



### Introduction

This ARRISCRAFT•NOTE discusses the causes and mechanisms of efflorescence including the possible sources of soluble compounds and moisture needed to dissolve these compounds. The purpose is to provide a rudimentary understanding of efflorescence occurrence.

Efflorescence is a crystalline deposit of water-soluble compounds on the surface of unit masonry. It differs from cryptoflorescence in that it occurs only on the surface of the masonry rather than within the masonry itself.

Although it is unsightly and considered a nuisance to remove, it is not normally harmful.

Efflorescence is usually white in colour. Coloured stains can be produced by acid-soluble vanadium and magnesium compounds in clay masonry, but they do not apply to this discussion of efflorescence.

### Causes of Efflorescence

In the simplest of terms soluble salts in solution are drawn to the surface of the masonry wall where they are deposited upon evaporation of the moisture. These soluble salts can migrate through the pore structure of the mortar of the masonry units, across surfaces of units, or between the masonry units and the mortar.

Certain conditions must exist in order for efflorescence to occur:

- soluble salts must be present within the wall construction;
- a source of water must be present and in contact with the soluble salts for a sufficient period of time to permit them to dissolve; and
- the migration of these salts in solution to the masonry surface where the moisture is allowed to evaporate.

### Sources of Salts

When constructing with masonry, it is certain that soluble salts will be present. They can be found within the masonry units, within ingredients used for the production of mortar, introduced at various stages of the construction phase, or subsequently introduced from exterior sources, such as salt-laden soils and air pollution.

The chemical composition of efflorescent salts is usually alkali hydroxides or sulphates, such as sodium, potassium, and calcium. These may be inherent in the raw materials or formed during material processing. Upon exposure to atmospheric carbon dioxide, these may change to a carbonate form.

Chlorides have also been found to be present, usually as a result of calcium chloride being used as a mortar accelerator, contamination of the masonry materials by

sea water, or the improper use of hydrochloric acids during the cleaning process.

### Sources of Moisture

**Rain Water** and other forms of precipitation are the primary source of moisture for the occurrence of efflorescence. Precipitation in the form of rainwater and melting snow or ice, if allowed to penetrate the wall and remain in contact with the masonry, will be sufficient to dissolve soluble salts within the wall.

**Condensation** is another source of water in walls. This may occur when the humidity and temperature on one side of a wall are greater than on the other, and either no air/vapour barrier has been installed or it has been installed incorrectly. Warm, moist air from the building's interior is allowed to travel through the wall assembly towards the exterior. The air may reach its dew point as it passes through the wall insulation, and the moisture then condenses on the first available colder surface, such as the rear face of masonry units.

**Ground Water** may be considered a source of both salts and moisture in masonry walls. Soluble salts in soil are dissolved by water penetrating the ground; and if the resulting salt-laden moisture is not prevented from being wicked up into the masonry, could saturate the masonry units and the result is efflorescence.

### Reducing Efflorescence Potential

**Careful Selection of Materials** to minimize soluble salts is a prudent first step towards minimizing the potential for efflorescence. It is not considered practical, however, to attempt to preclude all soluble salts from within masonry wall construction.

**Designing Walls to Reduce Moisture** is a more realistic way of minimizing the potential for efflorescence. There are essentially two design considerations which must be addressed to successfully reduce efflorescence-causing moisture within the wall construction:

- prevent sufficiently large quantities of water from penetrating the wall; and
- ensure that any water penetrating the wall is allowed to quickly leave the wall assembly, thus minimizing absorption by the masonry units and the mortar.

Masonry walls designed and constructed to prevent water penetration need to include:

- impervious sills, watertables, caps or copings of sufficient length to minimize the number of joints, properly sloped to direct water away from the masonry, and designed with adequate overhangs and drip mechanisms;

- flashing membranes at parapets, sills, lintels, and any other locations where water may collect;
- dampproof flashing membranes at ground level;
- neatly tooled mortar joints that are compressed to provide a weather-resistant skin;
- caulked joints between masonry and wall openings; and
- caulked joints between individual sill, watertable, and cap or coping units.

Masonry walls designed and constructed to properly drain moisture and encourage drying of the wall system need to include:

- drainage cavity spaces devoid of mortar fins, protrusions or bridges;
- through-wall flashing membranes at the base of all cavities; and
- adequate numbers of weep hole vents located at the same level as the through-wall flashing.

Another beneficial feature may be to include vents at the top of the walls. By incorporating weep hole vents at the bottom of the wall and vents at the top of the wall, this should encourage air to flow through the cavity and this should aid in drying the wall system.

**Construction Practices** can also affect a wall's tendency to effloresce. The following recommendations will help minimize potential problems:

- protect partially completed masonry walls during construction from rain and other elements to ensure the wall is kept dry;
- store masonry units and cementitious materials off the ground, adequately protected from precipitation and ground water;
- store aggregates for mortar off the ground to prevent contamination from dirt, plant life, organic materials and ground water;
- keep mixers, mortar boxes and boards free of contamination; and
- keep tools free of rust, salts, and other contaminants.

### Coatings

Clear water repellent coatings are sometimes recommended to reduce or prevent efflorescence. Their use, however, on a wall which has a tendency to effloresce, without first stopping the mechanisms causing the efflorescence, may lead to more serious damage. We do not recommend the use of water repellent sealers to replace good masonry wall design and construction methods.

### Summary

This ARRISCRAFT•NOTE discusses the causes and mechanisms of efflorescence. Careful selection of materials combined with proper design and construction to minimize water saturation are key to the reduction of efflorescence.

The information and suggestions contained herein are based upon the available data and information published by the listed references and the experience of Arriscraft International architectural and engineering staff. More detailed information may be found by referring to any of the related references listed below.

The information contained herein must be used in conjunction with good technical judgement and a competent understanding of masonry construction. Final decisions on the use of the information contained in this ARRISCRAFT•NOTE are not within the purview of Arriscraft International and must rest with the project designer or owner, or both. It remains the sole responsibility of the designer to properly design the project, ensure all architectural and engineering principles are properly applied throughout, and ensure that any suggestions made by Arriscraft International are appropriate in the instance and are properly incorporated through the project.

### Related References

1. Brick Industry Association, Technical Notes on Brick Construction 23 (Revised), Efflorescence, Causes and Mechanisms, Part I of II, May 1985 (Reissued February 1997).
2. Brick Industry Association, Technical Notes on Brick Construction 23A (Revised), Efflorescence, Prevention and Control, Part II of II, June 1985 (Reissued January 2000).
3. Hooker, Kenneth A., Reducing Efflorescence Potential, Aberdeen's Magazine of Masonry Construction, February 1994; pp 76-79
4. Schierhorn, Carolyn, Efflorescence & Stains: A Quiz, Aberdeen's Magazine of Masonry Construction, August 1995; pp. 409-412.

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