In the gun.

Different shooters view these different sources of black powder from their own experience with them.

It is simply not possible to produce a single black powder, in several grain sizes, that is ideal in every gun in every possible loading configuration.

With black powder, a low mass projectile such as a patched round ball is most efficiently accelerated through the bore of the gun using a very fast, very hot burning sporting type powder. These give high velocities with relatively small charges. A heavy projectile, in relation to its diameter, is best accelerated in the bore using a powder that burns cooler and produces a large volume of gases, compared to a low mass projectile.

If one uses a slow-burning grade of black powder with a low mass projectile, powder charges must be rather large to get desirable velocities and that comes at a price of excessive bore fouling simply do to the large amount of powder being used. At the same time one must use care in using very fast, very hot burning powder with a heavy projectile, in relation to its diameter, will create rather high breech pressures and accuracy usually suffers as a result.

The author shoots only muzzleloading black powder rifles so the information on how the powders perform in a gun is written with that view in mind.

Misconceptions with black powder.

Publications aimed at black powder shooters will often have bits of information regarding the behavior of black powder that are simply not true.

Hygroscopic in nature.

The hygroscopic behavior of black powder is primarily a factor of the quality, or purity, of the potassium nitrate used in its preparation. High purity potassium nitrate will pick up only trace amounts of moisture from the air until the Relative Humidity reaches 92%. As the R.H. rises above 92% the potassium nitrate begins to pick up increasing amounts of moisture from the air. The maximum amount one would see when the powder is exposed to just below dew point conditions would be around 1.6%. In addition, with a properly prepared powder the moisture would be given back to the surrounding air as soon as the Relative Humidity begins to go down.

The burn rate and overall performance of the powder does not begin to suffer until the moisture content of the powder exceeds 1.0%. Most commercially prepared black powders are shipped with a moisture content of about 0.5%.

Comparing 3 brands of black powder.

Samples of the three powders were dried in an oven at 160 F until constant weight. That then being assumed to be a zero percent moisture content.

Weighed samples of each powder were then placed in shallow aluminum foil trays. This were placed outside on a roofed over deck. Periodically weighed and the temperature and humidity noted. Percentage of weight increase, or decrease, calculated from any change in weight.

Conditions	KIK 3Fg	GOEX 3Fg	Elephant 3Fg
	00.04	98MA09B	Lot S-10, Date Code 22/00
82F - 56% RH	1.0%	0.7%	0.7%
77F - 62% RH	1.1%	0.9%	0.8%
73F - 71% RH	1.2%	1.1%	1.0%
73F - 73% RH	1.2%	1.2%	1.1%
Left out overnight, colder drier air moved into the area.			
72F - 46% RH	0.8%	0.7%	0.6%

In this data we see the powder responding to changes in Relative Humidity. None of the brands seen in this would be considered to be overly hygroscopic. In 2000 GOEX changed potassium nitrate suppliers and the “new” source would be a match for the Elephant data.

It should also be pointed out that most of the BP subs are more hygroscopic compared to black powder. In the case of Pyrodex, it would give values double to triple those seen with these samples of black powder.

Corrosiveness.

There have been any number of articles on black powder that state it is excessively corrosive in the gun. About 10 years ago one of the black powder substitute manufacturers began to advertise that their powder was not corrosive because it contained no sulfur.

There has been a concept that the elemental sulfur in black powder will cause it to be corrosive in a gun both before and after powder combustion. In pre-combustion corrosion it is claimed that the particles of sulfur, in the powder, have a mono-molecular layer of the oxide of sulfur on the surfaces of the particles. That when damp this oxide of sulfur forms sulfurous acid which then acidifies the powder making it corrosive. This ignores the fact that the charcoal used contains carbonate minerals (ash) that would act as a buffer or anti-acid in the powder. In a properly prepared black powder this simply does not happen. In a powder prepared with very impure water or a sulfur that is acidic then the idea of the chemical decomposition reactions would be correct.

There have been instances where charges of black powder were left in a gun unfired for some time. When the charge would be removed it would be seen that the bore is badly pitted in the area of the bore where the powder charge had been.

This pitting would occur with any type of “salt” being in contact with the bore metal. Thin films of water on the surfaces of salt crystals in contact with a metal set up electrolytic corrosion cells where the salt crystal contacts the metal. Such an event certainly is not unique to black powder.

Black powder residue is said to be corrosive in the bore of the gun due to the presence of sulfur-bearing gases. Created during powder combustion. That then combine with the hygroscopic solid products of powder combustion to form corrosive acids.

Black powder combustion produces both sulfur dioxide and trace amounts of hydrogen sulfide.

