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Volume 4, Issue 6

Making KP Burst Charge

Introduction:
"KP" is the name given to a type of shell burst charge that uses Potassium Perchlorate as the oxidizer in combination with charcoal and sulfur. The KP burst charge was developed in 1955 as an alternative to the chlorate containing H3 charge. While it is not strong enough to replace H3, flash or whistle mix in shells smaller than 4", it makes a great burst charge for shells in the 4" to 6" range. The advantage over H3 is that there are no sensitivity issues when coming into contact with meal primed stars. The bursting strength of KP is also equal to H3, although the burn rate is somewhat slower and varies according to the containment strength of the shell casing. KP is less friction sensitive than H3, flash and whistle mix burst charges, thus making it safer to work with. Every commercial ball shell I have ever dismantled also featured KP burst rolled onto rice hulls, so I guess the Chinese prefer it as well.

The thickness of the KP coating on rice hulls is critical to performance, especially when used on the thin, flakey type of rice hulls available to most hobbyists. The thicker the coating is, the less compressible the resulting burst charge is and the better it will perform (read here to find out why). The football shaped grains of commercial KP hulls found in Chinese shells seem to be rolled on something more like a grain of rice rather than the hull of the rice, which gives a solid, uncompressible grain. Coating the flakey type of rice hulls commonly available in America with a ratio of at least 7:1 KP to hulls will help reduce the compression issue and works well for many mid-size shell configurations.

Rather than stock many different ratios of KP hulls, I tend to design a range of burst configurations for shells that work using just the 7:1 charge (see configurations at end of article). This allows me to make single large batches of just this one charge rather than several smaller batches of various ratios. In the cases where the charge is too strong for the given volume to be filled, I simply cut it with BP puffed rice or color stars. Trying to cut the burst strength by lowering the charge ratio will increase the compressibility of the charge, and also result in uncoated bare spots on your hulls that will reduce the rate of flame propagation. You can actually build any type of ball shell from 4" all the way up to 12" using nothing but various combinations of 7:1 KP hulls and 4:1 BP puffed rice. The bigger the shell gets, the more the BP charge replaces the KP charge and vice versa.


Figure 1: 500 grams of dry hulls ready for

Mixing the KP:
The formula for KP burst charge given by Shimizu calls for 70% Potassium Perchlorate, 18% charcoal, 12% sulfur and +2% glutinous rice starch (can be replaced with +5% dextrin). However, using the standard 75/15/10 formula for black powder works just as well and is what I typically use. I like to mill my charcoal and sulfur together in a 3:2 ratio, then store this pre-milled C/S mix for later use when making both BP and KP. This way I can mix one part C/S with three parts of the appropriate oxidizer for the final mixing, be it perchlorate for KP or nitrate for BP. The table below shows the amounts to mix for

rolling.

Figure 2: 3500 grams of KP rolled onto the hulls.

Figure 3: Resulting hulls ready for drying.

Figure 4: Closeup shows clean, unclumped hulls that flow easily even when wet.

milling the C/S with a typical 6" dia x 8" long milling jar (or equivalent volume).

C/S Pre-mix (light charcoal)

Home Made Charcoal	**300 g**
Sulfur	**200 g**

C/S Pre-mix (dense charcoal)

Commercial Airfloat Charcoal	**360 g**
Sulfur	**240 g**

Because home made charcoal tends to be more fluffy than commercial charcoal, smaller amounts must be used to properly charge the mill jar compared with the denser charcoal. The type of charcoal used is not as important to performance when making KP the way it is when making BP. Fancy charcoals like willow or paulownia are simply not necessary here, as the commercial airfloat will work just fine.

Potassium perchlorate is certainly less sensitive than its chlorate brother, but still too sensitive to safely process in a ball mill. For this reason the perc must be screened together with the C/S mix by hand.

Final Mix (screened by hand 3 or 4 passes)

Potassium Perchlorate	**2500 g**
C/S Mix	**833 g**
Dextrin	**167 g**

This will give you 3500 grams of KP, which will then be rolled onto 500 grams of rice hulls to give the desired 7:1 ratio. These numbers were arrived at by working backwards from the largest batch of rice hulls that my rolling tire can process, which is about 500 grams of dry hulls.

Rolling the Hulls:
For reasons explained here, using a star roller to apply burst charges to rice hulls or any other type of core is the best method to use. Initially I thought the NASCAR tire roller would not work well for doing this, but after some experimentation it turns out a tire roller is actually capable of performing this task.

Figure 1 shows the tire roller charged with 500 grams of rice hulls. Unfortunately the light weight of rice hulls causes them to slide in place once the roller is started, rather than form a tumbling pile the way stars do. This tends to make getting the process

started a bit of a pain, since you have to manually tumble the pile by hand until they are coated enough to tumble on their own. This is done by continually scooping hulls from the top of the pile so that they cascade down the slope after applying each powder increment. It is important to continually tumble the pile by hand in this way during the early stages of rolling.

One key to rolling rice hull charges is to use plenty of water between powder increments. There is a natural tendency to add powder and water in the same way you would for rolling round stars, but this process actually requires much more water between powder increments than star rolling does. If it looks like the powder is not sticking to your hulls, then you are not spraying them enough. A paint sprayer or weed sprayer filled with water can actually help reduce the fatigue of continually pumping a spray bottle during this process. Paint sprayers driven by an air compressor must have the pressure turned down below 10 psi however, otherwise the air blowing out the nozzle will blow your hulls and powder all over the place.

Once your powder bucket is about half empty, the hulls will begin tumbling more on their own. At this point the process becomes much easier, freeing up both hands to do the spraying and powder scooping.

As your powder bucket starts getting close to empty, stop adding water to the hulls and just add powder. Allow more time between powder increments so that the hulls can pick up the dry powder before adding more. As in star rolling, this final step helps to "dry out" the material so that it will flow easier and dry faster.

Once all your powder has been rolled onto the hulls, use a milk jug scoop to remove the hulls while the roller continues to run. The hulls should be smooth and flow easily without sticking to anything. The hulls should be dried on drying screens lined with newspaper to help draw moisture out of the hulls. The dry-box shown here is capable of drying a batch of hulls this size in just one day!

Figure 3 shows the finished hulls, which is enough to fill two one gallon containers and last the typical hobbyist a year or more.

Recommended Uses:

4" single petal
5" single or double petal
6" double petal
6" single petal w/pistil (pistil stars mixed 50/50 with

the KP burst)
6" single petal (4:1 BP puffed rice mixed 50/50 with the KP burst)

NOTE: All shells noted are paper ball shells. Not recommended for plastic ball shells, canisters and especially multi-break canisters.

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