

Efflorescence - Causes and Prevention

Abstract: This *Technical Note* describes the mechanisms leading to the formation of efflorescence, including probable sources of soluble salts and moisture. Conditions necessary to cause efflorescence to appear are presented, along with design recommendations and practices that reduce the potential for efflorescence.

Key Words: admixtures, chlorides, condensation, efflorescence, masonry, mortar, rain water, soluble salts, sulfates, trim.

SUMMARY OF RECOMMENDATIONS:

General

- Positively identify efflorescence (see *Technical Note 23*)
- Determine if the efflorescence is "new building bloom"
- Identify causes of efflorescence using the included troubleshooting list and correct the causes before attempting removal
- Design and construct brickwork to maximize water penetration resistance
- Consider materials that contain fewer soluble salts
- Coatings are not recommended as the sole treatment to control efflorescence

Design

- Isolate exterior brick wythe with an air space
- Waterproof the exterior of walls that extend below grade
- For walls without an air space, separate the brick wythe from the backing with a dampproof coating

Construction Practices

- Store masonry materials off the ground and cover with waterproof materials to protect them from groundwater and precipitation
- Protect unfinished masonry from weather during construction

INTRODUCTION

Brickwork provides aesthetically pleasing structures. Occasionally, a white crystalline deposit will appear on the surface. These deposits may be efflorescence, water-soluble salts that occasionally occur on the surface of masonry. Although undesirable, efflorescence is usually not harmful to brick masonry.

This *Technical Note* describes the mechanisms of efflorescence, including possible sources of salts and water, providing a basic understanding of the phenomenon of efflorescence that is essential to minimize its occurrence. Although similar, sources of salts and the development of efflorescence on paving surfaces are discussed in the *Technical Notes 14 Series* on brick pavements.

A thorough program of efflorescence prevention or control may include identification of the type of efflorescence and investigation of its causes before options for correction are considered. This *Technical Note* is intended to serve as a guide in this process. Procedures for removal of efflorescence are discussed in *Technical Note 20*.

CAUSES OF EFFLORESCENCE

There are many, often complicated, mechanisms of efflorescence. Simply stated, efflorescence occurs when water containing dissolved salts is brought to the surface of masonry, the water evaporates and the salts are left on the surface of the masonry. The salt solutions may migrate across surfaces of masonry units, between the mortar and units, or through the pores of the mortar or units.

There are certain simultaneous conditions that must exist in order for efflorescence to occur:

- Soluble salts must be present within or in contact with the brickwork. These salts may be present in brick, backing materials, mortar ingredients, trim, adjacent soil, etc.
- There must be a source of water in contact with the salts for a period of time sufficient to dissolve them.
- The masonry must have a pore structure that allows the migration of salt solutions to the surface or other locations where evaporation of water can occur.

Efflorescence on brickwork less than one year old can often be attributed to new building bloom. When efflorescence occurs more than a year after construction is complete, it can generally be attributed to excessive water penetration or poor drainage and is often associated with or is most severe in winter.

Under certain specific circumstances and conditions, it is possible for the crystals of efflorescence to form within the bodies of brick. When this occurs, it is possible that the growth of crystals and the resulting pressure may cause cracking and distress to masonry.

It is not practical to attempt to preclude all soluble salts from masonry materials or possible to prevent moisture from coming in contact with masonry exposed to weather. However, reducing each contributing factor is a realistic approach that will usually prevent the occurrence or reduce the severity of efflorescence.

The most effective means of preventing efflorescence is to minimize the amount of water that penetrates brickwork. This, as well as separating brickwork from sources of salts, is primarily accomplished through careful design and construction. To the extent possible, the amount of salts available is reduced through material selection.

MATERIAL SELECTION

Material selection provides the first opportunity to reduce efflorescence potential, however the ability to eliminate these salts is somewhat limited and less practical than minimizing water penetration. The following recommendations are presented to assist the designer in the selection of materials to limit the occurrence of efflorescence.