If one collects black powder fouling from the bore of a freshly fired gun one finds that the residue has a pH of around 9.0 to 9.5. That would be moderately caustic. The major portion of the solid products of the combustion of black powder is potassium carbonate. Roughly 3 to 4 parts of potassium carbonate for every part of potassium sulfate. Gives the amount of potassium carbonate, or potash, in the residue it would be impossible for any sulfur-bearing acids to attack the bore metal. It would take moisture to convert the sulfur-bearing gases into an acid and the same moisture would “activate” the potash which would immediately neutralize, or kill, the acid.

It is true that black powder residue is indeed corrosive. But only mildly corrosive. The primary solid product of combustion is potassium carbonate, or potash. Above 30% R.H. it is hygroscopic. As the R.H. increases the potassium carbonate will pick up increasing amounts of water from the air. When it becomes “wet” it produces an electrolyte that then begins electrolytic corrosion of the metal surface on which it rests. In the case of brass cartridges it will begin to leach copper out of the surface of the brass.

This same activity will go on in the bore with the black powder substitutes that claim to be non-corrosive. Any propellant powder that uses potassium nitrate as an oxygen source produces potassium carbonate as a primary product of combustion.

Potassium carbonate will corrode the surface of a metal almost uniformly across the surface. Forming a very thin film of rust that is free of any pitting.

When the propellant powder contains any chlorides one will then see deep pitting of the metal’s surface. At least two black powder substitutes contain potassium perchlorate. This potassium perchlorate is converted to potassium chloride during powder combustion. Being a chloride salt it is highly corrosive and will result in deep pitting of the metal rather than a thin film rusting. Cheap grades of potassium nitrate, i.e. fertilizer grades, may contain residual potassium chloride that had not been converted to potassium nitrate during its manufacture.

Bore fouling.

There was an incident in 2001 that caused the author to get into a lengthy project looking into bore fouling differences with the different brands of black powder.

A shooter had purchased a case of 2000 production Elephant brand black powder shortly after it went out into the distribution system. The shooter complained to the importer that when he went to shoot with this powder he had to force the second round down the bore. He had no wiped the bore after the first shot. He commented that he had never had this problem when he shot GOEX black powder.

The author was put on the Elephant Black powder Company payroll for the 4 hours required to recover the case of powder from the shooter who lived a short distance away. He was reimbursed in full.

Two days later the author took the same can of powder the shooter had complained about to the range. The original purchaser had shot this powder in a .50 caliber flintlock ignition T/C Renegade. The author shot the same can of powder in a .50 caliber Lyman Trade Rifle with percussion ignition. Other than the ignition system these guns are nearly identical when it comes to barrels.

The author was able to fire 10 rounds without wiping between shots and it was not necessary to really force any rounds down the bore.

It became a question of what was the variable giving the difference in performance.

Looking at the weather statistics it was noted that on the day that the original purchaser had shot the powder the Relative Humidity was very low for the area. Down around 20%. On the day the author shot the powder the Relative Humidity was 60%.

The author had previously noted that on some days after having fired his flintlock rifle the powder residue on the area around the lock would turn white. On other days it would turn black. The change to white happened when the RH was very low and the change to black when the R.H. was in the normal range for the area.

The project then became one of shooting both Elephant and GOEX in the same rifle in the same charges on different days with different levels of relative humidity. Out of this came the direction to go with simple experiments.

Metal salve tins were set up outside. Small amounts of each of the two brands of black powder were open flashed in the tins repeatedly until a good amount of powder residue was collected. These powder residue samples were then had their weights adjusted to a specific weight. Placed in an oven at 160 F for 6 hours. The residue had turned almost snow-white in color. These then went out on the roofed over deck to see how the residue responded to changes in Relative Humidity.

Out of that work came the data showing that when the Relative Humidity is below 30% the powder residue will hold no water. So below 30% it is non-hygroscopic. Then above 30% R.H. the residue begins to pick up water from the air. At about 60% R.H. the residue begins to look more like a paste. Rather black in color. At about 80% R.H. the residue begins to actually look wet.

Another salve tin containing powdered technical grade potassium carbonate was set up with the two powder residue salve tins. The potassium carbonate produced data that closely matched the powder residue samples.

With the powder residue the residue is roughly 70 to 75% potassium carbonate. The 25 to 30% of potassium sulfate has little influence in how the powder residue reacts to moisture in the air. The potassium sulfate is relatively non-hygroscopic over almost the full range of R.H.

This then explained how one can of powder could act so differently on two different shooting days. It was also found that when shooting the Elephant and the GOEX there was little difference in the two, relative to bore fouling, when shot in the same gun, in the same loading configuration and on the same day.

This also showed why late 19th century writings so highly value what they called a "moist-burning" powder. At present the only true moist-burning black powder on the market is the black powder produced in Switzerland.

With the powders that do not burn moist the shooter is at the mercy of the humidity after the shot leaves the bore. When the shot leaves the bore there is a pressure collapse in the bore that draws air into the bore from outside the gun. It is this air that then provides moisture to the powder residue left in the bore.

