How to Make Black Powder
(and other explosives)

Introduction

Black Powder, also known as Gunpowder, is an explosive that has been around, literally, for centuries. The exact origins of the formula are lost in time, but it is known that the Chinese used Black Powder in weaponry at least 1,000 years ago.

Technically, Black Powder burns by a process known as *deflagration*. This differs from *detonation* in that Black Powder produces subsonic shock waves, as opposed to the supersonic shock waves produced by explosives such as Dynamite, C-4 or TNT. This means that Black Powder is better suited as a propellant (such as in fireworks, bullets and cannons) than blasting (such as in construction or demolition).

Safety

Black Powder is dangerous!. The powder burns at a very high temperature, and is easily ignited. (High grade powder doesn't even need a flame to ignite – it can be set off by percussion, such as the firing pin of a pistol.) Basically, what I am saying is that if you are not careful, you could land up with very severe burns, or worse. Some basic guidelines to follow:

1) Always mix ingredients in small amounts. Do not try to make 10 Kg of black powder (or any explosive) in one batch. Mixing small amounts of powder limits the potential damage should an unexpected explosion occur.
2) Keep your workplace tidy. Always carefully clean up spilled chemicals. Some materials can spontaneously combust when mixed (this is especially true of nitrates and chlorates). For the same reason, use separate instruments (plastic spoons, mixing cups, etc) for different chemicals. Label your instruments so that you know what materials they have been in contact with.
3) Mix materials outdoors. Chemical explosives contain their own internal source of oxygen, and cannot be smothered. If you start a chemical fire indoors, it can be nearly impossible to extinguish.
4) Be aware of static sparks. Do not use metal instruments to mix or grind materials. Do not store chemicals in metal containers. Use ceramics or plastics wherever possible. Store chemicals and mixtures in plastic containers or ZipLoc™ bags.
5) Wear safety goggles. Should the worst happen, skin can be grafted. Eyes cannot be replaced.

Ingredients

Black Powder has traditionally consisted of three ingredients: Potassium Nitrate (KNO_3, also known as Salt Peter), Sulfur and Charcoal. The Sulfur and Charcoal provide fuel for the reaction, while the Potassium Nitrate provides Oxygen. By themselves, Charcoal and

Sulfur will burn, albeit very slowly. The addition of an oxidizer (such as KNO_3) greatly speeds up the burn rate of the fuel, resulting in an explosive reaction.

The traditional ratio of the ingredients is 15:3:2 of KNO_3, Charcoal and Sulfur by weight (not volume!). However, simply mixing the dry ingredients together will not give you black powder. At best, you will get a green powder that will do little more than produce vast quantities of smoke, and annoy your neighbors. In order to make high-grade powder, a little work is needed.

Preparing the Ingredients

The quality of the resulting powder depends on a number of factors. The most important of these is *binding*, which refers to how tightly the KNO_3 is mixed in with the Charcoal/Sulfur mixture. This is why a loose binding, such as a dry mix, produces a very low-grade powder.

The quality of the powder is defined by its *burn rate*, usually expressed in cm^3/s. A burn rate of about 14 cm^3/s or higher is required to use the powder as a propellant. (Also, possession and manufacture of powder with a burn rate of 14 cm^3/s or higher constitutes a weapons violation under US law, unless you are also in possession of an ATF license.)

I will present two methods of preparing black powder here. The first produces powder with a slightly lower burn rate, but is safer to prepare. The second can produce very high quality powder, but contains an element of danger. The methods presented here will get you a burn rate of 14 cm^3/s or better, depending on how much patience you have, and the quality of your ingredients.

The Charcoal/Sulfur mixture must be ground as finely as possible. Simply whacking away at your barbeque charcoal with a hammer is not going to cut it. The charcoal must be ground into a very fine powder. Commercial manufacturers use large machines known as *ball mills* to crush the charcoal and sulfur. A ball mill is basically a large rotating drum filled with charcoal, sulfur and a crushing agent, such as lead balls or heavy stones. The mill is rotated at high speed for up to 48 hours or longer. The result is a very finely powdered charcoal/sulfur mixture. (Note: for reasons which should be very obvious, the Potassium Nitrate is **not** mixed in with the fuel during the milling stage, unless you want to be picking bits of your ball mill out of the walls of your factory.)