The chemical composition of efflorescing salts is usually alkali and alkaline earth sulfates and carbonates, although chlorides may also be present. The most common salts found in efflorescence are sulfate and carbonate compounds of sodium, potassium, calcium, magnesium and aluminum. When chlorides occur as efflorescence, it is usually a result of the use of calcium chloride as a mortar accelerator, contamination of masonry units or mortar sand by salt water, or the improper use of hydrochloric acids in cleaning solutions.

Since efflorescence appears on the face of the brickwork, it is often erroneously assumed to come from the brick. Usually however, soluble salts originate in other masonry units and materials that make up the assembly.

Brick

It is possible for brick to contain soluble salts, however brick that do not contribute to efflorescence are readily available throughout the United States and Canada. Soluble salts contained within a brick may be dissolved by any water the brick absorbs, contributing to the development of efflorescence.

The potential for brick to effloresce can be assessed using the efflorescence test in ASTM C 67, Standard Test Methods for Sampling and Testing Brick and Structural Clay Tile [Ref. 1]. This test consists of partially immersing brick in distilled water for a period of 7 days. At the end of this period, the brick are allowed to dry, examined for efflorescence and compared to brick that were not immersed. The individual performing the test, based on visual observation, rates the brick as either “not effloresced” or “effloresced.”

The ASTM C 67 efflorescence test is more severe than normal environmental exposures. It is important to understand that this is a product test that only establishes whether the brick contain enough soluble material to effloresce under laboratory conditions. Brick rated “effloresced” may not exhibit efflorescence in service; brick rated “not effloresced” may exhibit efflorescence in service. Migration of salts from other sources may also cause brick to effloresce. Construction practices that reduce the potential for contamination of brick are discussed later.

Mortar and Grout

Mortar can be a significant contributor to efflorescence. W.E. Brownell, the author of a research report on efflorescence in brickwork [Ref. 2] states:

“The primary and most obvious source of contamination of otherwise efflorescence-free brick is the mortar used in wall construction. The mortar is in intimate contact with the brick on at least four and sometimes five sides. It is applied to the brick in a wet, paste-like condition which provides ample moisture for the transfer of soluble salts from the mortar to the brick. If any appreciable soluble material is present in the mortar, it will be carried into the brick proportionately to the amount of moisture transferred.”

This would also apply to grout, which is made with the same constituent materials as mortar, and contains a greater amount of water. Brownell continues:

“The simplest case of soluble salt contamination of efflorescence-free brick is the migration of ‘free-alkali’ solutions from the mortar to the brick. This situation is not only the simplest mechanism, but it is also the most common. In the trade, it is known as ‘new building bloom’.”

New building bloom is typically fairly uniform across the wall surface. New-building bloom, tends to occur shortly after construction ends, due to normal water loss during post-construction drying. Efflorescence that reappears after this initial period is likely due to water entering and remaining in the wall.

Mortar types and proportions should be selected on the basis of structural and exposure requirements for the particular project. Recommendations for mortar are contained in *Technical Notes 8* and *8B*.

Cement. The principal contributor to efflorescence in mortar and grout is the alkali content of portland cement. The tendency of cement to effloresce may be predicted with reasonable accuracy from a chemical analysis of the cement. Cements high in alkalies are more prone to produce efflorescence than cements of lower alkali content.

All cements contain some water-soluble alkalies. Those common in mortar and grout are sodium and potassium. It is suspected that the sulfate content of the cement may be as significant as the alkali content in contributing to efflorescence.

ASTM C 150, Standard Specification for Portland Cement [Ref. 1], includes provisions for specifying low-alkali cement, when required. In these cases, the optional compositional requirements limit equivalent alkalis ($\text{Na}_2\text{O} + 0.658\text{K}_2\text{O}$) to a maximum of 0.60 percent as measured using ASTM C 114, Standard Test Methods for Chemical Analysis of Hydraulic Cement [Ref. 1]. The alkalies referred to are the total of acid-soluble and water-soluble fraction alkalies. In general, the water-soluble alkali content will be of the order of 60 percent of the total. Brownell [Ref. 2] states:

“Experience has shown that 0.1 percent free alkali in a portland cement used in common mortars will cause ‘new building bloom’; therefore, if such efflorescence is to be avoided, the free alkali of the cement should be less than this and should be specified as low as possible.”