In the case of a moist-burning powder it produces a small amount of water as a product of combustion. The shooter is then no longer dependent on the moisture level of the air entering the bore after the shot leaves the muzzle. With the moist-burning powder some guns will shoot with greater accuracy if the bore is not wiped between shots. There is of course a limit with the moist burning powders if the charges used are too large and the fouling begins to fuse in the bore from high gas temperatures. This will be explained a little later here.

But this work explained why one day the shooter might struggle to get a second or third round down the bore if the bore was not wiped between shots and another day any number of rounds may be fired without wiping between shots.

The next issue that had to be looked into was the actual amounts of fouling left in the bore. With the same powder and the same gun there was a difference in the quantities of bore fouling on different days under different weather conditions.

During the latter half of the 19th century the two leading black powder researchers in England were Captain Noble and F.A. Abel. Through extensive test firings in closed bombs they determined that about 55% of the original charge weight will be found as solid particulate matter in the residue left by the burning of black powder.

So the question in this work was to determine how much of that 55% of the original charge weight is retained in the gun as bore fouling and how much is ejected suspended in the gases behind the projectile after it exits the muzzle of the gun.

The common concept is that the smoke produced by black powder is composed mainly of unburnt charcoal. Collecting solid particulate matter blow out of the barrel behind the projectile showed this is simply not true. The so-called smoke is the same solid particulate matter that is found in the bore. That being a mixture of potassium carbonate and potassium sulfate.

This "smoke" was collected by firing the rifle through a large plastic funnel. A portion of the solids would adhere to the inside of the plastic funnel where it could be collected and examined.

The author's work with black powder residue collected from the bore of a freshly fired black powder rifle was almost totally soluble in water. The only water-insoluble in the residue was graphite from the grain coating that did not burn in the bore because the gas temperature behind the projectile did not reach the 2000 C temperature required to ignite and burn the graphite.

This almost total solubility in water then formed the basis for a test to measure the amount of fouling left in the bore after a shot had been fired.

A set of ten commercial circular waffle pattern cleaning patches would be dried in an oven at 150 F for 4 hours. Wrapped in a piece of weighed aluminum foil to protect them from the air and then weighed. The weight of the patches alone then being calculated.

At the range, weighed charges of powder were fired in the gun. In this case a .45 caliber rifle with a flat-face breech plug. This allows between shot cleaning patches to go right down onto the face of the breech plug. After each shot one of the weighed cleaning patches would be moistened with water and then run slowly down the bore. As it was slowly run down the bore it would collect the powder residue which would then dissolve into the water contained in the cleaning patch.

To insure the accuracy of this method the same rifle had been shot and the bore flushed with water. The collected flushing then being evaporated and the resulting solid residue weighed. Both methods gave the same results with the wet patch being the easier test to work with.

When the cleaning patches were withdrawn from the bore they would go between plastic. Once 10 from the string of shots were collected the plastic would be sealed.

Once home from the shooting range these patches would be dried in the oven at 160 F until constant weight. This would generally be 5 to 6 hours to insure total dryness.

Knowing the weight of powder used in the 10 shots and the weight of the residue collected by the set of 10 wet patches it was possible to calculate the percentage of the original charge as fouling left in the bore.

The first round of testing used Elephant brand black powder. For a specific reason. The 1998 production run of Elephant had been done with some high fixed carbon content charcoal. This increased bore fouling. This powder also had a lot of dust clinging to the surfaces of the grains. Dust created during the polishing step in the production and not removed prior to packaging. This also contributed to greater bore fouling.

With the 1999 production run of Elephant the plant insured that the fixed carbon content of the charcoal used was in the range of 75 to 77%. This powder also had been cleaned up during polishing by adding large pieces of cotton muslin to the powder in the polishing barrels. The cloth removing any powder dust created during the polishing operation.

The 2000 production run of Elephant did not deviate any great deal from the 1999 run.

Test rifle: TVM Southern Mountain Rifle, flintlock ignition, .45 caliber.
35.25 inch internal barrel length.
.440 Speer balls with .018" #40 cotton drill patching.
Ball patches lubed with Lehigh Valley Shooting Patch Lubricant.
Using 3Fg powders.

1998 production, 3.8% of the original charge weight as recovered bore fouling.
1999 production, 2.3% of the original charge weight as recovered bore fouling.
2000 production, 2.5% of the original charge weight as recovered bore fouling.

This testing was done on a day when the air temperature was in the 40s and the R.H. around 50%.

The second round of testing used GOEX, Elephant and Swiss powder in the same rifle. The results showed that there was little difference between GOEX and Elephant in regards to the percentage of the original charge weight as recovered bore fouling.

