock paper over the sharp edge of a table to pre-curl the paper. Keep the pencil mark line facing the table so the mark is on the inside of curl. Now roll the paper to form a tube and insert the tube into the PVC stand tube. Work the rolled up paper so it is snug against the inside of the PVC tube and the ends are square. Now apply a small piece of transparent tape to the overlap joint on the paper, one at each end.

Lay a piece of 2" x 2" aluminum foil over each casting stand base, center the foil over the PVC ring. Now push the PVC stand tube with the paper liner in it onto the base and over the foil. Make sure the pencil line is at the top of casting tube, this is the line you will fill to when casting the grain. Gently push on the paper liner to make sure it has good contact with the foil below. The foil seals the bottom of the stand and is easily removed after the propellant hardens.

When all the erythritol is melted no clumps should be visible. Stir the mixture slowly but thoroughly, the idea is to mix the KNO₃ and erythritol without stirring in air bubbles.

You should now be ready to cast your first grain. Carefully pour the melted propellant into the casting tube, a thin slow stream is best. Once you reach the mark on the paper tube inside the casting stand stop. If you overfill the tube, pour some back into the cooker. It's a little messy trying to pour propellant out of the casting tube, so clean up any messes with your spoon as best you can. Don't overfill the casting tubes! They need to be filled as exactly as possible to the fill line.

After the first casting tube is filled, insert a Delrin rod into the propellant with the tapered end down. Try to keep the rod in the center of the tube as you insert it, when you reach the bottom gently prod for the hole in the bottom of the base. Once you hit the hole, push and twist slightly to insert the rod into the hole. Then install the PVC centering cap over the top of the Delrin rod and over the PVC stand tube.

Tap the entire stand gently a few times on the table top to help settle the propellant, and drive air bubbles to the surface. Repeat the process for the second casting stand.

The propellant in the casting stands will be firm in about 15 minutes, but it is nearly impossible to remove the coring rods until the propellant has cooled. It usually takes 45 minutes to an hour to cool sufficiently. Waiting for the grains to cool isn't a lot of fun, just make sure you don't leave the cook pot unattended while the grains cool.

The melted propellant has an almost unlimited pot life, you may simply leave the melting pot at the 275 degree setting while you wait for the first pair of grains to cool, or you could lower the temperature to 200 degrees, bringing the temperature back up several minutes before casting. I've found leaving the propellant at 275 degrees for extended periods actually increases the propellant grain density by allowing more bubbles to escape. To speed up the process, you could make or buy additional casting stands.

When the casting is complete, you should have some left over propellant. You can save and reuse this, simply pour/scrape out the remaining propellant onto a sheet of aluminum foil and store in a safe place when cool. Add these chunks of propellant to an already melted batch of fresh propellant in the future. Don't try heating only scraps in an empty cook pot, there isn't enough surface area on the chunks to provide good melting, and you may have a hot spot that causes propellant ignition.

After the coring rods have been removed, knock off any high edges from top end of the grain core. Also remove any propellant on the outside of the grain, which may have worked from the bottom of the casting stand and covered the paper inhibitor layer. Sandpaper is probably the easiest way to remove this layer if present. Careful, tight wrapping of the paper inhibitor layer in the casting tube will help to prevent this from occurring.

To finish your grains, wrap each grain with the supplied foil tape. The foil tape has a peel off backing, so remove the backing and position the tape over the grain. Carefully wrap the tape as tightly as possible, smoothing out any wrinkles with extra finger pressure.

The top surface of the grain will appear somewhat uneven and porous. This is just the surface layer and presents no appreciable change in propellant performance. The grains have good strength, but are fairly brittle and should be protected from impact, dropping or the like. It is advisable to inspect each grain with a small, bright flashlight for cracks. I use an LED light in a dark room. The propellant is translucent, and a crack can usually be seen using this method.

Remember, the top of each grain needs some free space. So don't fill the casting tubes full! It may be tempting to get the motor as full as possible with propellant, but all you'll likely get is a motor Cato (Big Boom!). Keep safety in mind at all times, melted propellant ignites easier than cooled propellant. Always work with the assumption the propellant will ignite at any given moment. Avoid working with you face directly over the cook pot.

Store the propellant grains in a safe manner. Locked in a container away from heat, sparks or static discharge. Humidity isn't a concern with KNER propellant, so no special precautions are needed in that respect. Always follow any and all federal, state or local laws that may apply to your activities. It's your responsibility to know the law.

Most of all, be safe, and enjoy the wonderful sport of Experimental Rocketry!