Canadian Conservation Institute
Institut canadien de conservation

CCI Notes 9/6

Care and Cleaning of Iron

Introduction

Iron in the form of cast iron, wrought iron, or steel is abundant in museum collections. Iron is often found associated with other materials such as wood, plastics, textiles, leather, or other metals. Because iron is usually coated, the nature and condition of the coating, be it paint, oil, or lacquer, is a major concern. Care of iron must therefore take into account the care of associated materials. The natural tendency of iron to rust — sometimes rapidly — means that close monitoring and consistent care are very important in the preservation of iron artifacts.

Bare surfaces of iron oxidize rapidly. That is, a layer of corrosion, or rust, is formed. Rusting is slow in clean dry air, more rapid in humid air, and more rapid still when the metal surface is covered with a thin film of water. An evenly distributed layer of rust affords some protection to the object; irregularly rusted surfaces offer less protection. Uneven corrosion permits water and oxygen to penetrate to the underlying metal surface, where further corrosion will occur.

Rust formation is accelerated by water-soluble salts, especially salts containing chloride ions (such as sodium chloride) or sulphate ions (such as calcium sulphate). Salts are introduced when an object is used (e.g. during cooking), handled (e.g. transfers from the skin), or simply exposed to certain environments (e.g. polluted air, sea spray). If an object has been stored outside or has been buried, it will likely contain water-soluble salts. (For more detailed information, see Selwyn 2004.)

Museums should establish a program of cleaning and care to extend the life of iron objects. This Note describes ways to identify and store actively corroding iron, and explains how to clean and store stable iron. It also outlines several options for coatings that deter rusting.

Examination

The first step in caring for iron is to determine which objects are stable and which are actively corroding (see CCI Notes 9/1 *Recognizing Active Corrosion*).

The term "stable" describes iron objects that range from having uncorroded silver-gray surfaces to having compact and adherent rusted surfaces that vary in colour from blue-black to red-brown. The term "unstable" describes iron artifacts suffering from active corrosion that can rapidly turn an object into powder. Because unstable iron sheds rust particles continually, rust "powder" will be observed underneath and around actively corroding iron. The corrosion occurs at the interface between the metal core and the outer corrosion layer, resulting in cracking, flaking, and detachment of the outer corrosion layers.

Close examination of any iron artifact suspected of being unstable may reveal active iron corrosion either in the form of akaganéite or in the form of "weeping" or "sweating".

Akaganéite

Akaganéite is an iron hydroxide oxide (ß-FeOOH) that forms vivid orange crystals. Although the presence of chloride is not indicated by the chemical formula, these crystals grow only when there are enough chloride ions present to stabilize its structure. Akaganéite, which grows on the iron at the metal–rust interface, exerts enough pressure on the corrosion layers to break them off, thus causing cracking and spalling. This active corrosion appears as orange crystals in the cracks of a spalling surface.

"Weeping" or "Sweating"

"Weeping" or "sweating" is caused by high concentrations of chloride-containing salts. When the

relative humidity (RH) is high (over about 55%), the salts absorb water vapour from the air, dissolve into the water, and form droplets of yellow, brown, or orange liquid on the surface of the corrosion. This liquid is acidic, so it will corrode iron and will damage acid-sensitive materials that come into contact with it. If the RH decreases, the droplets dry out and form either shiny crusts in cracks on the surface or round, orange-brown blisters. When viewed under low magnification, these blisters resemble broken and empty bubbles with thin, shiny, fragile shells. (For more information on active iron corrosion, see Turgoose 1982; Selwyn et al. 1999.)