The surprise was the Swiss powder. While GOEX and Elephant gave 2.5% to 2.8% of the charge weight as recovered bore fouling the Swiss powder gave 3.2%. This was a first something of a puzzle requiring some logical thought.

With the combustion of black powder all of the potassium, from the potassium nitrate, will be found in the solid products of combustion. There are no potassium based gases produced. GOEX is formulated with a potassium nitrate content of 75%. Elephant was formulated with a potassium nitrate content of 76%. The Swiss powder is formulated around 78% potassium nitrate. More potassium nitrate simply produces a greater proportion of solid products of combustion relative to the volume of gases produced. The moist-burning property of the Swiss powder gives a slight increase in the proportion of solid residue retained in the bore versus the amount ejected from the bore in the spent propelling gases. But since the Swiss powder fouling is moist and readily soluble in the water in a between shot swab it gives the impression of giving far less bore fouling.

During this work it became clear that there were other factors involved in how a shooter perceives bore fouling differences in the different brands of black powder.

The work was continued to see if it was possible to understand these differences. This became a very lengthy project performed in stages to isolate the different factors.

Old writings on black powder shooting indicated that a point is reached in charge volume increases where there is then a dramatic change for the worse in bore fouling and dealing with it in the gun. Possibly tied to what is commonly refereed to as the point of diminishing returns.

So in the next round of testing the charge volume/weight of the powder charges used were increased in increments.

The rifle used was the .45 caliber TVM Southern Mountain Rifle as detailed on page 91. Charges are by weight in grains.

40 grs. 2.5% of the original charge weight as recovered bore fouling.
50 grs. 2.6%
60 grs. 2.4%
70 grs. 2.3%
80 grs. 2.3%
90 grs. 2.5%

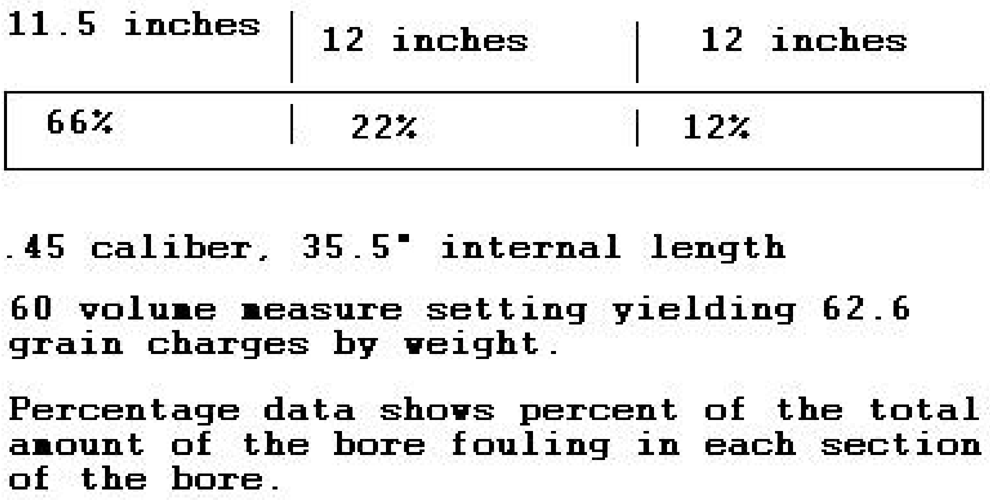
This data closely matches the previous work. The data shows that there is no marked increase in the percentage of the charge weight as recovered bore fouling.

What this trial showed was that while there was no dramatic increase in weight there was a marked difference in how the bore fouling felt when the wet recovery swabs were run down the bore. A point was reached where it became a bit difficult to get the wet patch into the fouling down towards the breech in the barrel.

A few weeks after performing the work shown on pages 91 and 92 the weather turned quite warm. With full sun and air temperatures in the 80's the powders that gave 2.3 to 2.8% of the charge weight as recovered bore fouling suddenly gave 15% of the original charge weight as recovered bore fouling. The same cans of powder no less.

One aspect that had to be looked into was how the bore fouling was distributed throughout the length of the bore.

The bore of the TVM Southern Mountain Rifle was divided into 3 sections. The cleaning rod was marked to give depth into the bore indication.