This severe limitation on water-soluble alkali content is only met by a few cements other than portland blast-furnace slag cement and masonry cements made with slag cement. It should be stated, however, that all investigators do not agree. Many believe that Brownell is extremely conservative.

Other ingredients for mortar and grout, i.e., lime, sand and water, should also be selected with care, although their contribution to efflorescence is typically less than that of cement.

Lime. Various investigators disagree as to the possible contribution of lime to efflorescence. It has been demonstrated that lime, clay or sand additions to a mortar do not generally contribute to efflorescence [Ref. 6]. In fact, these ingredients tend to dilute the deleterious effects of high alkali cement.

On the other hand, lime is somewhat water-soluble. Its presence may serve to neutralize sulfuric acids generated within the masonry. Under certain conditions, lime reacts with unbuffered hydrochloric acid to produce very soluble calcium chloride, which can migrate to the surface. Nevertheless, lime improves the extent of bond between mortar and brick, and thereby increases the water resistance of the masonry.

Sand. Sand used in mortar and grout is not water-soluble; however, it may be contaminated with material that will contribute to efflorescence. Sand for use in mortar or grout should be taken from sources free of contamination from salt water, soil runoff, plant life and decomposed organic compounds, among others. Using clean, washed sand will eliminate any efflorescing contribution.

Admixtures. A wide variety of admixtures for masonry mortar and grout is available. Most of these products are proprietary and their compositions are not disclosed. In general, they are classified as workability enhancers, bond enhancers, water repellents, set retarders or set accelerators.

Compressive strength, water retention and air content are generally the only properties included in reports on mortar. However, an admixture’s effect on extent of bond and bond strength may also influence the efflorescence potential, as a reduction in either may make masonry walls more vulnerable to water penetration. Therefore, admixtures with unknown compositions are not recommended for use in mortars unless it has been established by

experience or laboratory tests that they will neither materially impair mortar bond nor contribute to efflorescence.

Chlorides that occur as efflorescence may result from the use of calcium chloride and compounds containing calcium chloride added to mortar as set accelerators. Because calcium chloride causes corrosion of metal embedded in mortar under certain conditions, *Specification for Masonry Structures*, ACI 530.1/ASCE 6/TMS 602 [Ref. 5], limits chloride ions to 0.2 percent for mortar admixtures. Normally, this amount of calcium chloride will not contribute materially to efflorescence.

Backing

Materials commonly used as backings or inner wythes of masonry walls, such as concrete and concrete masonry units may contain large quantities of soluble salts. As with mortar, the cement in concrete and concrete products is the principal contributor to efflorescence. Measurements of the soluble salt contents of clay and concrete masonry units and their efflorescing tendencies have shown that concrete products can contain two to seven times as much soluble material as the fired clay material [Ref. 3]. Such salts found in backing materials may contribute to efflorescence on the face of the brickwork if sufficient water is present to dissolve the salts and there is direct contact between the brick and backing or a pathway for the solution to reach the masonry surface.

As with mortars, concrete and concrete masonry units made with low alkali cements decrease the quantity of salts available for efflorescence. Design suggestions and construction practices that prevent absorption of these salts by brick are presented later.

Trim

Building trim, such as caps, coping, sills, lintels, keystones, etc., are often built into the brick wythe. These items may be natural stone, cast stone, precast concrete, etc. any of which may contain soluble salts. Such materials may contribute significantly to efflorescence on the face of adjacent brickwork. As the amount of soluble salts contained in these materials cannot usually be controlled, their effects on brickwork should be carefully considered. The contribution of these materials to efflorescence can be minimized as discussed in **Design and Detailing**.

DESIGN AND DETAILING

The most meticulous design and detailing may be thwarted by the selection of inappropriate materials or by poor workmanship. The converse is also true: the use of the best possible materials and craftsmanship will not in themselves ensure a successful and permanent structure if the design is improper.

As previously discussed, the mechanism of efflorescence is dependent upon the presence of free water in the masonry to dissolve the available soluble salts. The primary source of moisture for the occurrence of efflorescence is rain water that penetrates or comes in contact with masonry. Rain water will penetrate all masonry walls to some degree, more so if they are improperly designed or detailed.