Caring for Actively Corroding Iron

Separate any actively corroding objects from the rest of the collection, and store them in conditions with an RH below 35%. If there is still active corrosion at this low RH, it may be necessary to store these objects in extremely dry conditions with less than 12% RH (see Watkinson and Lewis 2004). Small, important pieces can be stored with dry silica gel in desiccators, in closed containers (e.g. Tupperware), or in closed cabinets. (For more information on conditioning silica gel, see Lafontaine 1984). Dry conditions significantly decrease the corrosion rate of actively corroding iron, but do not remove the source of the problem. Seek advice from a conservator for the care and treatment of such objects, because the maintenance and cleaning procedures outlined in this Note will not be sufficient to stabilize them.

Caring for Stable Iron

Keep iron objects as free of dust and dirt as possible. Clean iron away from the storage area to avoid introducing iron-laden dust particles to the area. Do not clean museum objects down to bare iron unless appropriate. If the corrosion product is removed totally, the iron can re-corrode and disfiguring orange spots of rust will result.

For small iron objects stored indoors, use cleaning methods that do not involve water or detergents. Brush off dirt and accumulated dust with various sizes and stiffnesses of toothbrushes and natural-bristle brushes (sometimes called "stencil brushes"). Trim the bristles to the required shape. The length of the bristles determines the stiffness of the brush — shorter bristles are stiffer than longer ones.

Take care not to chip off any corrosion layers because the underlying metal may be fragile. If thick corrosion is removed inappropriately, the object will be disfigured. If the extent of corrosion or the fragility of an object is in doubt, pass a magnet over the surface: the attraction will be strong where the corrosion is thin and will be weak where most of the metal has corroded.

A thin, even layer of surface rust can be removed from objects by rubbing gently with fine steel wool (000 or 0000 grade) and a few drops of light oil (e.g. sewing machine oil). Use clean, lint-free cloths wetted with mineral spirits (e.g. Varsol) to wipe off the resulting oil/rust slurry; this will prevent the slurry from being transferred to other materials. Follow this with a fresh coat of oil, applied and wiped thin with a clean cloth. Keep in mind that too much oil will attract dust and dirt, but too little oil will not protect against rusting. Treatment with oil is especially suitable for tool blades and for lightly rusted machinery parts. Oil enhances the surface appearance of the object and leaves a film, which acts as a thin vapour barrier that temporarily protects the underlying iron against rusting. Examine objects cleaned in this way regularly and re-oil them if fresh rust appears.

When cleaning iron, avoid using commercial liquid rust-strippers. These products contain acids to dissolve rust, and may quickly strip some areas of the object to bare metal. Ideally, any iron-containing composite object should be dismantled and its component parts cleaned separately. If this is not possible, clean each of the different parts of the object with appropriate methods and products. Take care not to damage the non-iron parts of the object when cleaning the iron parts, and vice versa. (For more information on cleaning copper alloys, see CCI Notes 9/3 *The Cleaning, Polishing, and Protective Waxing of Brass and Copper*. For more information on cleaning silver, see CCI Notes 9/7 *Silver — Care and Tarnish Removal*.)

Iron is often painted, labelled with decals, or plated with another metal such as tin or chromium. Corrosion may cause any of these outer coatings to be lifted away from the underlying iron surface. Take care not to remove any of these surface coatings because they contain historical information about the object. If a painted or plated object must be cleaned, consult a conservator. Document and save any detached paints or decals because these may be useful to a conservator carrying out restoration work or historical research.

Large machinery stored or displayed outdoors frequently becomes covered with accumulated salts, dirt, and acidic deposits that need to be removed regularly. Information on cleaning such objects is available in CCI Notes 15/2 *Care of Machinery Artifacts Displayed or Stored Outside*.

Finishes

Tannic acid is one possible coating for rusted iron that is to remain indoors (see CCI Notes 9/5 *Tannic Acid Treatment*). It may be used to enhance the appearance of an object for exhibition purposes. Applying tannic acid to rusted iron will produce a uniform blue-black finish. It reacts with the corrosion layers to form ferric tannate, which will prevent the most susceptible areas from re-rusting in the short term. If the object starts to re-corrode, tannic acid can be re-applied easily. However, it is important to understand the limitations of the tannic acid treatment. The resulting iron tannate layer is not a permanent coating or a vapour barrier, and it will not eliminate or reduce the effect of salt contamination. Furthermore, the treatment is not normally used in conjunction with a vapour barrier.

