

Making Iron Gall Ink

"What an astonishing thing a book is. It's a flat object made from a tree with flexible parts which are imprinted with funny dark squiggles. But one glance at it and you're inside the mind of another person, maybe somebody dead for a thousand years. Across the millennia an author is speaking clearly and silently inside your head directly to you. Writing is perhaps the greatest of human inventions, binding people together who never knew each other, citizens of different epochs. Books break the shackles of time. Books are proof that humans are capable of working magic." ~ Carl Sagan

It was when we started to write on some kind of storable surface that the human race really began to make its first leaps forward after learning how to tame fire and use the wheel. It allowed people to learn from people they had never met and could never meet. It stored knowledge for others to learn from so they didn't have to go reinvent all over again. Ink made it possible to store more information, in less space with less effort than chiseling rock and pressing clay tablets. Both were fragile and easy to break through mistakenly dropping it. Parchment and paper written on with ink stores better, more easily and more efficiently as well as being much easier to write on.

There are many kinds of ink used today, in the time period we study of the pre-1600 world there were two major types of ink; Lamp Black and Oak Gall Ink. We will be looking at Oak Gall Ink.

Where Does the Word "Ink" Come From?

It comes from Middle English *enke*, from Anglo-French *encre*, *enke*, from Late Latin *encaustum*, from neuter of Latin *encaustus* burned in, from Greek *enkaustos*, verbal of *enkaiein* to burn in.¹

This is the same root word that the word "caustic" come from. Oak Gall ink "bites" or burns in to the surface it is written upon.

What is ink?

Also, what makes ink different from paint and dyes. Dyes fundamentally change the material they come in contact with, in other words, dyes stain things. Paints on the other hand sit on top of whatever surface they are on and do very little to that surface except cling to it. Inks do a little of both making it an intermediary liquid. Ink bites, or burns, into the surface it is on and it stays on top of that same surface. Now these are simple definitions but also fairly accurate. It is the ingredients of ink that give it these properties.

What are the ingredients of Oak Gall ink?

There are a lot of recipes for Oak Gall ink out there and lots of different things you can use to make oak gall ink. There are however, four basic ingredients:

- 1 - Oak Galls (which have tannic acid)
- 2 - Copperas which is chemically known as Ferrous(II) Sulfate

¹ Merriam-Webster online dictionary 2/19/2011 <http://www.merriam-webster.com/dictionary/ink>
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Making Iron Gall Ink

3 – Water

4 - Binder (I prefer Gum Arabic).

Oak galls have tannic acid in them in varying amounts. Tannic acid is *not* tea tannin. They have different chemical formulas².

Tannic Acid
C14 H10 O9

Tea Tannin
C20 H20 O9

Ferrous (II) Sulfate's chemical formula is Fe(II) SO₄. Ferrous Sulfate in period was called a couple of different names: Copperas and Green Vitriol. Ferrous Sulfate comes in two forms one is a moist blue-green odorless crystal and the other is a white powder form. It was believed that because it is greenish in color that it had copper in it. However, one of the ways ferrous sulfate was made by first pouring water over sulfurous earth and then pouring that solution over iron such as nails and spent filings. Green Vitriol is a name used to differentiate it from Blue Vitriol which does contain copper.

I often here that this ink is bad for writing with because it is acidic

That is a common statement to hear about Oak Gall ink. Observation and common sense both confirm and deny this. It is absolutely true that that this ink has been known to create holes in parchment destroying the pages it is on. In fact the Vatican called the conference of St. Gall in 1898 to determine what was causing ancient manuscripts to deteriorate and how to better preserve these manuscripts. One of the topics was about the ink. And this is an ongoing issue that is not resolved.

However, one must also realize that there are literally hundreds of thousands of manuscripts out there written with iron gall ink that have no damage to them whatsoever. So there must be, and are, several factors coming together to cause the problem, it isn't just the ink.