Photo 1
Efflorescence from Water Penetrating Wall Top

Limiting available moisture helps to suppress the development of efflorescence. Therefore, much depends on the design and attention to certain critical details, particularly those that are associated with preventing moisture entry into the brickwork and directing water away from wall tops and horizontal surfaces, see **Photo 1**.

A general discussion of water penetration resistance is provided in the *Technical Notes 7 Series*. The following paragraphs present design measures that minimize the potential for efflorescence by improving the water resistance of brickwork. The craftsmanship employed in the construction of a masonry wall also has a significant effect on the amount of water penetrating the wall and is discussed later.

Air Space

Drainage walls are recommended for maximum resistance to rain penetration and minimum efflorescence.

The drainage wall system provides a cavity or air space that separates the exterior brickwork from other elements in a wall assembly, as shown in **Figure 1**. This separation impedes the development of efflorescence in two ways. It allows water to drain down the back of the brick wythe and out of the wall without wetting other materials and prevents the migration of salts from backing materials by isolating the brick wythe.

Photo 2 illustrates the transfer of soluble salts from backing units to brick when the two materials are in direct contact. This result was obtained by placing the concrete masonry units in pans of water with five brick on top of each block. The brick had previously been subjected to the efflorescence test and rated "not effloresced." The potential for backing materials to effloresce can be determined by using the same efflorescence test method used for brick.

The barrier wall strategy of filling a collar joint between masonry wythes with mortar or grout to provide a continuous barrier to water penetration is not recommended. Because mortar and grout contain cement, collar joints increase the potential for efflorescence by placing a source of salts in direct contact with the brickwork.

Providing a dampproof coating on the exterior surface of concrete and concrete masonry backings of drainage and barrier walls may reduce the potential for brick veneer to effloresce. These coatings limit the passage of salts and moisture between backing materials and the brick wythe. Dampproof coating materials for concrete masonry walls are typically bituminous and applied by spraying or brushing.

Trim

Because trim materials are often in contact with brickwork, any salts they contain may contribute to efflorescence as stated earlier in **Material Selection**. These materials are frequently used in locations that are most vulnerable to water penetration, such as caps, copings and sills. Therefore, all three of the conditions necessary for efflorescence are met almost anywhere these elements are used. However, placing flashing or other materials that can act as a capillary break between trim materials and brickwork can reduce the contribution of trim materials to efflorescence by preventing contact and the migration of salts from trim.

Below Grade Walls

Soluble salts in soil are dissolved by water that percolates through the ground. Consequently, most ground water contains a high concentration of these salts. When masonry is in contact with the earth, ground water may be absorbed by the masonry and may rise through capillary action several feet above the ground. An accumulation of salts in the masonry is then possible, as shown in **Photo 3**.