11.5 inches	12 inches	12 inches
66%	22%	12%

.45 caliber, 35.5" internal length

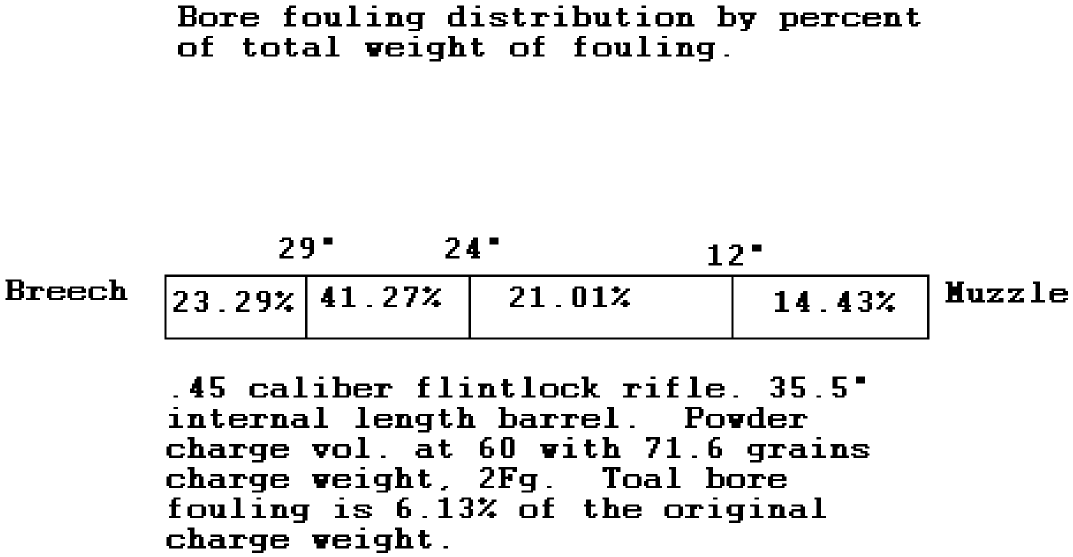
60 volume measure setting yielding 62.6 grain charges by weight.

Percentage data shows percent of the total amount of the bore fouling in each section of the bore.

Figure 92. Bore fouling distribution in the bore.

Late 19th century writings suggested that most of the powder charge is consumed before the projectile moves any great distance up the bore. The pattern of bore fouling deposition tends to back that idea.

Another test session was set up at the range to better define the breech area in the bore.



Bore fouling distribution by percent of total weight of fouling.

.45 caliber flintlock rifle. 35.5" internal length barrel. Powder charge vol. at 60 with 71.6 grains charge weight, 2Fg. Toal bore fouling is 6.13% of the original charge weight.

Figure 93. Closer look at the breech section.

In this diagram the breech area is divided into two sections. Essentially, halved from the previous diagram of bore fouling distribution. The line denoting 29" into the bore from the muzzle indicates where the patched round ball sat on the powder charge in the bore.

The data simply reflects what is often felt when a damp cleaning swab is run down the bore That being that fouling appears to be heaviest just forwards from where the patched ball sat on the powder charge before the gun was fired.

Another point in this work was to look at powder fouling build up in the bore when the bore is not wiped between shots. This will vary with weather conditions and brand or lot of powder being used.

Shooting conditions on this day had air temperature in the 70's and Relative Humidity around 50%.

8.9% of the original charge weight as recovered bore fouling.
Firing and wiping between shots.

9.1% of the original charge weight as recovered bore fouling.
Firing two shots before swabbing the bore.

10.7% of the original charge weight as recovered bore fouling.
Firing three shots before swabbing the bore.

10.7% of the original charge weight as recovered bore fouling.
Firing 4 shots before swabbing the bore.

It should be pointed out that several days before shooting for this data the same can of powder gave 2.8% of the original charge weight as recovered bore fouling. The difference being the air temperature at the time of shooting.

The data suggests that when a shooter does not swab between shots a point will be reached where the relative amount of fouling becomes constant from one shot to the next.

When shooting over the chronograph it was often necessary to fire a number of rounds with swabbing between shots to reach what might be described as a steady state in the fouling left in the bore after cleaning. The first round out of a squeaky clean bore will produce a velocity below that of a second shot even if the bore was damp swabbed between shots. With some lots of powder a steady state would not be reached until 4 or 5 shots had been fired.

Shooting the black powder fueled muzzle loading rifles showed differences in the visual appearance of the bore fouling collected on damp cleaning swabs. On some days a particular can of powder might give bore fouling that simply discolored the damp cleaning swab. On another day there might be a bit of tarry matter clinging in addition to the discoloration. On yet another day the damp swab might come back heavily encrusted in tar-like bore fouling.

The work showed that the ambient air temperature at the time the gun was fired will play a big part in the quantity of bore fouling produced by the firing of the gun.

That then raised the question if barrel temperature played a part in this

In this round the rifle was fired repeatedly and the barrel was not allowed to cool.

3.17% of original charge weight, 10 shots, slow fire in a cool barrel.
3.38% of original charge weight, 10 shots, barrel warming, warm to the touch.
3.45% of original charge weight, 10 shots, too hot to touch but not above 200 f.
Rifle placed in the shade and allowed to cool for 15 minutes.
3.35% of original charge weight, 10 shots, slow rate of fire.
Air temperature 75 F at the time of shooting.

