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ACRYLIC RESIST ETCHING

Metal Salt Etching - etching without Acid

The Metal Salt etching processes outlined here have undergone thorough safety assessments and chemical analysis by two professors of chemistry at RIT,NY, Dr Paul Craig, and Dr Paul Rosenberg, who recommend the use of these processes in Keith Howards new book 'The Contemporary Printmaker'. The electro-etching expert Cedric Green also endorses the new Metal Salt Etching system as a replacement for acid etching.

In Acrylic Resist Etching metal plates are etched in metal salt solutions rather than acids. Since the first publication of the Edinburgh Etch process in 1997 I have been able to further develop, test and refine a whole range of new metal salt etching processes for all metals commonly used in intaglio printmaking, and for sculptural plate making. The system comprises specific metal salt solutions for the fast and accurate erosion of copper, brass, zinc, steel, and aluminium. All of the etching processes given below are compatible with the entire range of acrylic resist mark making methods such as hard ground, stop out, aquatint etc. The benefits of this new etching methodology over the traditional acid etch approach are compelling, both in environmental terms and regarding the superior quality of bitten work. Metal salt etching comprises two basic kinds of process: The Edinburgh Etch and The Saline Sulphate Etch. The Edinburgh Etch (© F.K. 1997), suitable for copper, brass and steel, consists of

Cause and Effect
Traditional acid etching processes produce significant amounts of toxic fumes. In the commonly used nitric acid etch, for example, the nitrous gases produced are suspected of causing eye, nerve, lung and kidney damage, as well as impotence and genetic defects; in contact with chlorine-based cleaning products nitric can even turn into mustard gas! In industry today, regulations prohibit the use of nitric acid without fully extracted and filtrated glove units similar to those used in the nuclear industry. Regrettably, despite these facts many artists, workshops, and printmaking departments maintain that their existing measures provide adequate protection.

Safe and Simple
By contrast, the Metal Salt Etching system is free from harmful gas emissions……No new printmaking process, however safe or simple would be worth its salt if the results did not equal or exceed those produced by traditional means. Perhaps the most exciting fact about the Edinburgh Etch and the Saline Sulphate Etch is that the results are startlingly good - biting plates quickly and cleanly.
Ferric chloride is available from most chemical suppliers either as yellow granules or as a saturated solution, both of which are fairly inexpensive, especially if bought in larger quantities. If at all possible the ready made solution should be used, which for its industrial use comes in 25l or even larger containers at about 42 to 48 BE (Baume) density. When ordering ferric it is easiest simply to ask for a 'saturated' ferric chloride solution without referring too much to density scales that the suppliers are unsure about. Remember that liquid ferric is a heavy solution of ferric chloride salt crystals in water; the solution could not go beyond a certain strength (i.e. 48BE) unless the crystals solidify. It is easy to dilute a strong solution with water to obtain a weaker strength, but impracticable to strengthen a ferric solution which is too weak for a good etch from the outset. Even though ferric chloride is relatively safe to use eye protection and gloves must always be worn when handling it.

The saturated ferric solution of about 42-48BE is an ideal base ingredient for making up various mordants needed in the etching workshop. Only in exceptional circumstances (i.e. very delicate etched photo-polymer work) would it be useful to obtain the much more expensive, purer but weaker, laboratory grade ferric, which actually etches less well than the impurer industrial grade. Due to the variable strength of saturated ferric chloride certain adjustments to the mordant recipes given here may have to be made. If, for example, a mix of one part ferric to three parts water does not etch as expected simply reduce or increase the water content accordingly. This, as well fine tuning of the recipe, will entail some testing, but working some things out for oneself is always half the fun of printmaking!

Tip: Eye protection and gloves must always be worn when handling Ferric Chloride.
For reasons of safety and quality use a ready-made ferric chloride solution whenever possible
Before using fresh etching solution take the 'sting' out of it to prevent uncontrolled biting. Either insert a blank piece of metal of the kind that is to be etched in the bath and allow it to completely dissolve, or add a small amount of exhausted mordant to the fresh mix.

