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Stains – Identification and Prevention

Abstract: This *Technical Note* provides descriptions and photographs that aid in identifying commonly found stains and efflorescence on brick surfaces. This document includes information on stain composition, factors that influence their occurrence and methods of prevention.

Key Words: carbonates, chlorides, efflorescence, manganese, rain water, silicates, stains, soluble salts, sulfates, vanadium.

SUMMARY OF RECOMMENDATIONS:

Identification:
- Use photos and descriptions for preliminary identification of efflorescence or stains
- When uncertain of correct identification of efflorescence or stains, have experienced brick personnel or professionals sample and/or test stains to verify identity prior to cleaning

Prevention:
- Do not clean brickwork with unbuffered hydrofluoric or hydrochloric (muriatic) acid
- Use cleaning agents and procedures recommended by brick manufacturer to prevent cleaning-related stains
- Store brick off ground and cover with non-staining, waterproof material
- Protect top of unfinished brickwork from weather

INTRODUCTION

Brick has been used to create beautiful buildings for centuries. Most of these structures have a substantial history of outstanding performance. In some instances, the appearance of brickwork is affected by the development of efflorescence or stains. Stains may originate from materials in the brick or mortar, from adjacent materials, or from outside sources, such as cleaning agents. Each stain has a specific chemical composition and requires unique means of removal.

Identification of the origin of the efflorescence, stain or foreign material is the first step in returning brickwork to its intended appearance. When correctly identified, efflorescence and stains can usually be removed. The color and appearance of the stain should be considered during identification. However, some stains are often misidentified or are mistaken for other stains, like efflorescence, due to their appearance. Since correctly identifying efflorescence or a stain can be difficult, it is recommended that experienced brick personnel or professionals verify the efflorescence or type of stain. In some cases, the stain may need to be identified by extracting samples and sending them to a laboratory for testing. Once the stain has been properly identified, appropriate cleaning methods for the stain can be implemented. Misidentification of a stain may result in application of an inappropriate cleaning method, which may result in further staining or damage to the brickwork.

Further information on the formation and prevention of efflorescence is discussed in *Technical Note* 23A. Once identification of efflorescence or a stain is made, refer to *Technical Note* 20 for recommendations on cleaning brickwork to remove stains.

Efflorescence

Efflorescence is not considered a stain but will be discussed here for identification purposes. Refer to *Technical Note* 23A for causes and prevention. Efflorescence is usually a white, crystalline deposit on the brick surface. However, not all white stains on brick masonry are necessarily efflorescence. For instance, lime run and white scum are other types of white stains that are occasionally mistaken for efflorescence. Efflorescence is normally harmless and occurs when water-soluble salts are taken into solution within the masonry, carried to the surface through evaporation and deposited on the brick surface after the water evaporates. This results in a powdery, white, crystalline deposit as shown in Photo 1. Efflorescence may occur in a variety of locations on brickwork. In some instances, efflorescence may appear only on the mortar joints, as shown in Photo 2. In other instances,

Photo 1
Efflorescence

Photo 2
Efflorescence on Mortar Joints

Photo 3
Efflorescence in Limited Areas

efflorescence may appear in limited areas on the surface of brickwork as shown in Photo 3 or, in extreme cases, cover the entire brick surface, as shown in Photo 1.

Lime Run

Calcium carbonate deposits, sometimes referred to as “lime run,” usually appear as white or gray crusty formations. This is also not technically a stain but is rather a deposit. These deposits can be found emanating from weep holes or from fine cracks between brick and mortar joints. The term “lime run” refers to the pattern formed by the salt as it travels down the face of the wall, as shown in Photo 4 and Photo 5. Due to their white appearance, lime run stains are sometimes mistaken for efflorescence. However, after lime run fully carbonates it is water insoluble, whereas efflorescence is water soluble. The term “lime run” can be misleading since the stain is not a direct result of the lime component in the mortar. In fact, hydrated lime can actually help reduce the risk of lime run. The source of the calcium compounds

Photo 4
Lime Run

Photo 5
Lime Run

that contribute to lime run can be found in cementitious materials from masonry trim, mortar, backing or other construction materials. Materials containing cement are sources of calcium compounds and are either an integral component of brickwork or may be in contact with the brickwork; as a result, it may not be possible to eliminate the source of the salt.