One Recipe for Iron Gall Ink

Ingredients:

1 gallon (3.8 l) steam distilled water
1 oz (28g) Ferrous Sulfate (copperas)
1 oz (28g) Gum Arabic

6 oz (168g) Aleppo Oak Galls

Why are the measurements first in imperial? The Metric System is out of the SCA time period.

Materials explanation:

² The Tea Man 2/19/2011 <http://www.teatalk.com/science/tannin.htm>

Making Iron Gall Ink

I use distilled water because tap water and modern day rain water certainly have chemicals in them that would almost certainly not have been found in the rain water in period. The ferrous sulfate can be purchased from a chemical supply and often from a greenhouse supply place. The Aleppo Oak Galls can be ordered from John Neal Bookseller but you can also pick your own North American oak galls.

Process:

In a well ventilated area, put the distilled water in a pot to boil. You can use an earthenware pot (period practice) but make sure it is a new and never before used earthenware pot. While waiting for the water to boil, break up the oak galls. I prefer to use a mortar and pestle but a stick works just as well. Just cover the galls when you are breaking them or you will lose pieces. Add in the broken oak gall pieces (and powder) to the water. You can do this before the water actually comes to a boil. This process leaches out the tannic acid from the oak galls.

The water will show color as the tannic acid is leached from the galls. It starts off a “tan” color and eventually turns a dark brown, similar to that of good strong coffee and black tea. As this process advances you will notice a smell growing stronger. It is an earthy acrid smell of the tannic acid and other part of the oak galls being released into the air. Thus the need for a well ventilated area. A fan blowing air to the outside has proven sufficient in my experience. Breathing the fumes can be unpleasant and I don’t recommend it despite never having been harmed by it.

Filter out the oak galls. The filter most mentioned in period recipes I have seen is linen cloth. I use linen cloth supported by a metal or wooden filter. The linen is a very good filter getting even grit sized particles out. I use a support to keep my fingers away from the scalding liquid.

Add the ferrous sulfate (copperas) to the tannic acid solution. It should turn black almost instantly. Congratulations you have made a dye. To make ink you will need to add in the Gum Arabic. You can add it in slowly and stirring to incorporate it. You can just dump it in and stir for a long time. Or you can dump it in and stir it occasionally over the next day or two until it incorporates fully into the ink. Not letting the Gum Arabic incorporate fully into the ink means the ink will be thinner. This of course is a personal choice how thin or thick one wants their ink.

Acidity revisited and how to deal with it.

Having tested this solution in previous batches using calibrated lab equipment I have found the pH to be between 2.8 and 5. This is slightly less acidic than a lemon to the acidity of regular rain water today, coffee and bananas. The acid is mildly reactive. I have put my hand and wrist into a warm solution and had no ill effects despite not rinsing it off for more than an hour. No, I don’t recommend doing this.

Making Iron Gall Ink

It would be very easy to make the solution more acidic simply by adding more oak galls and/or adding more ferrous sulfate. The lowest pH I have ever gotten when testing it with the calibrated lab equipment was 2.8. 2.8 on the pH scale is somewhere between vinegar and soda or lemon juice and orange juice.

To temper the ink, or neutralize it, you can add in the egg shells, chalk and cuttlefish bone. These contain calcium carbonate, which is a base. It is important to put this in after the Tannic Acid and Ferrous Sulfate reaction occurs. The chemistry would change dramatically. After putting in the egg shells the pH becomes less acidic. Having tested this solution previously with the same calibrated lab equipment I find the pH to be around 5.5 to 6. A pH of 6 is roughly the same as saliva, cow milk and egg yolks. When the egg shells are dropped in, they dissolve and a precipitate floats to the surface. You can leave this alone or you can fish it out.

Precipitates are common in acid base interactions. I have not been able to determine what this precipitate is exactly though one can determine from comparison that it is not simply egg grinding floating to the surface. I take out the precipitate as it could clog the pen while writing.