The data indicated that the barrel temperature did not appear to increase bore fouling with increasing barrel temperature.

Increases in bore fouling appeared to relate directly to air temperature at the time of shooting.

One aspect of this subject was not investigated and in hindsight should have been addressed. That being the temperature of the powder being charged to the gun.

During the work on quantifying bore fouling the weighed powder charges were placed in glass vials with caps. Placed in plastic bags and then carried to the range in the shooting box. The shooting box sitting on the shooting bench during the work. So the powder charges used were at a temperature almost the same as the air temperature.

In other words. If ambient air temperature played such a great role in bore fouling quantities but a hot barrel did not then how did the ambient temperature at the time of shooting have such a great influence. Powder charge temperature may play a key role in this.

Visual observations of differences in the physical form, or consistency, of the recovered bore fouling were next looked at using an Intel microscope that attaches to a computer.

For this work a Lyman Trade Rifle with percussion ignition was used. Mainly due to the fact that the barrel has very shallow rifling. The question was one of how to recover bore fouling after having fired the gun and have no change in it between the time it was recovered and the time it was looked at and photographed under the microscope.

Figure 94. Bore fouling thief.

A .50 caliber ramrod ferule was modified as a bore wall scraper.

After firing the rifle the bore fouling thief is run down the bore. The rifle is then inverted muzzle down. The fouling scraped from the bore walls falls into the ferule cup. The recovered fouling is then placed in an old cap tin and covered to exclude contact with any real quantity of air.

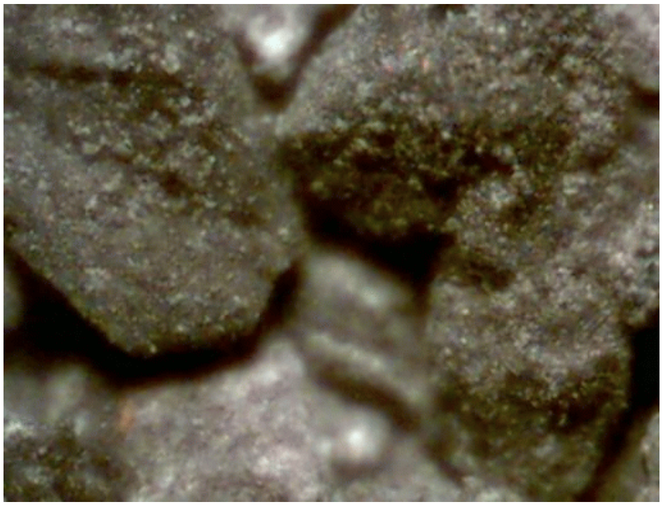


Figure 95. 25/99 Elephant fouling, 60X.

A microscope photograph of recovered bore fouling produced by a 25/99 lot of Elephant.

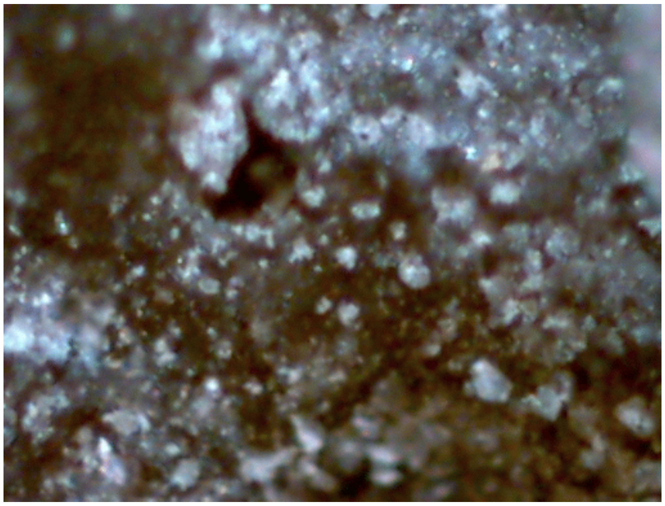


Figure 95. Sample from above at 200X.

The same sample magnified 200 times.

The solid products of black powder combustion are mainly potassium carbonate and potassium sulfate. The glass-like beads seen in the photo are potassium carbonate.

This based on the point that there is 3 to 4 times as much potassium carbonate as there is potassium sulfate.

The papers published in England in the latter-half of the 19th century by Noble & Abel gives maximum combustion temperatures for the various types of black powder. Through experiments in closed bomb studies they determined that a cannon type powder would produce a maximum combustion temperature of about 1800 C. The maximum combustion temperature of a sporting type powder would be around 2200 C.

According to Lange's Handbook Of Chemistry the melting point of potassium carbonate is 891 C. Potassium sulfate is shown as 588 C.