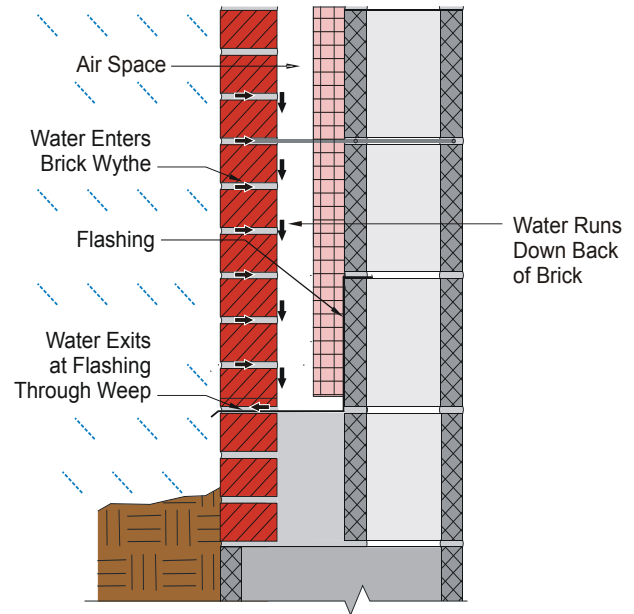


Figure 1
Drainage Wall System

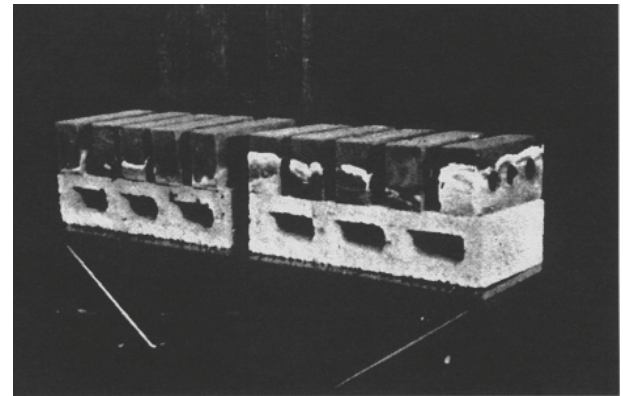


Photo 2
Migration of Soluble Salts from Backing to Brick



Photo 3
Migration of Soluble Salts from Soil

To eliminate these salts as sources of efflorescence, waterproof the masonry that extends below grade and install flashing a few courses above grade. The waterproofing prevents the masonry from absorbing dissolved salts from the adjacent soil and the flashing acts as a capillary break, preventing any absorbed salts from rising higher in the wall.

Condensation

In addition to rain water and ground water, water may accumulate within a wall as a result of condensation of water vapor. On rare occasions, accumulation of condensed water within a wall may provide enough moisture to cause brickwork to effloresce.

Condensation typically contributes to efflorescence when the moisture originates inside buildings. Indoor air may have a particularly high moisture content due to a building's use (e.g., swimming pool) or certain activities that take place inside such as cooking, bathing, washing and other operations employing water or steam. During cold weather, building interiors conditioned to normal comfort settings may contain enough moisture to cause condensation at lower temperatures.

If this water vapor reaches a vapor-resistant surface at a temperature below the dew point temperature, the vapor will condense and can provide the moisture necessary to trigger the mechanism for efflorescence. This condensed moisture can contribute to efflorescence on the wall surface.

Condensation is typically controlled through design that considers the possibility of its occurrence. Using materials with the appropriate water vapor permeance and preventing the transfer of air through the building envelope reduce the possibility of condensation. See *Technical Note 47* for detailed guidance on avoiding condensation.

CONSTRUCTION

Construction practices and workmanship employed in building masonry walls can significantly affect the amount of water within masonry materials and the completed construction. Some discussion and recommendations for proper construction practices follow.

Storage of Materials

The method of storing materials at a construction project site may influence future occurrence of efflorescence. Masonry units, cementitious materials, sand and water should be stored off the ground, in such a manner as to avoid contact by rain or snow, or contamination by dirt, plant life, organic materials or ground water, any of which may contribute to efflorescence. These materials should also be covered by a waterproof membrane to keep them dry.

Water

Water used in mortar or grout, for wetting brick, cleaning or other applications can also be a source of contaminants. Clean, potable water free of salts, deleterious acids, alkalies or organic materials should be used at all times.

Workmanship

Workmanship characterized by the complete filling of all mortar joints intended to receive mortar is critical, as is the need to keep all cavities and air spaces clean and free of mortar droppings. Attention to both of these items is of primary importance in preventing efflorescence. Full mortar joints are more effective at reducing water penetration and clean cavities help masonry dry faster and separate brickwork from backings containing salts. *Technical Note 7B* discusses recommended workmanship practices for masonry construction. Brick masonry with workmanship characterized by partially filled joints, deep furrowing of the mortar beds and improper execution of flashing and sealant joint details is subject to increased rain penetration.

Unfinished Brickwork

Partially completed masonry walls exposed to rain and other elements during construction may become saturated with water and depending on climatic conditions can require weeks, or even months to dry after the completion of the building. This prolonged saturation may cause many "slightly" soluble salts, as well as the highly soluble salts within masonry, to go into solution. Such conditions may also contribute to the contamination of the masonry with soluble salts from elsewhere in the construction (concrete, plaster, trim, etc.).