For lime run to occur, there must be both a source of calcium compounds and water. Lime run forms due to a large quantity of water that dissolves water-soluble calcium compounds. Similarly to efflorescence, the mobilized salts are carried to the surface through evaporation; however, lime run has the tendency to follow the same path over an extended period of time, similar to stalactite formation in limestone caves. These elements will continue to migrate through the wall assembly and deposit on the surface of the masonry via the opening. At the surface, the dissolved calcium reacts with carbon dioxide (in the atmosphere) and forms the hard, crusty calcium carbonate deposit. Since calcium carbonate, or lime, is not a water-soluble compound, it will not wash away with rainwater and may be more difficult to remove. To reduce the possibility of lime run, excess water must be eliminated, or the path must be disrupted. Once lime run begins, it is likely to continue until the water source is stopped. A best practice is to ensure that wall cavities are protected during construction and that drainage wall assemblies are detailed and constructed properly.

White Scum (Silicate Deposits)

Silicate deposits, often referred to as white scum, usually appear as white or gray discolorations on the face of brick masonry, as shown in Photo 6. The discoloration may be present over the entire face of the brickwork or in smaller, irregularly shaped areas. White scum may also occur adjacent to masonry trim elements, precast concrete and, occasionally, large expanses of glass.

White scum is typically related to the cleaning of brickwork with unbuffered hydrofluoric or hydrochloric (muriatic) acid, or other improper acidic cleaners. It can also occur when an insufficient amount of water is used while prewetting or rinsing during cleaning activities with some acidic solutions. In either scenario, components of the brick and mortar dissolve in the acidic cleaner and produce insoluble silicate deposits on the wall surface. White scum is not water soluble like efflorescence and cannot be removed as easily. Specialty cleaning solutions, recommended by the manufacturer, should be used to remove silicate deposits from the wall surface.

Photo 6
White Scum

Note that silicate deposits on brick masonry should not be confused with scumming that sometimes occurs on brick during the manufacturing process. This type of scumming will be evident on brick units before they are placed in the wall.

Vanadium Stains

Vanadium stains are yellow, green or purple salt deposits in the heart of light-colored brick units, as shown in Photo 7 and Photo 8. Vanadium stains occur when vanadium salts present in clays used to manufacture light-colored bricks come in contact with an acidic environment, such as unbuffered hydrofluoric or hydrochloric (muriatic) acid cleaners or acid rain. They may be found on tan, buff or white brick; however, they are more conspicuous on lighter-colored brick. The yellow, green and purple stains are usually crystallized vanadium salts, consisting of sulfates and chlorides, or hydrates of these salts.

Vanadium stains occur in a manner similar to efflorescence, except that vanadium oxide and sulfates are dissolved and result in a solution that may be quite acidic. As water evaporates from this solution at the surface of the brickwork, the salts are deposited on the brick. The chloride salts of vanadium, such as vanadyl chloride,

Photo 7
Yellow Vanadium Stain

Photo 8
Green Vanadium Stain

may also form as a result of washing with unbuffered hydrofluoric or hydrochloric (muriatic) acid or exposure to excessive moisture [Ref. 2].

Preventing vanadium stains is important, since they can be difficult to remove, and improper cleaning efforts may result in a brown, insoluble deposit that is even more difficult to remove. To minimize the potential for vanadium stains, the following steps are recommended:

- Store brick off the ground and under non-staining protective covers.
- Never use or permit the use of highly concentrated, unbuffered hydrofluoric or hydrochloric (muriatic) acid solutions to clean light-colored brick.
- Follow the cleaning recommendations of the brick manufacturer.