Protective coatings, such as oils, waxes, paints, and lacquers, can be applied to iron objects to reduce the rate of transmission of water vapour and oxygen from the environment to the metal surface. However, if coatings are applied to the porous corrosion layers on rusted iron, they may be very difficult to remove should the object begin to re-corrode actively. Use protective coatings only on the advice of a conservator, and then establish a regular program of inspection and maintenance for the coated artifacts. Maintenance may involve the periodic removal and re-application of the coatings.

Waxes are particularly difficult to remove from heavily corroded iron surfaces, so are not normally recommended for use on rusted iron. As mentioned earlier, oil is suitable as a protective coating for tool blades, gun barrels, and lightly rusted machinery parts. Paints and lacquers may be appropriate for some objects, especially for those stored or exhibited outdoors. However, painting museum objects that would not normally have been painted when in use betrays their historical accuracy (see CCI Notes 15/2 *Care of Machinery Artifacts Displayed or Stored Outside*). Moreover, paints and lacquers must be maintained regularly because outdoor exposure causes them to deteriorate rapidly and, for many, the longer they are exposed outdoors the more difficult they become to remove.

Storage

Ideally, iron should be stored at low RH (see CCI Notes 9/2 *Storage of Metals*). However, because iron objects usually have fittings of other materials that may be damaged by very low RH, this is not always practical. For a mixed collection, it is safer, easier, and less expensive to select an average ambient RH that will balance the needs of the entire collection. It is important to maintain a constant RH. An RH of 50% will not damage most iron that does not contain exceptionally high levels of soluble salts or that is not actively corroding. An RH over about 65% will lead to progressive damage to all iron.

Use acid-free unbuffered paper to wrap iron objects. It will help to reduce the effects of a sudden increase in RH and will prevent artifacts from touching one another. Line shelves or drawers with a resilient padding, such as thin sheets of polyethylene or polypropylene, to protect the artifacts from shock or abrasion. Alternatively, individual supports for the objects can be carved from thick polyethylene foam (see Schlichting 1994).

Temperature and illumination of iron are not critical factors except when they affect RH or associated materials, such as a paint layer. When displaying composite objects, consider the tolerance of each component material.

Some iron objects come with protective coverings or sheaths (e.g. daggers with scabbards). Do not store these objects in their protective coverings because the concealed iron may rust unnoticed. Also, the corrosion may stain the covering or, at worst, may permanently anchor the iron inside the container. Therefore, store iron objects adjacent to, not in, their coverings.

Handling

Wear gloves when handling clean iron objects, even those with corrosion layers. Otherwise, salts from the skin will be retained on the objects and will promote corrosion.

Conclusion

This Note provides broad guidelines for the basic care of iron. However, it must be remembered that there are many types of iron (e.g. wrought iron, cast iron, hardened steel) and iron finishes (e.g. paints, decals, plating) in museum collections. Although the requirements for storing and handling each of these types of objects are similar, always seek the advice of a conservator before cleaning a new type of object (e.g. swords, blued gun barrels, painted signs, tin cans) encountered in the collection.

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.

Stencil brushes:
art supply stores, watch repair shops

Neutral, acid-free tissue paper (non-buffered or unbuffered tissue):
conservation suppliers such as:

Carr McLean
461 Horner Avenue
Toronto ON M8W 4X2
Canada
tel.: 416-252-3371 or 1-800-268-2123
www.carrmclean.ca

or

Conservation Resources International Inc.
8000-H Forbes Place
Springfield VA 22151
USA
tel.: 703-321-7730 or 1-800-634-6932
www.conservationsources.com

Silica gel:
suppliers of laboratory equipment and of chemicals

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