Make Black Powder 7/2/2012

Making black powder isn't difficult but does require some technique and a bit of knowledge. In the past we had tried to make it from various kinds of charcoal we made ourselves and our skill was literally nonexistent. The powder was very low quality and not good for much. It would burn but it wouldn't work in a gun or a rocket. It seemed all the places we got instructions from were leaving something out.

Years later we returned to the project with a US Army Improvised Munitions manual. The instructions were clear and I made my own charcoal as before, the improvements were noticeable and it did burn at least twice as good as our previous attempts years before. We called this Batch 1. It was enough to show us that we could make black powder, but there was something not quite right. It left sulfur spot like scales where it burned. It did not burn completely and it wasn't all that fast.

Our KNO3 was very high quality prilled (tiny balls) at 99.8% pure. Our sulfur was laboratory quality. Our charcoal was the only thing in question. So I found a place on the Internet and ordered a pound of it at nearly $20 per pound. Later I found that Skylighter.com has all the popular graded high quality charcoal for a fraction of the price, under $4 per lb.

Made from assorted hardwoods it was called air float and is the finest charcoal dust you can use for making black powder. I can't even remember what became of batch 2 I think it was also made with homemade charcoal but batch 3 was really impressive. It worked in a rocket and the gun. It still wasn't as good as manufactured black powder. We changed one thing in our process. The book said to heat until you see little bubbles making sure the formula was completely dissolved then to dry and grate it as quickly as possible.

Batch 4 we heated all the way to a boil and at that time we were impressed. It was noticeably better than batch 3. It worked very well in rockets and the gun. Please note that air float is intended for rockets and fireworks not for guns of any kind.

Batch 5 was once again made from homemade charcoal from a bon fire and had been out in the weather for more than a month. We used the same procedure we had on Batch 4. It was better than Batch 1 but not as good as 3. It did work in the rocket but still left sulfur scales when it burned. It was not dissolving all the KNO3 correctly.

Batch 6 was once again made with factory charcoal but this time we ground the prills in a blender until they were dust before we began. We re-measured the mix to learn the prills were actually more than 75% of the mix. Ground up we were adding less than we had been before. We made our mixture as we had with batch 4 and this Batch 6 was amazing! I'm not brave enough to put it into my black powder gun, though I am confident it would work quite well.

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We made rockets as before but these were exploding from over pressure a few yards off the ground. I took the last two of the same type and drilled the hole out several sizes over to ¼" to allow the pressure out of the engine casing faster and these two went up in a blinding streak going supersonic as high as we could see! The formulas are as follows.

To make ½ lb of Black Powder.

KNO3 ¾ cup (ground to powder)

Charcoal ½ cup

Sulfur 1/8 cup

Alcohol 20 oz

Water ¼ cup and mix well then add another ½ cup heat to a boil.

To make 1lb of Black Powder

KNO3 1 ½ cup (ground to powder)

Charcoal 1 cup

Sulfur ¼ cup

Alcohol 40 oz

Water **½ cup and mix** then add 1 cup mix while heating to a boil then process.

If you want 2 lbs of mix you double this.

The Process requires slow heating on a stove to a boil while mixing continuously.

When it boils remove it from the heat and carefully pour this mix into a larger pan with the alcohol in it while stirring vigorously. The powder will once again fluff out and expand. After this you pour it into another pan with a cloth draped over it to separate the liquid from the powder. Squeeze it out hard removing as much liquid as you can then grate the powder through a screen onto a large flat pan to dry.

Place in the sun where it's warm. Keep it spread thin stir it frequently until dry. One of the keys to making GREAT black powder is drying it as quickly as you can in the hot sun.

Using this process you can make one full pound of black powder in about an hour and a half depending on how hot and dry the air is.

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NOTE: This powder is excellent for the uses I mentioned and it will explode like crazy when contained in a solid housing. We have had rockets explode in flight as I said before. The trick to preventing this is three part. When doing burn regulating I usually only mix small amounts at a time enough for one or two ¾" engines.