Manganese (Brown) Stains

Under certain conditions, tan, brown or occasionally gray staining may occur on the mortar joints of brickwork, as shown in Photo 9. Occasionally, a brown stain will extend onto the faces of the brick, as shown in Photo 10. This type of stain is the result of using manganese oxide as a coloring agent in tan, brown, black or gray brick and its reaction to an acid.

During the brick firing process, manganese coloring agents undergo several chemical changes, resulting in manganese compounds that are insoluble in water. Manganese compounds have varying degrees of solubility

Photo 9
Manganese Stain

Photo 10
Manganese Stain

in weak acids. Once dissolved, these compounds may migrate in solution toward the surface of brickwork. As previously discussed, acid solutions can dissolve the manganese compounds in brickwork under certain conditions, such as the use of unbuffered hydrofluoric or hydrochloric (muriatic) acid during cleaning. It is also possible that the brick may have been subjected to acid rain [Ref. 4].

Manganese staining is closely related to efflorescence, since it is the sulfate and chloride salts of manganese that travel to the surface of the brickwork. When the manganese solution reaches the mortar joints, the salts are neutralized by the cement or lime in the mortar, producing insoluble manganese hydroxide. The manganese hydroxide precipitate is deposited on the mortar joint and, when dry, converts to brown manganese tetroxide, resulting in the unsightly brown stain [Ref. 2].

Unbuffered hydrofluoric or hydrochloric (muriatic) acid must not be used to clean tan, brown, black or gray brick. Proprietary cleaning solutions are available for cleaning brick containing manganese. Test the effectiveness of the cleaning solution on a small stained area prior to full-scale application, and follow the recommendations of the brick manufacturer. To prevent manganese staining, follow the cleaning recommendations of the brick manufacturer.

Stains from External Sources

Stains that affect the appearance of brickwork can be caused by the environment or other external sources, such as pollution or runoff. Usually, the source or composition of these stains is obvious due to the appearance or location of the stain.

Biological Growth. Masonry that remains in a damp condition or is in a minimally sunlit location can lead to organic/biological growth on its surface. Stains that are isolated to the north facade or north-facing elements of the facade are likely related to biological growth. These stains will also be concentrated along areas that are frequently wetted, such as parapet caps, or under projecting elements, such as window sills. Biological growth/ organic stains, as shown in Photo 11, can include algae, lichen, mildew or other organisms.

Adjacent Materials. Certain materials above or adjacent to brickwork such as copper (Photo 12), bronze, aluminum, synthetic stucco or paint (Photo 13) can stain brickwork surfaces. In addition, externally caused stains such as hard water from sprinkler systems can affect brickwork (Photo 14).

Photo 11
Organic Stain

Photo 12
Stain from Copper

Photo 13
Runoff Stain from Paint

Photo 14
Hard Water Stain

Photo 15
Rust Stain

Rust. Rust-colored stains may actually be corrosion, as shown in Photo 15. Such stains can be the result of corrosion of wall ties or joint reinforcement in or adjacent to the brickwork. The use of improper mortar additives or ingredients, placement of wall ties or joint reinforcement with inadequate cover, welding splatter on the brick, or the corrosion of a material placed on the brick cube or pile prior to being laid in the brickwork can all contribute to these stains.

SUMMARY

The proper identification of efflorescence and stains on brickwork is essential to stain removal. Photographs and laboratory or field testing can assist in this effort. When uncertain of the composition or origin of efflorescence or stains, verification by trained, experienced brick personnel or professionals is recommended. The use of an incorrect cleaning agent or method on a stain could result in further staining that is more difficult to remove than the original stain or could result in damage to the brick. Understanding the mechanisms involved with the formation of efflorescence and stains on brickwork is useful in design and construction to minimize their occurrence.

The information and suggestions contained in this Technical Note *are based on the available data and the combined experience of engineering staff and members of the Brick Industry Association. The information contained herein must be used in conjunction with good technical judgment and a basic understanding of the properties of brick masonry. Final decisions on the use of the information contained in this* Technical Note *are not within the purview of the Brick Industry Association and must rest with the project architect, engineer and owner.*

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