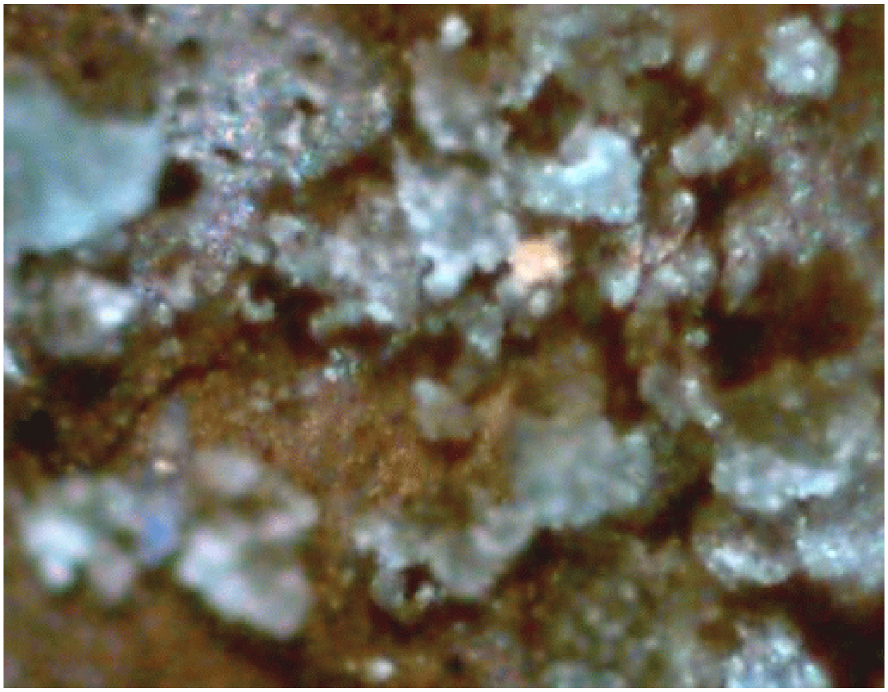


Figure 96. 2001 Elephant fouling at 200X.

The microscope views of the powder at various charge volumes and different temperatures show that at low temperatures the powder's combustion residue appears to be a fine powder forming a thin coating of dust in the bore.

As charge volumes are raised there will be a change in the physical appearance of the fouling. The same change of appearance will be seen with increasing ambient temperatures.

Initially the fouling will appear to contain what look like fluffy little white snow balls. Then there will be a mixture of tiny "snow balls" and glassy beads. Finally the beads will all be glass-like. The matrix in which they are seen undergoes changes. At high temperatures or large charge volumes the bore fouling begins to look like fused foundry slag.

Noble & Abel described their observations on the state of the solid products of black powder combustion in their pressure bomb work. They found that the solids could melt and form a liquid if the gas temperature in the bomb was high enough.

It appears that the solid products of powder combustion are formed as very minute particles. The little white balls that look like snowballs under the microscope are composed of a large number of particles that formed agglomerated masses. Given increasing gas temperatures there is some fusion between the particles. As the temperature is increased the particles melt, forming what appears to be minute glass beads.

The differences in the amount of fouling found in the bore after each shot on days where the air temperature differs appears to be related to the particle size of the fouling. On cold days the fouling is more akin to a coating of a fine powder in the bore. On hot days it is more akin to a coating of tarry matter in the bore.

This most likely relates to how much of the fouling is in a small enough particle size to remain suspended in the gasses in the bore until the projectile leaves the muzzle and the gasses increase dramatically in speed as they exit the muzzle Increasing the particle size of the solids produced by powder combustion would reduce the amount suspended in the gases and increase the amount settling out of the gasses onto the bore walls.

Patch lubes and bore fouling.

Manufacturers of patch lubes for black powder fueled muzzleloading guns try to convince the shooter that by using their lube the days of bore fouling problems will be over.

To quote from an add for Ox-Yoke Wonder Lube 1000 Plus as published on Page 39 of the Summer 1993 issue of Blackpowder Hunting magazine.

An Historic Feat!
1000 Rounds
Without Cleaning
August 1, 1990
Milo, Maine
U.S.A.

A new T/C New England muzzle loader rifle completed a test firing of 1000 consecutive shots loaded with lead balls, black powder, and the new pre-lubricated Wonder Patch 1000 Plus. (Wonder Patch and 1000 Plus being trademarked.)

There was no cleaning between shots!

Periodically the rifle was turned over to get out the powder residue. The rifle loaded safely and easily, and shot accurately. No rust or corrosion occurred in the bore either during or after the test, which extended over five weeks. The last five-shot group had a standard deviation of 8.8, which is far better than modern ammunition.

Ox-Yoke's new Wonder Patch 1000 Plus is what made this record-breaking, historic event possible.

The new Wonder Lube 1000 Plus is an all-natural, non-toxic, environmentally safe lube with no petroleum, chemicals, or synthetic ingredients. It is an enhanced version of the original

Wonder Lube, where an ingredient particle size has been reduced to sub-micron size (.00002"). This results in a vastly superior shooting and gun care product.