1. **Burn control your powder using baking soda**. A tiny pinch will slow the mix down enough to regulate the burn. Too much will ruin it, prevent it from burning at all so be careful. If it burns too slowly you can add more good powder and mix again. Do burn tests until it burns fast but doesn't flash.
2. **The size and shape of the core and the size of the nozzle are critical.** The larger the core the faster it will burn, the more internal pressure it creates. The smaller the nozzle the more pressure you have, the larger the nozzle the more gas escapes faster. These things all regulate the pressure inside the engine casing. Small nozzles and fast burning powders will either cause it to explode or make a very fast rocket. If you want power to get that rocket into the air fast you want a fast burning powder, a larger core can increase the power and a larger than usual nozzle to allow the gas to escape the engine without over-pressuring. These engines usually do not burn more than a second but they hit with a hard powerful punch instantly. By using different combinations you can balance your engine output to get the results you want. You can make a half core ¼" to 5/16", get a powerful lift off and then go into cruise power for the last two seconds.
3. **The amount of pressure you use when pressing the powder into the engine case is also important**. Since my home made press has 5 Chevy 350 valve springs in the top that compress when I pressure the powder into the case I can't tell you the exact pressure I use. **I can give you an idea that I'm pressing to around 300 lbs sometimes a little more**. I made 5 marks at the top and as the slide bar at the top moves up I have relative pressure indicators. Somewhere between line 4 and 5 the slide compresses the springs to their limit. I call this "Max Pressure**." All clay nozzles are pressed to the max** and all the faster powder is pressure to at least level 4. NOTE: If you don't compress the powder at the correct pressure for your burn rate the BP will burn too fast and explode.

Refined Technique: Since our first attempts I've refined my technique making sure all the ingredients are ground to fine powder and then sifted through a fine screen. I set the burner lower at 4-4.5 on the scale to allow the mix to come to a boil slower than before. I make sure the mix is stirred well then sometimes will allow it to set and cook while watching until I see tiny bubbles form and push up under the crust making a bulge in the crust. I stir again and do this until the frequency of the bulges becomes rapid allowing them to bulge within seconds after I stop stirring. Then it's time to dump into the denatured alcohol, process through the rag, ring out the liquid, process through the wire screen onto a tray then dry in the hot sun as quickly as possible.

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This process has produced the fastest burning black powder we have made so far. When testing you must lay it out in a fine **line do not pour a pile and light it, you won't have time to pull your hand back before being burned**. The moment the flame touches this powder it's gone in a flash. You don't have time to blink and it's gone. If your hand is too near you will get burned.

Another thing some do to cause surface burning of BP is to add a tiny amount of **graphite**. This prevents IR from the burn from penetrating the BP and causing pre-ignition (explosion). Graphite dust/powder is very expensive by the pound which is why I use the baking soda burn control method. Perhaps next year I will buy 1lb of graphite and give it a try.

Estes rockets adds a little bit of **dextrin about 0.95% to the mix**. As yet I think that's used to preserve the engine's shelf life. Since they do not say what kind of dextrin they use we might guess it's used by Estes as a bonding agent like a kind of glue in the BP mix. It is used in fireworks as a bonding agent and causes the BP and other ingredients in the mix to stick together. Dextrin is used in balls, stars in rockets and mortars and also used in sparklers to hold the mix together and onto the stick. I've never used dextrin in my rockets though I do have a pound of it.

Sparks: The best way to make sparks using black powder is to add a small amount of Titanium powder. The more powder the more sparks, the larger the particles the larger the sparks. These are bright enough to be seen in daylight they look GREAT at night. Aluminum powder also makes sparks but makes the powder burn differently. This is one of the things they use to create flash powder and when added to **black powder it becomes pressure sensitive**. Do not mix it with pressure or place it into the rocket engine press. Titanium does not make BP pressure sensitive and can be compressed into a rocket engine or fountain. (NOTE***: I've never pressed BP with aluminum but I was warned that it can explode under pressure so I've not done it. I'm speaking second handed on this information and have no desire to blow myself to bits***. I have pressed engines with Titanium and I'm still here to tell the story so I know you can get away with this up to 300 lbs maybe a little more.)

Red Gum: I've read this is what they use in flash powders but didn't understand the purpose until after I tried it in batch 7**. It doesn't make the powder better or more powerful at all, in fact it slows the powder down**. What it does is make the flames more visible by adding red sparks. We made batch 7 using red gum and soon realized it wasn't as powerful as batch 6, but did have bright red sparks that emitted from it. In the engine we tested it was a full pound of thrust less than batch 6 that was made the same way without the red gum. Batch 6 put out about 3 lbs of thrust in a half inch inches while batch 7 put out 2 lbs of thrust.

