



## Tannic Acid Treatment

### Introduction

Iron objects are often covered with a layer of corrosion, which can vary from a light rust film to heavy, disfiguring scale. Corrosion is undesirable when it detracts from an object's appearance and usefulness for display. Also, because iron rarely corrodes in an even, regular manner, the corrosion layers formed are not as protective on iron as are corrosion layers forming on other metals (CCI Note no. 9/1, *Recognizing Active Corrosion*).

Uneven corrosion permits the penetration of water vapour and oxygen, which react with underlying metal. Protective coatings such as waxes and lacquers can be applied to metal objects to reduce the transmission of water vapour and oxygen. However, if coatings are applied to porous corrosion layers, they may be very difficult to remove at a later date, should the object begin to actively corrode.

Tannic acid on the other hand, is a preferable coating for iron because it can be applied both to heavily corroded and lightly corroded iron to enhance the protective qualities of these corrosion layers. Also, tannic acid can be removed. Tannic acid is a complex organic acid found in most plants. Individual products are usually identified by the species of plant

from which they come. When applied to iron, tannic acid reacts with the iron to form ferric tannate, a protective blue-black film whose quality can be controlled to some extent by the method of application. This coating will inhibit the most susceptible areas from reacting with water vapour, in the short term. It will also enhance the appearance of an object by producing a uniform finish.

However, it is important to remember that the application of tannic acid will not eliminate the need for environmental controls, nor will it remove damaging soluble salts from actively corroding objects (CCI Note no. 9/6, *Care and Cleaning of Iron*).

### Preparing the Iron

Prior to applying tannic acid to iron, the surfaces should be free of surface dirt, extraneous accretions, oils, and grease (CCI Note no. 9/6, *Care and Cleaning of Iron*). Ideally, composite objects should be dismantled. If this cannot be done, care must be taken to ensure that, during application of tannic acid, none of the acid touches material other than the iron. Irreversible staining may result, especially on proteinaceous materials such as wool, silk, leather, bone, horn or ivory.

It is not necessary or desirable to remove light rust films or heavy corrosion prior to application of tannic acid.

### Preparing the Acid Solution

Tannic acid is a light, fluffy powder. Its colour varies from brown to golden brown, depending on the grade and the manufacturer. Because a fixed, uniform formula for tannic acid does not exist, there is considerable variation in quality among available brands. At CCI, tests carried out on grades from various manufacturers have found that the brand yielding the most consistent and predictable results is produced by BDH Chemicals, at a reasonable price.

Any concentrated chemical poses a potential health hazard. Care must be taken not to inhale the powder or bring the acid in contact with the skin. A dust mask should be worn when weighing and mixing the dry powder. For convenience, it is recommended that a 10% solution be prepared; this can be refrigerated and portions used or diluted as needed.

### Recipe for one litre of 10% solution of tannic acid

100 grams tannic acid  
deionized or distilled water  
(about 900 ml)  
50 ml ethanol  
approx 2 ml of dilute phosphoric acid (H<sub>3</sub>PO<sub>4</sub>), if available

### Notes on the ingredients:

Tannic acid is very light; a 100-gram measure is bulky. A mixing vessel holding at least 1.5 to 2.0 litres is required.

Use deionized or distilled water; tap water may contain chlorine and other dissolved salts, which should not be introduced to iron.

Ethanol acts as a wetting agent that will enhance the flow of the solution into porous corrosion layers and into all the fissures of a corroded iron surface.

Phosphoric acid lowers the pH of the acid solution, and increases the amount of iron available for reaction with tannic acid. It is not necessary to be concerned about residues of the acid remaining on the iron, since phosphoric acid will react with iron to form ferric phosphate, which protects iron. So little acid is introduced in this method that there is no danger of excess amounts crystallizing on the surface.

### Equipment

- balance
- mixing container (glass), at least 1.5 litre, that can be heated
- scoop and stirring spoon or rod
- eye dropper
- pH papers
- measure in mls (i.e., graduated cylinder)

### Mixing the solution

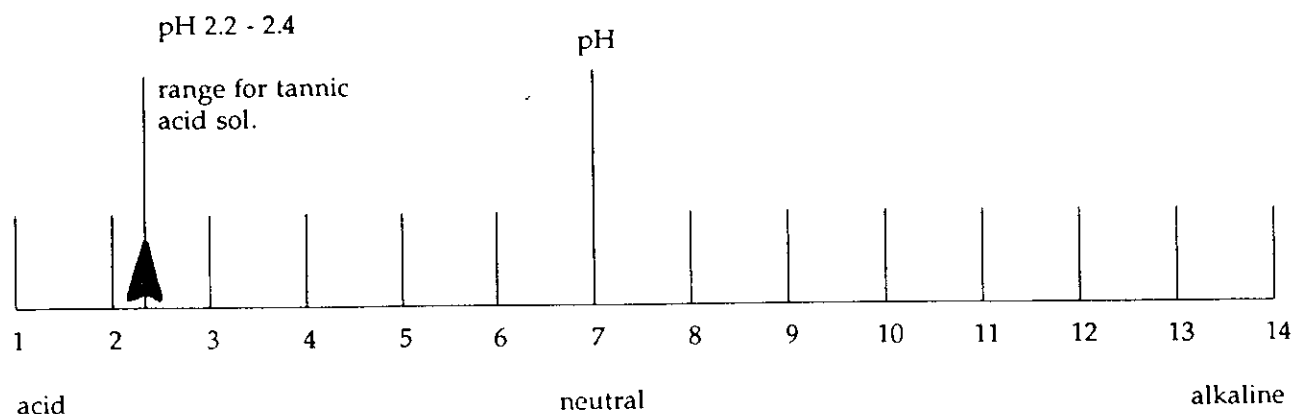
Measure and mix 800 ml of water and the 50 ml of ethanol in a glass or high-quality stainless steel container. Plastic containers should not be used because they cannot be heated.