Ball Mills are very expensive, and it is unlikely that the average hobbyist will be able to afford one. There are alternatives, however. One is to simply buy the charcoal in a powdered form. There are several mail order companies that will provide powdered charcoal. (See the list of suppliers at the end of this article). The other alternative is to fashion a ball mill of your own, if you happen to be a handyman. Or, you could simply buy a cheap gem-polishing toy mill from your local Wal-Mart, and use kids marbles, or heavy decorative stones as a crushing agent. You will have to run the mill continuously for at least 72 hours with this method, however.

Assuming that you have a powdered charcoal/sulfur mixture in the right quantities, how do you get the KNO_3 to bind to the mixture? The solution is to employ a useful property of Potassium Nitrate – it is soluble in water.

Charcoal and sulfur, on the other hand, are not soluble in water. They will, however, absorb KNO_3 from water under suitable circumstances. The addition of cold alcohol to the mix will have the effect of suddenly leaching the water out of the mixture, leaving just the salt behind, hopefully tightly bound to the fuel.

Method 1 - Boiling

Requirements:
Skillet, stovetop (preferably outdoors!), plastic strirrer, 750 ml of Isopropyl Alcohol, household sieves, coffee filters.

The recipe for producing black powder using this method is as follows (adjust quantities as desired, but remember to stick to the ratio). Before you start, have a 750 ml bottle of rubbing alcohol chilled in a freezer for at least 24 hours. (You can purchase rubbing alcohol, also known as Isopropyl Alcohol, from most any drugstore or supermarket).

1) Mix 30 grams of **powdered** charcoal with 20 grams of powdered sulfur, as described above.
2) Using a deep skillet, bring about three or four cups of water to boil. Stir in 150 grams of KNO_3. Keep stirring until the Potassium Nitrate is completely dissolved. Add water as necessary, but try not to over-water the mixture.
3) Slowly sift in the charcoal/sulfur mixture. The mixture will tend to float on top of the water, so you will have to agitate the slush with a spoon or a whisk. Keep stirring until you get a wet, grayish sludge. This could take a while, so take your time and **be careful**. Don't let any of the mixture slop out of the skillet onto the hot stove-top, or you will most likely start a fire.
4) Once the sludge is uniformly mixed, remove the skillet from the stove. Pour in the chilled alcohol, and stir. Keep pouring and stirring until the sludge is cool enough to touch.
5) Pour the sludge into a coffee filter placed in a sieve over a plastic container. Allow the water/alcohol to drain out until the sludge is dry enough to leave an impression when you press into it.
6) Using a fine sieve, press the sludge through the sieve onto a large piece of cardboard or blotting paper. This should produce fine granules of powder. Take your time, evenly spreading the granules onto the paper or cardboard.
7) Allow the granules to dry in direct sunlight for at least 24 hours. When dry, pour the granules through a finer sieve to remove any fine powder from the granules. This fine powder (known as meal powder) is not useful for firecrackers or propellants, but can be used to make fuses or fountains.

You should now have real, honest-to-goodness Black Powder. Congrats.

Method 2 – Agitation

This method is very similar to that described above, but differs in the manner in which the ingredients are mixed. Because it uses electrical equipment, it is considerably more dangerous than the previous method, but can produce very high quality powder.

Requirements:
Electric kitchen blender, 750 ml of Isopropyl Alcohol, household sieve, coffee filters.