The Discovery of the Edinburgh Etch

My aim in developing the new Edinburgh etching solutions was to harness the eroding power of ferric chloride fully. Due to its generous filling with mordant and vigorous agitation a dip-tank represents the best facility for the mechanical removal of the crystalline sediments that ferric chloride generates as it etches metal. Keith Howard's reasonably priced etching tank takes several medium sized plates, and larger tanks can be custom made by most professional acid unit manufacturers, preferably from welded polypropylene. For small-scale work even a square bucket will make a serviceable etching tank, especially if fitted with an aquarium aeration pump. One or several tubes of fish tank 'airline' are fitted to a rod on one or two ends of the tank. The air outlets should point upwards and are connected to a powerful fish tank aeration pump. The powerful stream of bubbles rising on the side of the tank produces a circular flow within the solution which activates the etch mechanically. Aquarium shops also supply small valves which can be inserted in the air line in order to regulate the air flow and the resulting current inside the tank. In the course of my research I approached the issue of activating the ferric etch from a new angle, searching for additives to ferric chloride which might be able to dissolve the sediment as it is produced. After experimenting with a variety of possible substances I tried a new kind of non-toxic additive normally more associated with food rather than etching - citric acid. It turned out that a citric acid solution mixed at a certain ratio with a ferric chloride solution not only speeds up the bite of ferric but produces an entirely new kind of mordant with outstanding biting properties. Different kinds of metal require a different mix of this mordant I then called 'the Edinburgh Etch'. On copper, brass, and mild steel I found the unique property of the Edinburgh etch to be consistent throughout: the etch process takes place with the utmost precision and without the build-up of sediment typically associated with unmodified ferric chloride. The crucial catalyst contained in the Edinburgh Etch, citric acid, is widely available from larger chemical suppliers and suppliers to the food industry. This white powder ordinarily finds its way into cakes or fizzy lemonade rather than into an etching tray. It should be obtained as 'anhydrous citric acid'. Its handling and storage it is about as non-toxic as a chemical could be. Do however wear a dust mask and goggles when dispensing the fine powder. Anhydrous citric acid powder is now available both from chemical and printmaking suppliers.

It is absolutely essential that different kinds of metal are always etched in different etching facilities, such as in separate tanks or trays. If a metal plate is accidentally placed in the wrong tank or tray this causes electrolytic processes, contaminates the solution, and in the case of a zinc or aluminium plate inserted in a dip tank can even lead to violent chemical reactions.

Edinburgh Etch for copper

Copper sheets are supplied by printmaking suppliers, or more cheaply by an industrial sheet metal dealer. Industrial copper (and zinc sheets) tend to have a more or less pronounced rolling-texture which may become visible during open biting. In practice this is rarely a problem, and any thickness of sheets ranging from about 0.5mm to 1.2mm, or 0.2in - 0.5 in are suitable for intaglio printmaking. Printmaking suppliers also sell copper sheets of the more expensive 'hammered' variety, as these do not have any rolling texture.

Intaglio marks made with acrylic grounds on copper plates and etched in Edinburgh Etch are of the best possible quality: Lines, textures, and open areas are cut into the metal as with a razor blade, and even the finest detail registers accurately on the bitten plate, which in turn produces a crisp intaglio print.

For large edition sizes of, say 40 to 50 prints professional workshops often have copper intaglio plates steel-faced prior to printing; the electrolytic coating hardens the surface and renders the plate more durable. If, however, an etching project is executed from the outset using brass or steel plates no steel-facing is needed for a large edition, as the plate itself will already have the required durability for a large edition.

years of intensive use of ferric chloride I have however encountered two cases of printmakers who were hypersensitized to the smell of ferric chloride. In rare cases such as these fume extraction and the use of an inorganic respirator are of course mandatory, and preferably an alternative process should be used. The non-sedimenting properties of the Edinburgh etch are enhanced by the use of a dip-tank in which agitation takes place automatically. This results in very speedy biting times for copper plates. For instance a black aquatint, a crisp line, or a well developed open bite ridge are already deeply etched at about 20oC after a 30 - 40 minute immersion in a dip tank aerated with an aquarium pump.
The Edinburgh etch mixture given below is a universal mordant both to be used in flat trays or upright tanks. If no citric acid is available a saturated ferric chloride solution can also be used, but the etch will be slower and somewhat less precise.

Edinburgh Etch for Copper and Brass

4/5 saturated ferric chloride solution (40%)

+ 1/5 citric acid solution,
which consists of 3/4 tap water
+ 1/4 citric acid powder (anhydrous)

in actual quantities this works out, for example at

6l saturated ferric chloride solution (40%)
+ 1,2 litres of tap water
+ 400ml citric acid powder (by volume)
(this equals 400g powder)

Fill a bucket with 1,2l of hot water. Gradually add the citric acid powder content while stirring continually. Once this has fully dissolved gradually pour this into the ferric solution and keep stirring until you have produced a uniform liquid. Fill this into the etching tank or tray which is now ready for use.
Try to maintain a reasonable temperature in your etching facility for copper. Good results are ensured at 18 to 20oC, but higher temperatures of up to 30oC can further improve biting times as well as the overall responsiveness of the mordant. This solution is exceptionally long lasting; a tank filling used daily, occasionally topped up to compensate for loss, has been known to remain active for several years without a significant drop in its biting properties. When eventually the mordant acquires a deep olive colour it becomes less active and is then ready for replacement, neutralisation and disposal. Even during etching Edinburgh Etch trays or tanks can be covered with a lid to prevent evaporation. When not in use etching solutions should be stored in clearly labelled containers, stating the composition of the solution and the kind of metal etched in it. Also place safety notices such as 'corrosive - wear eye protection' on all containers and work areas.