Wearing gloves and a dust mask, weigh the tannic acid. If your museum does not have a balance, a school science lab may be able to lend one.

Add the acid to the water/ethanol solution gradually, stirring constantly. To accelerate the process, gently heat the solution on a hot plate. When the tannic acid has dissolved, add enough water (approximately another 100 ml) to make a total volume of 1 litre.

Prepare a dilute phosphoric acid solution by pouring 9 ml of distilled or deionized water into a glass container and adding 1 ml of concentrated phosphoric acid, usually sold in an 85% concentration. Always add acid to water, rather than vice versa, in order to avoid violent reactions.

If the pH of the tannic acid solution exceeds 2.4, it will be necessary to lower the pH by adding dilute phosphoric acid. With the aid of a dropper, add the dilute phosphoric acid prepared above, stirring continuously. After adding about 10 drops, test the pH again. Continue until the pH reaches 2.2 to 2.4, a concentration that may require about 2 ml, or 50 drops,



As solution becomes more acidic, pH drops.

of the dilute phosphoric acid, depending on the initial pH of the tannic acid.

Store the tannic acid solution in a labelled, sealed container, preferably in a refrigerator. The label should bear the solution strength, composition, pH, date of preparation, name of the person who prepared it, handling precautions (gloves, protective clothing), and disposal instructions (pour down drain with ample water).

### Dilution of Tannic Acid Stock

To achieve an even coating of ferric tannate, it is best to apply several coats of a dilute solution of tannic acid rather than one concentrated coat. Ten percent tannic acid, as prepared above, is too concentrated to produce a good result. For most purposes, it should be diluted from 2% to 3%.

A simple method of dilution is to mix the 10% solution 50/50 with deionized water, thereby yielding a 5% solution. If desired, this 5% solution can then be diluted 50/50 again with deionized water, yielding a 2.5% solution.

Test the pH after dilution and add more drops of phosphoric acid if necessary until the pH is again in the range of 2.2 to 2.4.

### Applying the Tannic Acid

Prepare a working space, preferably a table, covered with absorbent paper towelling or plastic, and free of extraneous objects. Two stiff bristle brushes, such as tooth brushes, are required: one with which to apply the acid and one with which to brush the object after the acid has dried. As this procedure can be messy, ensure that the acid will not splatter surfaces that it could stain (e.g., wood, clothing). In good weather, the procedure could be performed out-of-doors. Protective clothing (gloves and a full apron) are advised. If eyeglasses are not worn, safety glasses or goggles should be.

Once a 2.5% solution of tannic acid has been prepared, brush it onto the object. To accelerate the reaction between the acid and iron, heat the acid to approximately 50°C before application.

Continue brushing as the acid dries to distribute the solution evenly and to introduce oxygen, which will produce an even colour.

Discolouration will develop quickly, usually beginning in pitted areas. As these areas become coated with an even, coherent film of ferric tannate, they resist further reaction, and the tannic acid will begin to react with less corroded areas. The presence of phosphoric acid assists in establishing an even reaction over the surface. Once the first coat has dried, the surface of the iron should be brushed with a stiff, dry brush to remove flaky areas of ferric tannate. Another coat of tannic acid should then be applied, still brushing as the acid dries.

These steps should be repeated until a coating of the desired density and colour is achieved.

When the tannic acid in the container becomes black, it should be discarded and replaced with fresh solution.

When dealing with case-hardened objects and steels such as cutting tools, it may be found that the tannic acid/iron reaction is different around the working edges. Also, if there are welds or joins, a different appearance in the ferric tannate should be expected at these points. Heavy corrosion layers on objects will take longer to react than will light rust or bare metal.

Some practice may be necessary to become familiar with the ferric tannate film and how its formation can be controlled. By increasing the concentration of tannic acid to 2.5% to 5%, a much darker, thicker film can be achieved. However, excess ferric tannate will merely flake off the surface.

It is not necessary or advisable to put a further protective finish, such as a wax, oil or lacquer, over a surface treated with tannic acid.

### Care of Objects Treated with Tannic Acid

Ferric tannate films are not vapour barriers. They will delay or retard corrosion by forming a passivating film over iron, but this effect will not last indefinitely. The life of the film will be extended by

storing the object in a stable RH, preferably at 50%;

wearing gloves when handling the object; or

protecting the surface from dust and abrasion.

Ferric tannate sometimes rubs off on other materials. Surfaces treated with tannic acid should not be allowed to contact absorbent objects such as paper, textiles, leather, bone, and wood, which stain easily.

If spots of rust begin to appear through the ferric tannate film, it is advisable to check the relative humidity, and carefully examine the object to ensure that the spots are not a result of chloride contamination (CCI Note no. 9/6, *Care and Cleaning of Iron*). If recurrence of rust appears to be due to breaking down of the protective ferric tannate film, the object should be retreated with tannic acid. It is not necessary to strip off the original ferric tannate layer.

Iron objects being maintained in stable conditions by rubbing with oil and steel wool (CCI Note no. 9/6, *Care and Cleaning of Iron*) should not be treated with tannic acid unless all traces of oil can first be removed.

For further information on storage, consult CCI Note no. 9/2, *Museum Storage of Metals*.

## Suppliers

*Tannic acid:* BDH Chemicals  
(in major cities)

*Phosphoric acid:* drug stores or some  
school chemistry departments

*Ethanol:* some school chemistry  
departments or chemical suppliers  
such as Fisher Scientific.

*Brushes:* art supply or hardware  
stores

*Distilled water:* drug stores, hardware  
stores

*pH paper:* Fisher Scientific or other  
chemical suppliers

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Copies are also available in French

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