1) Pour 3 or 4 cups of boiling water into the blender. Slowly add 150 grams of KNO_3. Cover the blender, and agitate at medium speed for about ten minutes. (Note – it is advisable to use an extension cord to start the blender from a safe distance. Again, this should be done outdoors!)
2) Slowly mix in 50 grams of charcoal/sulfur mixture. This should be done by turning off the blender, pouring in a small amount of the mixture, restarting the blender and mixing until the charcoal/sulfur is completely wet. Repeat until all the fuel has been added and thoroughly mixed. (Take your time – remember: haste kills!)
3) Let the blender run at high speed for about 15 minutes. Slowly pour in the alcohol while the blender is running. You should hear the blender slow down as the mixture solidifies. Add more alcohol until the mixture is cool to the touch.
4) Follow steps 5 through 7 from method 1.

Testing Your Powder

In order to test the burn rate of your powder, all you need is a stopwatch and a soda can. Thanks to the magic of the metric system, it turns out that 1 ml = 1 cm^3. Soda cans are usually marked with the volume in ml (the average can is 340 ml). You may not want to use an entire can, however, as that would be a waste. Most supermarkets sell soda in half-size cans (such as you usually get on airliners). Or, you could simply cut a full sized can using a pair of metal shears, and calculate the volume of the can. (For those of you who slept through math at high school, the formula is $v = h*pi*r^2$. Remember to use **metric** units. In other words, measure the height and diameter of the can in centimeters, not inches, miles or furlongs, or whatever else you Yanks have got stuck with.)

Now, fill the can to the brim with powder. Do not cover the can! One word – shrapnel! Insert a fuse (you can usually buy so-called 'safety fuses' from a supermarket around the 4^{th} of July, or New Years. Also, fireworks retailers almost always carry lengths of safety fuse. If you are desperate, simply insert a match into the can, with the match-head just under the surface of the powder.) Light the fuse, wait for the powder to start burning, and time the burn with the stopwatch. Divide the volume of powder by the time it takes to burn completely, and you have your burn rate.

Things that go Bang!

So now you have black powder. What do you do with it? Short answer – you make it explode, of course! This is achieved by confining the powder inside a container and initiating a pressure-feedback loop. For the physics-impaired, this is how it works: the burn rate of black powder is directly proportional to the surrounding pressure. The more the pressure increases, the faster the powder burns. If the powder burns in a confined space, it will release large quantities of gas, which in turn increase the internal pressure, which increases the burn rate of the powder, which releases more gas….well, you get the idea. The feedback loop continues until the internal pressure bursts the container, resulting in a large bang.

The whole process takes place in a matter of milliseconds, if your powder is of sufficient quality. This is why we use granulated powder for firecrackers – granules means more surface area. More surface area means that the hot gases traveling through the container can ignite more powder, more quickly.

So, what do we use for a container? All those of you who said 'metal pipes' or 'glass bottles', please pick up your things and get the hell out of my classroom. Anyone with two brain cells to rub together should realize that when a metal or glass container bursts, the air will suddenly be filled with very tiny pieces of glass or metal, traveling at speeds of several hundred meters per second in all directions. This, boy and girls, is what we call **shrapnel**, and our aim is to avoid it, unless you want to end up looking like a piece of Swiss cheese.

Firecracker containers are made of cardboard, or soft plastic. Not only is a piece of flying cardboard far less dangerous than a supersonic piece of sharp metal, but cardboard and plastic containers tend to be consumed by the heat of the explosion, leaving even fewer potentially dangerous missiles to fly around.

The suppliers listed below will carry pre-made cardboard tubes, with plugs that are glued into the ends to form a tightly contained tube. If you happen to be impatient, you can probably find something around your house that might do the trick.

Two fairly common household items that you could use are the soft plastic containers that 35 mm film is usually sold in, or the soft plastic containers in which your local pharmacist usually dispenses drugs. (By the way – if your local pharmacist is a guy named 'Jim' who hangs around dark alleys, you shouldn't be experimenting with explosives. Kapish?)

To start with, make a small hole in the top of the container. Punch or drill a hole about 2 to 3 mm in diameter in the top of the container. Place a wooden toothpick in the whole (you'll find out why later.) Fill the container about one-third to one-half with granulated black powder, and glue the top back on. Use a strong glue, like Welder's all-purpose, or a hot glue gun if you have one. Regular model cement glue will not be strong enough to keep the top in place during the explosion.