Edinburgh Etch for brass
Brass is a superbly suitable material for intaglio etching and printing. The metal has a golden, mirror-like finish, and usually lacks the more or less pronounced rolling texture known from other industrial sheet metals.
It is often supplied by the same sheet metal merchants that sell copper, and is only marginally more

Saline Ferric Etch for steel

Mild steel etches best in the following Edinburgh Etch solution in a well aerated dip-tank. Tray etching of steel plates in ferric chloride or the tailored Saline Ferric Etch is only satisfactory if the bath is kept warm and is frequently agitated. The process using the Edinburgh Etch brings out a self-texturing property in steel, which causes open areas of the plate to acquire an aquatint-like roughness. Etching trays can be placed on a darkroom tray heater or inside a warm water bath. Some etchers even construct a second 'radiator' tank around their dip tank which can be circulated with hot water for heating up the Edinburgh etch solution in the inner tank.

Edinburgh Etch for steel

8litres of saturated ferric chloride solution (about 40%)
\+ *3litres of tap water*
\+ *800ml cooking salt (by volume)*

mix ingredients as described for Edinburgh Etch for copper

Backing the Plate

Before a metal plate can be etched the back of the plate has to be covered with an acid resist. Plates etched without this protection erode from the back, and the grounds applied to the front may lift off. A very quick and reliable way to cover the back of an etching plate is by applying sheets of self-adhesive film or strips of parcel tape to it.
The plate is now ready for etching if horizontal trays are used. If the plate is to be etched in an upright dip-tank a handle still has to be attached for lowering the plate into the bath. The handling strip should be longer than the depth of the tank. Before etching inspect the surface of the plate for any greasy deposits and clean if necessary.

Etching safely

Etching should take place in a separate area of the etching workshop, which may be combined with a stripping facility in an overall 'corrosive area'. It is important to keep this space separate from other workshop activities because the handling of acidic and alkaline substances requires extra caution, and a number of safety measures should be observed by users at all times. Artists become very absorbed by their work and are at times less aware of the safety aspects involved in their activity; however, in a corrosive work area adequate protection in the form of acid resistant gloves and goggles, or a visor should always be worn. Also make sure there is clean running water or an emergency eye wash station within reach. Mop up any ferric chloride (or copper sulphate) spills with sodium carbonate and water. When the plate is satisfactorily etched it is rinsed thoroughly under a running tap or hose. Copper and brass plates should also be de-oxidised with a solution of salt and vinegar in water before reapplication of acrylics. Oxidisation is also minimised by blotting and speed-drying plates in hot air. If a plate has reached the reclaiming stage it can be transferred into the stripping solution straight after rinsing to take the acrylic ground off. Any backing should be removed prior to printing.
Safety Note: All metal salt solutions in dip tanks and etching trays should be covered up or filled into sealed containers when not in use. This minimises cross-contamination between different solutions as well as evaporation, thus extending their useable life.

Neutralisation and Disposal

A simple gravity-fed siphon pump is ideal for transferring the solution from the tank into plastic storage containers. The best way to dispose of spent etching solutions is to take them to a chemical disposal company. Local authorities may also permit the disposal of ferric / Edinburgh Etch solutions down the drain if they have been properly neutralised, and highly diluted. To neutralise an Edinburgh Etch or ferric chloride solution add a strong sodium carbonate solution gradually to this; (you may also use a

NEW: Saline Sulphate Etch

The new Saline Sulphate Etch for zinc is ideal for those etchers to whom the creative possibilities of the fairly inexpensive yet versatile and malleable metal zinc are indispensable. Intaglio text books often list the relative softness of zinc and its slight effect on some colour etching inks (especially yellow) as a drawback, but in practice this is outweighed by the many unique pictorial possibilities of this silvery metal. Many printmaking suppliers stock the printing industry grade zinc, which has a backing and is harder, but the inexpensive titanium roofing zinc is also a popular choice. The Saline Sulphate Etch for zinc also works well for biting mild steel, but for the aluminium etch a higher salt concentration is required.