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Rocket Engine Tester

It's important to know what you are doing, after all **it is rocket science** and that's what it's about. You must find a consistency. You don't make several changes at time, you make little changes here and there until you find that consistency that allows you to make a balanced functional rocket engine. **Everything you do makes a difference**. Having high quality fuel is critical but the entire engine design is also critical to making a good rocket engine every time.

The more surface of the engine fuel you have burning the higher the burn rate the faster the fuel will burn up.

The larger the diameter of the engine the higher the burn rate the more pressure you have inside the engine case.

The smaller the nozzle the higher the pressure.

The larger the nozzle the less pressure the more power you can produce depending on the core and burn rate of your fuel.

These things apply to all solid rocket engines no matter what fuel you use to make them with.

KNO3 + Sugar / Lactose / Sorbitol rocket engines.

I've made engines using combinations of all these and the best mix I've found is …

65% KNO3 (ground to powder)

35% mix of one of the three. I like Sorbitol best for several reasons and will explain shortly.

I add a pinch **of Red Iron Oxide** for color and adds a tiny bit to the burn rate of the fuel. The main reason is it helps you know when the fuel is well mixed when the color uniform.

These will be cooked on a stove to melt and mix them so they can be formed into the engine case. Do not heat higher than about 200-220 deg. **In fact 180 is plenty hot**. If you reach ignition temperature it will go off in your face. Not fun! I've seen a man who says he heats all of his sorbitol engines at 250 deg. I'm not that brave.

Small engines of this type do not preform nearly as well as the black powder engines of the same size. **The larger engines of this type being ¾" cell or larger are much more efficient than the small ones**. The reason being the burn surface of the fuel is greater for the larger sizes.

I've sent ¾" stick rockets of this type to around 1,500 feet. It's hard to say, you can't see them anymore when they get up there far enough. They were not as fast as the black powder engines but the burn was longer and still impressive. Larger engines of this type 2.5" x 1" fuel cell with 5/16" cores lit in the center of the core ignite almost instantly hit hard up to 5+ lbs and burn out in about two seconds depending on the depth of the 5/16" core. This is also done with a 5/16" nozzle. I have tested two of these on my engine tester but have yet to fly one. **NOTE: As yet I've not made or tested a black powder engine of this size and can't give you a comparison between the two fuel types for this size engine as yet.**

Powdered sugar works but temperatures high enough to melt it it will caramelize quickly, turn brown and gets hard to work with. The burn rate isn't always consistent and is usually lower than the other two options. Powdered sugar is the cheapest easiest to get of the three. It's still too hot to touch when it gets too hard to press into the engine mold. **NOTE**: *You can put a small amount of water into the pan first and it prevents the sugar from caramelizing as long as there's a tiny amount of water in the mix. The problem that can happen is when there's a tiny amount of water still in the engine when you finish it. It can make the fuel burn inconsistent*.

Lactose engines heat, melt and mix slightly better than sugar and it takes about twice as long for them to caramelize in the pan. Like sugar it's sticky and difficult to work with. Like sugar it's still too hot to touch when it gets too hard to work with.

Sorbitol is not quite as sticky and is easier to work with, does not caramelize and is still soft enough to work with when it's at a temperature you can touch with your finger. I'm not certain of the actual burn rate but I will say it's higher than the other two since the rockets made from this seem to go higher faster and travel further. You can put it into the freezer in the mold, cool it for 30-60 min, take it out, remove the fuel cell from the mold and put it in a safe place on top end until it's solid. If put into a box you don't want anything laying on the cell as it can deform the shape of the fuel cell and make it difficult to put into the engine case. It can also change the shape of the core which will change the consistency of the engine.

I use 1" end caps to help keep the fuel core the right size and shape. These can be bought from some of the fireworks component suppliers on the Internet. These caps are thin light weight fire resistant and very useful to help seal the top end of the engine from blowing out.

At this time I'm using bentonite clay for the nozzles and wooden caps about ¾" thick, hot glued into the engine case on top of the cardboard plug. Then I drill a hole through the case and block slightly smaller than the nail I drive through it. Then I cut the nail off and grind or file it until it's smooth with the engine case. Later as I refine my engines I will make changes to these things so I can build rockets with recovery systems.