Things to think about when adding Gum Arabic:

The material and surface of your pen as well as how it is made directly contributes to the flow of ink from the pen to the writing surface. If you write with a metal dip pen, the ink goes from your pen to the writing surface through the capillary action of the cracks in the metal of the dip pen. It is a very well engineered process that pulls the ink slowly to beneath the pen tip. If you write with a feather quill the ink travels down the feather much more quickly. If you write with a feather quill and have removed the top layer from the feather's shaft the ink will travel more slowly to the tip of the pen but more quickly than if it were a metal nib.

The angle at which one writes has a direct effect on how gravity will act upon the ink. This means that if you write with your pen perpendicular to the surface of the ground, the ink will be drawn out of your pen very efficiently by gravity. If however, your pen is at an angle to the ground it will be pulled out of the pen with varying degrees of less efficiency the flatter your angle becomes. Writing on a scribal desk of 45 degrees causes your pen to go to a flatter angle. Writing on a scribal desk of 60 degrees causes an almost flat angle of your pen to occur.

If you write on a level surface, once on the writing surface the ink only takes up as much space as its surface tension allows. If you are writing on an angled surface your ink will tend to pool and run toward the portion of the writing surface closest to the ground. The more extreme the angle, the more gravity will affect the ink once on the writing surface. The writing surface itself also affects the ink. Parchment and vellum that is well polished and prepped is a dream to write on. It isn't hairy, coarse or fibrous enough to draw the

Making Iron Gall Ink

ink into spidering or cause other problems. Paper can cause spidering simply because of how it is made.

As we can see there are a lot of factors that affect how ink interacts with the pen and the paper. I put in the amount of Gum Arabic to fit the set of circumstances most likely to occur. If you write on flat surface with a quill on fibrous paper you are going to need a significant amount of Gum Arabic. If you write on a 60 degree scribed desk with a metal nib on manuscript quality vellum you will need very little Gum Arabic. I prefer to put in the amount of Gum Arabic for what is most likely to occur. That is best done after bottling the ink.

What color should it be?

This recipe produces an ink that is black when it hits most writing surfaces. Pergamentata and iron based inks do not get along well. When used on pergamentata this ink may go on a slightly gray and then darken up over the next 48 hours.

How Period is This Ink?

That is a very sticky question to answer. Let us start with the basics. The recipe follows the pattern of period ink recipes but is not directly a period ink recipe. The materials are as period as I can get them to be. None of them are directly or immediately harmful to someone. Though some of the ingredients will cause constipation and are used as mild herbicides they aren't as bad as mercury and arsenic that are in some period pigment recipes. Don't go drinking this stuff but if it gets on your hands, your fine.

However, the number one ingredient is impossible for me to get a period version of it. Water is the fundamental ingredient and chemically it is simply impossible for me to get water that is chemically similar to the water that would have been used in period. Some recipes call for using rain water. Rain water today is chemically very different from rain water in period as we have added a lot of chemicals to our atmosphere. Some recipes call for using water from a clean clear swift running stream. We have added a lot of chemicals to our streams just the same way we did to our atmosphere and the rain of course feeds those streams. And when we consider that water is a key ingredient in making the oak galls and the ferrous sulfate, well, we can see that it is impossible to make ink in a completely period fashion. The ingredients are as period as I can get them to be.

Some miscellaneous things to think about.

There is also chemistry that is occurring between the ink and chemicals used in making parchment. This process used slaked lime or calcium carbonate. Calcium Carbonate is a base.

Making Iron Gall Ink

The writing surface of vellum is often additionally prepped by the calligrapher with pounce which can be made up of a variety of materials, many of which are bases.

The ink, as we know, is acidic. It can have a pH of between 2.8 and 5.5. We also know that acids and bases when mixed rush toward the neutral pH of 7.

Conclusion

Writing stores knowledge and ink made this process quicker to do and easier to store. Oak gall ink was by far the favored ink of choice in Europe for more than a thousand years. This Oak gall ink is comprised of four basic ingredients on average Oak Galls (which have tannic acid in them), Copperas (ferrous sulfate), Water, and Gum Arabic. The amount of Gum Arabic used should be titrated to meet the specific ways and materials of the ways the calligrapher writes. This recipe is a period fashioned recipe and the materials are as period as possible.