The Saline Sulphate Etch for zinc works very well for straight tray etching and does not require additional measures such as heating or aeration. A copper sulphate solution as a safe mordant for zinc, the 'Bordaux Etch', was first suggested by Cedric Green in response to a number of safety concerns about the use of nitric or ferric as a mordant for zinc. During three years of comparative trials I found that a copper sulphate based etchant is indeed superior to any other solution both in terms of its safety and its creative possibilities within acrylic resist etching.

A straight copper sulphate solution does make a good mordant for zinc but etching is somewhat slow and the solution becomes exhausted quickly.
Similar to my thinking behind the Edinburgh Etch, I looked into ways in which the pseudo-electrolytic eroding potential of copper sulphate could be fully harnessed. I reasoned that as with ferric quite possibly the chemical 'hydrolysis bond' formed between the metal salt and water might account for a loss of reactivity.

I found this confirmed in recent tests. These showed that a solution made up from equal parts of copper sulphate and sodium chloride (i.e. cooking salt) activates the etch by diminishing the hydrolysis bond. This 'Saline Sulphate Etch' for zinc is three times more active than a straight copper sulphate solution, whilst producing a very crisp etch without the more settled sedimentation and surface roughness of the Bordaux Etch. During biting a coppery sediment of metal hydroxides and oxides continually floats to the surface, thus keeping the bitten work from clogging up. Etching can also be aided by occasionally brushing the plate surface with a soft brush. Delicate marks such as a spray aquatint or soft ground should however be etched without brushing. The solution works more effectively if floating solids are regularly skimmed off with a brush or a strainer and removed from the bath - this keeps the solution from turning alkaline and extends its useable life.

Making up the Saline Sulphate Etch for Zinc and Steel

The Saline Sulphate Etch is made up from copper sulphate and cooking salt crystals, which readily dissolve in water. This process works at its best if quantities and ratios given below are adhered to fairly accurately. It is recommended to use 'anhydrous copper sulphate' supplied reasonably priced in larger quantities by a chemical wholesale dealer. Do not use agricultural supplies as these often contain impurities. As with most etching chemicals, specifically ask for 'production' or 'industrial grade' copper sulphate rather than 'laboratory grade', since this is a lot more expensive.
Wear gloves, dust mask, and goggles when handling the crystals to avoid touch or inhalation of dust particles. Once the solution is made up it is quite safe to use with the customary etching precautions.

Saline Sulphate Etch for Zinc and Steel

Saline Sulphate Etch for Aluminium

Aluminium plates are widely available from sheet metal merchants. Printmakers occasionally use lithographic aluminium plates for straight drypoint work, but to date the lightweight metal was rarely used for etched intaglio. Using the following Saline Sulphate solution, however, there are benefits and features that are unique to aluminium etching. With the exception of copper, all metals build up a certain surface roughness during etching, which translates into more or less printable tones. Usually aquatint has to be used in order to fill open areas on the plate with durable tones or a black. The Saline Sulphate Etch for aluminium is fundamentally different. During etching a very distinctive surface roughness occurs in the open areas of the plate which can be compared to a hand made mezzotint. This crystalline texture can produce a beautiful black on the print all by itself. As a consequence in this process there is no such thing as 'open bite', since all bitten areas become carriers for etching ink, thus enhancing the graphic potential of the process. Unusually, neither of the basic components of the aluminium Saline Sulphate Etch, i.e. copper sulphate and salt, have any corrosive effect on the metal at all. But etching becomes possible in a combined solution containing at least double the amount of sodium chloride than the amount of copper sulphate. Whilst all other metals easily erode as long as they are grease free, the surface of aluminium plates also needs to be evenly treated with fine wire wool to create an etchable surface. This should be done before any acrylic grounds are applied to the plate. As with the zinc process, the Saline Sulphate for aluminium involves the production of a very loose coppery sediment, which floats to the surface and should be regularly removed. However, in this process the continuous rising of a small quantity of hydrogen bubbles also indicates that etching is in progress. For disposal proceed as with the Saline Sulphate Etch for zinc.

Semenoff and Bader *advocate a very fast acting copper sulphate based etching solution for aluminium which is acidified with a small quantity of Sodium Bisulphate. This makes a good mordant, but I would advise only using this process with fume extraction as it can generate excessive heat and hydrogen (which the new Saline Sulphate Etch does not).*
Semenoff and Bader also found an intriguing way to reclaim a spent copper sulphate etching solution through the addition of sodium bisulphate (see internet under: Nik Semenoff / Salt Etch).

NEW Saline Sulphate Etch for Aluminium

70gms copper sulphate
+ 140gms sodium chloride (salt)
+ 1litre water
(multiply these quantities by the same factor to make up larger amounts)

When stripping acrylics off an etched aluminium plate ensure that plates are not left in the soda ash stripping solution too long as this would result in their overall corrosion.