Muzzle loading has now become the fun shooting sport that we always wanted it to be – without the hassle and mess of frequent cleaning. The so-called "closet muzzle loader," who only shoots during hunting season, can now enjoy year round fun.

Then from the Winter 1997 issue of the same magazine in an add found on page 39.

The Ox-Yoke Originals System

Blackpowder has not changed, but using it has.
From start to finish, Ox-Yoke makes blackpowder shooting easier and more rewarding.
... Clean your barrel and breech, removing all oil and grease, using the Blackpowder Cleaning Kit.
... Swab the bore and external parts with Wonder 1000 Lube.
... Load and shoot using Wonder Patches, or Wonder Wads, with the lightning fast Cyclone Loader.
Each shot becomes self-cleaning and self-lubricating. No need to clean between shots. No need to climb your ramrod to seat balls or shotgun wads.
... And after a day's shooting RELAX. Ox-Yoke will take care of your gun for you. No need to clean the bore, no fear of rust.

The problem with the claims made in the adds is that the claims do not reflect real use in the field. Not stated in the adds was the fact that all of the shooting was done on an indoor facility where both the temperature and relative humidity were controlled closely. The Relative Humidity during the indoor testing was 30%. That is in the range where black powder fouling is non-hygroscopic. The fouling will contain no moisture nor will it pick up any moisture from the air. No moisture equals no rust or corrosion from the powder's combustion residue. In addition, as a dry powder, the black powder fouling will fall out of the bore if one inverts the muzzle and thumps the gun a few times.

They did not do any of this testing at temperatures down around freezing or below freezing where the lube film becomes rather hard. At below freezing temperatures the lube film is rather hard and adhesive.

And of course any shooter who could not duplicate their results simply did not know what they were doing.

Using the same .45 caliber TVM rifle used in the work detailed on page 91.

Saliva (spit patching)
3.0% of the charge weight as recovered bore fouling.

Lehigh Valley Shooting Patch Lubricant
Patched lubed and then allowed to dry.
2.6% of the original charge weight as recovered bore fouling.
Patches freshly lubed.
2.3% of the original charge weight as recovered bore fouling.

Ballistol
Patches lubed and then allowed to dry.
2.4% of the original charge weight as recovered bore fouling.
Patches freshly lubed.
2.1% of the original charge weight as recovered bore fouling.

T/C Number 13
Patches shot wet.
1.8% of the original charge weight as recovered bore fouling.

Moose Milk
Patches lubed and then allowed to dry.
2.2% pf the original charge weight as recovered bore fouling.

Ox-Yoke 1000 Plus
2.3% of the original charge weight as recovered bore fouling.

None of the lubes really reduce bore fouling in any great degree compared to other lubes.

What was different was the “feel” of the ramrod when swabbing between shots and the loading of a subsequent charge and patched ball.

Spit patching produced hard fouling deposits in the breech where the patched ball sat on the powder charge before firing the rifle. This rough “ring” could be felt with the damp between shot swab and during the loading and seating of the follow-up shot.

The Lehigh Valley lube gave a smooth feel during between shot swabbing and during the loading and seating of the follow-up shot.

The Ballistol (dry) patches gave a rough bore feel during the damp swabbing of the bore and during the loading of the follow-up shot.

With the firing with the wet Ballistol patches there was less of a rough feel than was observed when shooting the dry patches.

T/C Number 13 Bore Cleaner gave a smooth feel with the ramrod during damp swabbing of the bore and required very little pressure on the ramrod during the loading of the follow-up shot.

Automotive water pump lubricant "Moose Milk", with Murphy's Oil Soap added, gave an easy feel during the damp swabbing of the bore and during the loading of the follow-up shot.

The Ox-Yoke 1000 Plus lube gave difficulty during the damp swabbing of the bore and during the loading of a follow-up shot. Only marginally better than what was felt/observed with the use of saliva dampened patches.

The common concept of the function of a patch lube is that of a lubricant that reduces friction between the cloth patch and the bore walls as the patched ball is accelerated up through the bore when the gun is fired.

What we see in the above observations/comments is that the patch lube must also act as a form of a release agent in the bore.

When black powder combustion solid residue is deposited on unprotected bore walls it will adhere to the metal with a good deal of tenacity if the metal is not coated with something that will prevent this adhesion. A good lube performs a function that is akin to mold release agents during the molding of rubber or plastic goods. A good patch lube will act as a release agent and allow the black powder residue to be removed from the bore walls with a minimal amount of pressure being applied. Some are just better at this than others.

A patch lube may make cleaning a black powder gun easy or make it hard to clean. Grease or waxy patch lubes that are not soluble in water will when mixed with the bore fouling make it almost water proof.