During construction, *Specification for Masonry Structures*, ACI 530.1/ASCE 6/TMS 602, requires the tops of all unfinished masonry to be protected from the weather. At the end of each workday, shutdown period or times of inclement weather, unfinished walls should be covered with water-resistant membranes or tarpaulins, securely fastened or weighted in position. Mortar boards, scaffold planks and light plastic sheets weighted with brick should not be accepted as suitable cover. Additional recommendations and construction procedures for protecting walls during cold weather are discussed in *Technical Note 1*.

Sealant Joints

Sealant joints should be integral elements of construction, designed and installed with the same care as other elements of the structure. Sealants and caulk should not be used as a means of correcting or hiding poor workmanship that would permit water penetration.

Joints between masonry and door and window frames, expansion joints and other locations where sealants are required are the most frequent sources of rain penetration into masonry. These vulnerable locations should be given careful attention during design and construction.

Sealants and caulk do not have service lives as long as buildings. Maintenance programs should be established to identify and replace sealants and caulk that have dried or become ineffective, as shown in [Photo 4](#).

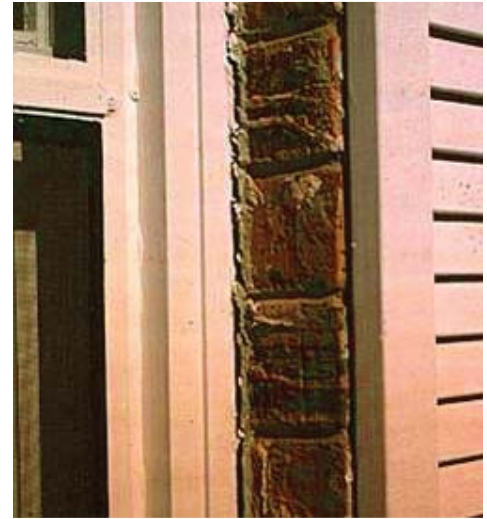


Photo 4
Sealant Joint in Need of Repair

POST CONSTRUCTION

Troubleshooting Efflorescence

In addition to the information given above, the following measures can be used to help determine the cause and extent of the efflorescence problem, and to suggest methods for repair and alleviation.

1. Determine the age of the structure at the time when the efflorescence first appeared. If “new building bloom” is involved (structures less than one year old), the source of the salts is often the cement in the mortar, and water that was used for or otherwise entered during construction is the source of moisture.

If the structure is over one year old, construction details should be examined to identify possible leaks in the wall or in the surrounding construction. The appearance of efflorescence on an established building, which had previously been free of efflorescence, is usually attributable to a new source of water in the masonry.

2. Observe the location of the efflorescence, both on the structure and on the individual units or mortar joints. The location on the building may offer some information as to where the water is entering. The recent use or occupancy of the building should also be noted. For example, has it been vacant for some time or has there been new construction? In short, what has occurred that might cause, or trigger, the appearance of the efflorescence?
3. Examine the condition of the masonry. The profile of the mortar joints, the condition of the mortar, the quality of workmanship employed, the condition of caulking and sealant joints, the condition of flashing and drips, obstructed weeps, any deterioration or eroding of mortar joints in copings or in sills should all be carefully noted. This information should offer clues as to the entry paths of moisture into the construction.
4. Review wall sections and details of construction for an indication of possible paths of moisture travel, and for possible sources of contamination by soluble salts. A careful examination of roof and wall juncture and flashing details should be made. If available, a comparison of “contract drawings” with “as built drawings” may be helpful. This examination will also be useful for determining steps for repair or alleviation of the efflorescence.
5. Review laboratory test reports on the materials of construction if they are available. This may help determine the source of the soluble salts, and may be of use in analyzing and making repair judgments.

6. Identify the efflorescence. Knowing the composition of efflorescing salts is sometimes of use. [Table 1](#), taken from Brownell's report lists the most probable sources of efflorescing salts. Commercial testing laboratories can use X-ray diffraction, petrographic analysis or chemical analysis can, in some instances, determine both the type of salts present and their relative quantity.
7. Consider miscellaneous sources of water when all obvious sources have been eliminated. Some of these sources are: condensation within the wall, poorly directed landscape sprinklers, leaky pipes, faulty drains and condensation on heating or plumbing pipes. If necessary, condensation analysis methods are described in *Technical Note 47*.