Now, we turn to the one supply that no pyro should be without – duct tape. Cut a long strip of tape, long enough to completely cover the container from top to bottom and back again. This is where the toothpick come in – push the tape slowly over the toothpick onto the top of the container. The toothpick will mark the place where the fuse will later be inserted. Repeat the process until the container is completely covered with tape. The purpose of the tape is two-fold: first, it strengthens the container allowing more pressure to build up before it bursts and secondly, it traps any pieces of the container that might otherwise have a tendency to be ejected from the explosion.

While the glue is drying, remove the toothpick and insert the fuse through the hole left behind. The fuse should fit snugly. When the glue is dry, take the whole device outside, place on the ground, light the fuse and get out of the way. If you are successful, you should soon have a visit from the neighbors.

Flash Powder

Black powder is not the only explosive agent out there – there are literally hundreds, all with different uses and characteristics. Flash powder is one such material. It was originally used to produce the bright flash for those old-time photographs. Flash powder has some pros and cons over black powder:

Pros: Flash powder is much, much easier to make. It also produces far more heat and sound than a BP explosion.
Cons: Flash powder is highly unstable. It can easily be set off by friction alone. It also produces a far more powerful explosion than BP. If you are dumb enough to hold a container of BP in your hand while it explodes, you will land up with severely burnt fingers. If you repeat the experiment with flash powder, you will land up with no fingers at all. I'm not kidding. I have personally seen 40 grams of flash powder in a cherry bomb leave a crater a half foot deep in my backyard.

Ingredients

There are several compositions of flash powder. The safest (relatively speaking) is Potassium Perchlorate ($KClO_4$) and Aluminum powder. This produces a powder which is relatively stable, but slightly less potent than the other compositions. Flash powder can also be made from Potassium Chlorate and Aluminum powder. This powder produces an extremely bright flash, and a window-rattling bang, but it is very sensitive to friction. Just staring at it long enough will set it off. I suggest you stick to the perchlorate version.

Making Flash Powder

The ratios by weight for flash powder are 70:30 of $KClO_4$ and Al powder. The powder is mixed as follows:

1) Place 70 grams of $KClO_4$ on a sheet of newspaper. Gently crush the powder with a rolling pin to break up any crystals.

2) Slowly sprinkle 30 grams of Aluminum powder on top of the $KClO_4$.
3) Pick up the top left corner of the paper and gently roll the mixture towards you. Pick up the bottom right corner of the paper and gently roll the mixture back to the center.
4) Repeat this rolling procedure with all four corners until the powders are thoroughly mixed. Take your time, repeat at least forty times.
5) Slowly pour the mixture into a clearly labeled ZipLoc™ bag.

Cherry Bombs

These are fun little devices. They look cool, make an extremely bright flash and an ear-splitting bang. They are also fairly easy to make.

Requirements: Ping-Pong (table tennis) balls, duct tape, box-cutter, strips of newspaper, liquid starch.

Method: cut a small hold about a centimeter in diameter in the ping-pong ball with the box cutter. Fill the ball about one-third with flash powder. Cover the hole with duct tape.

Cut a piece of newspaper into strips about 30 cm by 1.5 cm. Dip a strip of paper into a container of liquid starch, and wrap around the ball. Repeat until the ball is covered with at least three layers of paper.

Leave the ball outside to dry in direct sunlight for 24 to 48 hours, until the paper is completely solid. If you want to add a classic touch, paint the ball red with a can of regular spray paint.

Carefully drill a small hole in the ball for a fuse. It is best to use a hand drill for this purpose, to avoid sparks.

Insert the fuse. Attach the fuse to the surface of the ball with a little model cement or hot glue. (Don't use too much glue, or it will tend to smother the fuse).

Place the cherry bomb on the ground. Light the fuse and get away – quick. Apologize profusely to the neighbors.

Suppliers

www.skylighter.com
www.pyrosupplies.com
www.skyhighfx.com