



Tannic Acid Treatment

Caution:

This Note discusses actions that will physically affect the object, and/or procedures that involve the use of chemicals. Exercise caution, and seek qualified assistance if in doubt.

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 on iron are not as protective as those formed on other metals (see CCI Notes 9/1 *Recognizing Active Corrosion*).

Uneven corrosion allows water vapour and oxygen to penetrate the surface of an iron object and react with the underlying metal. To reduce the transmission of water vapour and oxygen, protective coatings such as waxes and lacquers can generally be applied to metal objects. Unfortunately, these coatings are not effective on iron that is contaminated with chloride ions. Furthermore, if applied to porous corrosion layers, the coatings may be very difficult to remove if the object begins to actively corrode. For iron, tannic acid is a preferable coating. It can be applied to both heavily and lightly corroded iron to enhance the protective qualities of the corrosion layers.

Tannic acid is a complex organic acid found in most plants. Different types of tannic acid 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 somewhat porous blue-black film whose degree of protection can be controlled to some extent by the method of application. In the short term, this coating will inhibit the most susceptible areas from reacting with water vapour. It produces a uniform finish that enhances the

appearance of an object. (For more information, see Selwyn 2004.)

Tannic acid produces a blue-black surface, and should not be used on objects originally intended to be brightly finished or painted. However, it is suitable for wrought and cast iron on which a black finish is appropriate.

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 (see CCI Notes 9/6 *Care and Cleaning of Iron*).

Preparing the Iron

Before applying tannic acid to iron, the surfaces should be free of surface dirt, accretions, oils, and grease (see CCI Notes 9/6 *Care and Cleaning of Iron*). Composite objects, i.e. objects composed of different materials, should ideally be dismantled. If this cannot be done, ensure that the tannic acid does not touch any material other than the iron. Tannic acid can permanently stain materials such as wood, paper, wool, silk, leather, bone, horn, and ivory.

It is not necessary or desirable to remove light rust films or heavy corrosion before applying 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, quality varies considerably among available brands.

As with any concentrated chemical, tannic acid poses a potential health hazard. Be careful not to inhale the powder or bring the acid in contact with 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 and portions used or



diluted as needed. Keep the 10% solution refrigerated to reduce the chance of it going mouldy.

Recipe for one litre of 10% solution of tannic acid

- 100 g tannic acid
- 900 mL deionized or distilled water
- 50 mL ethanol
- approx. 2 mL dilute phosphoric acid (H_3PO_4)

Notes on the ingredients:

Tannic acid is very light, so a 100-g measure is bulky. A mixing vessel holding at least 1.5–2.0 L is therefore required.

Use deionized or distilled water; tap water may contain chloride ions and other dissolved salts that encourage iron corrosion.

Ethanol acts as a wetting agent that enhances the flow of the solution into porous corrosion layers and into all fissures on 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 acid residues remaining on the iron, since phosphoric acid will react with iron to form ferric phosphate, which protects iron. Very little acid is introduced from this method, and there is no danger of excess amounts crystallizing on the surface.

Equipment

- balance
- mixing container (glass), at least 1.5-L capacity, that can be heated
- scoop and stirring spoon or rod
- eye dropper
- pH papers
- measuring device marked in millilitres (e.g. graduated cylinder)
- gloves
- dust mask
- hot plate

Mixing the solution

Measure and mix 800 mL deionized or distilled water and 50 mL ethanol in a glass container. Plastic containers should not be used because they cannot be heated.

Wearing gloves and a dust mask, weigh the tannic acid. If you do not have a balance, you may be able to borrow one from a school science lab.

Gradually add 100 g tannic acid to the water/ethanol solution, stirring constantly. To accelerate the process, gently heat the solution on a hot plate. When the tannic acid has dissolved, add enough deionized or distilled water (approximately another 100 mL) to make a total volume of 1 L.

Test the pH of the solution using pH papers. If it is greater than 2.4, it will be necessary to lower the pH with dilute phosphoric acid.

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

With the aid of a dropper, add a few drops of the dilute phosphoric acid to the tannic acid solution, stirring continuously. After adding about 10 drops, test the pH again. Continue until the pH decreases to between 2.2 and 2.4, a concentration that may require about 50 drops (2 mL) of the dilute phosphoric acid, depending on the initial pH of the tannic acid solution. (See Figure 1 for pH range.)

Store the tannic acid solution in a labelled, sealed container preferably in a refrigerator. The label should indicate the solution strength, composition, pH, date of preparation, name of the person who prepared it, handling precautions (gloves, protective clothing), and disposal instructions (according to local government regulations).