When the mechanisms causing the efflorescing salts to appear have been established and the sources of salts or moisture are identified (usually the latter), suitable corrections must be addressed. Solutions to efflorescence problems usually involve reducing water penetration into the masonry and removing the efflorescence from the wall. Recommendations for the correction of water penetration in masonry walls are contained in *Technical Note 46*.

Removal of Efflorescence

The removal of efflorescence from the face of masonry is generally a relatively easy operation. Most efflorescing salts are water-soluble and many will disappear of their own accord with normal weathering. This is especially true of new building bloom.

It is usually not advisable to wash efflorescence off of the brickwork except in warm, dry weather, since this results in the availability of considerably more moisture which may bring more salts to the surface. Many efflorescing salts can be removed by dry brushing.

For recommendations concerning removing efflorescence and other stains on masonry walls, see *Technical Note 20*. Special care should be exercised in cleaning new masonry, since improper procedures and errors can contribute to or cause efflorescence or stains.

Coatings

Clear water repellents, silicone and acrylic coatings are among the solutions often suggested for preventing efflorescence. A coating may prevent efflorescence from recurring by reducing the amount of water absorbed by an exposed masonry surface. However, applying a coating to brickwork that has a tendency to effloresce, without stopping the mechanisms causing that efflorescence, may lead to degradation of the masonry. Further, applying a coating that inhibits evaporation of water from the masonry may also lead to degradation.

As water and dissolved salts within masonry travel toward a coated exterior surface, they may be stopped at the inner margin of the coating (usually $\frac{1}{8}$ to $\frac{1}{4}$ in. [3 to 6 mm] below the surface). At this point, the water will evaporate, passing through the treated area as vapor and soluble salts in the water will be deposited within the masonry. Known as cryptoflorescence or subflorescence, salts that crystallize within masonry can develop tremendous pressures which may result in brick spalling. For this reason, coatings are not recommended as the sole treatment for efflorescence problems.

TABLE 1
Common Sources of Efflorescence

| Principal Efflorescing Salt | | Most Probable Source |
|-----------------------------|-------------------------------------------------------|-------------------------------------------------------------|
| Calcium sulfate | CaSO ₄ •2H ₂ O | Brick |
| Sodium sulfate | Na ₂ SO ₄ •10H ₂ O | Cement-brick reactions |
| Potassium sulfate | K ₂ SO ₄ | Cement-brick reactions |
| Calcium carbonate | CaCO ₃ | Mortar or concrete backing |
| Sodium carbonate | Na ₂ CO ₃ | Mortar |
| Potassium carbonate | K ₂ CO ₃ | Mortar |
| Potassium chloride | KCl | Acid Cleaning |
| Sodium chloride | NaCl | Sea Water |
| Vanadyl sulfate | VOSO ₄ | Brick |
| Vanadyl chloride | VOCl ₂ | Acid Cleaning |
| Manganese oxide | Mn ₃ O ₄ | Brick |
| Iron oxide | Fe ₂ O ₃ or Fe(OH) ₃ | Iron in contact or brick with "black core" or "black heart" |
| Calcium hydroxide | Ca(OH) ₂ | Cement |

OTHER STAINS

A number of stains that affect brick masonry are white in color and may be confused with efflorescence. There are still other stains that are different in color, but have a mechanism of development similar to that of efflorescence. Discussion of these stains is outside the scope of this *Technical Note*. Identification of these stains, as well as their causes and prevention, is addressed in *Technical Note 23*.

SUMMARY

The development of efflorescence requires the presence of soluble salts and moisture. To prevent or minimize efflorescence, the elimination of either will suffice. Design, detailing and construction practices that promote resistance to water penetration are the most effective methods of preventing efflorescence. When efflorescence does occur, careful observation is valuable in determining and correcting sources of water entry or salts prior to removal.

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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