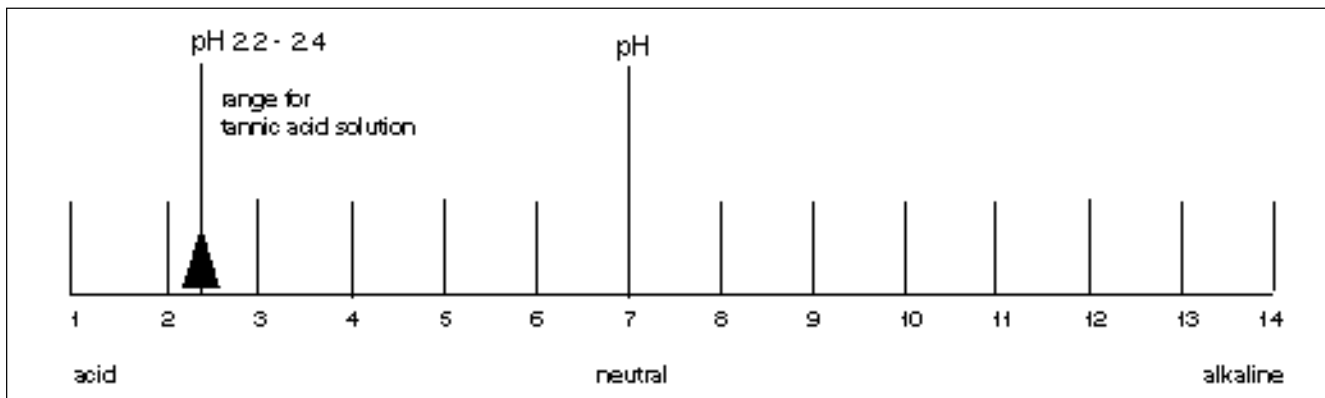


Figure 1. As solution becomes more acidic, pH drops.

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 to between 2% and 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.

Remember to test the pH of the diluted solution and, if necessary, add drops of dilute phosphoric acid until it is between 2.2 and 2.4.

Applying the Tannic Acid

Prepare a working space, preferably a table. Empty the table and cover it with polyethylene sheeting taped down at the edges. Two stiff bristle brushes, such as toothbrushes, are required: one to apply the acid and one to brush the object after the acid has dried. Because 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 can be performed out-of-doors. Protective clothing (gloves and a full apron) are advised. Safety glasses or goggles must be worn. If eyeglasses make it difficult or impossible to wear normal safety glasses, a full face shield should be used.

Transfer a small amount of 2.5% solution into a suitable container, such as a small Pyrex beaker. Heat the solution to about 50°C, and brush it on the object's surface. When this solution becomes black, discard it and start again with fresh solution.

Continue brushing as the acid dries in order to distribute the solution evenly and to introduce oxygen. This will produce an even colour.

Colour change will occur quickly, usually beginning in pitted areas. As these areas become coated with an even, coherent film of ferric tannate, they resist further reaction. The tannic acid will then begin to react with less corroded areas. The presence of phosphoric acid helps establish 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. Continue brushing as the acid dries.

Repeat these steps until a coating of the desired density and colour is achieved.

When dealing with case-hardened objects and steels such as cutting tools, the tannic acid/iron reaction may be different around the working edges. Also, a different appearance in the ferric tannate should be expected at welds or joins. 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 to control its formation. By increasing the concentration of tannic acid from 2.5% to 5%, a much darker, thicker film can be achieved. 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 protective film over iron, but this effect will not last indefinitely. The life of the film can be extended by

- storing the object in a stable relative humidity (RH), preferably around 50% (see CCI Notes 9/6 *Care and Cleaning of Iron*)
- wearing gloves when handling the object
- protecting the surface from dust and abrasion

Ferric tannate sometimes rubs off onto 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, check the RH, and carefully examine the object to ensure that the spots are not a result of chloride contamination (see CCI Notes 9/6 *Care and Cleaning of Iron*). If recurrence of rust appears to be due to failure of the ferric tannate film, the object should be retreated with tannic acid. It is not necessary to remove the original ferric tannate layer.

For further information on storage, consult CCI Notes 9/2 *Storage of Metals*.

Suppliers

Note: The following information is provided only to assist the reader. Inclusion of a company in this list does not in any way imply endorsement by the Canadian Conservation Institute.

Tannic acid:

VWR International
2360 Argentia Road
Mississauga ON L5N 5Z7
Canada
tel: 1-800-932-5000
fax: 1-800-765-3316
www.vwr.com

Phosphoric acid:

drugstores or some school chemistry departments

Ethanol:

some school chemistry departments or
chemical suppliers such as:

Fisher Scientific
112 Colonnade Road
Nepean ON K2E 7L6
Canada
tel: 613-226-3273 or 1-800-234-7437
www.fishersci.ca

Brushes:

art supply or hardware stores

Distilled water:

drugstores, hardware stores

pH paper:

chemical suppliers such as:

Fisher Scientific
112 Colonnade Road
Nepean ON K2E 7L6
Canada
tel: 613-226-3273 or 1-800-234-7437
www.fishersci.ca

Bibliography

Selwyn, L. *Metals and Corrosion: A Handbook for the Conservation Professional*. Ottawa, ON: Canadian Conservation Institute, 2004.

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