OAKS LANDSCAPE PRODUCTS

tech note

number L7

REMOVAL OF EFFLORESCENCE FROM HARDSCAPE PRODUCTS
(Last Updated October 23, 2018)

Efflorescence, which means "to flower out" in French, is a white residue that can form on the surface of concrete products. Although aesthetically unappealing, it is not an indication of poor product quality and can be removed. This tech note outlines how to minimize the potential for efflorescence from occurring, and should it occur how to best remove it from Oaks Landscape Products with minimal risk of damaging the affected hardscape surface.

For methods of removing stains other than efflorescence, refer to:

1. Oaks Tech Note 3 "*Inspection, Maintenance and Repair of Permeable Pavements*".
2. Oaks Tech Note 4 "*Maintenance and Repair of Interlocking Concrete Pavements*"
3. ICPI Tech Spec 5 "*Cleaning, Sealing and Joint Sand Stabilization of Interlocking Concrete Pavement*" (found at icpi.org)
4. NCMA TEK 8-2A "*Removal of Stains from Concrete Masonry*" (found at ncma.org).

1. WHAT IS EFFLORESCENCE AND WHY DOES IT OCCUR?

In order to form efflorescence four critical factors all must exist:

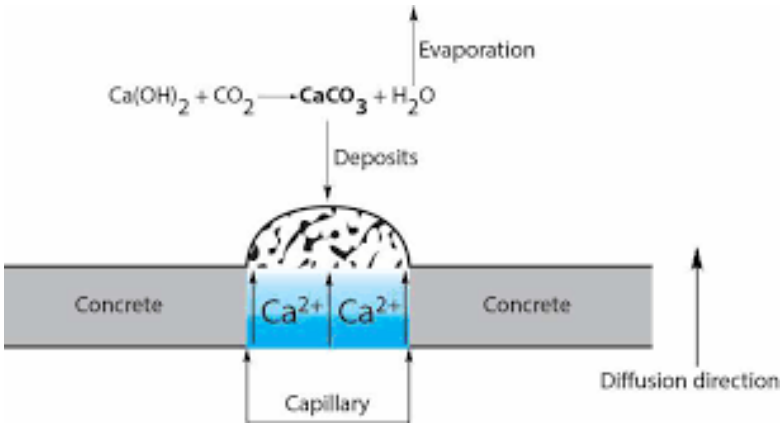
- A source of soluble compounds
- A source of water to dissolve and transport the soluble compound
- A pathway for the water laden with soluble compound to the surface
- A driving force for water migration

a. Sources of Soluble Compounds

Soluble compounds are those that are easily dissolvable in water, and include most "salts" containing sodium (Na+), potassium (K+), calcium (Ca+), chlorine (Cl-), bromine (Br-) and Iodine (I-). An example of a salt compound would be sodium chloride (NaCl), which is commonly known as rock salt and is used for de-icing purposes.

The most common salt compound in cement bearing products is calcium hydroxide ($Ca(OH)_2$), which makes up 20 % of the reaction products in Portland cement. Being highly soluble in water, it will migrate to the surface of the product through capillary pores where it reacts with carbon dioxide (CO_2) in the air and forms calcium

carbonate ($CaCO_3$, limestone). Calcium carbonate, which is not soluble, will drop out of solution and remain on the surface as a white residue after the water evaporates away.



Other possible sources of soluble compounds include:

- Other alkalis (Sodium and potassium) in the cement bearing products.
- Salt water
- Runoff/groundwater from alkaline soils
- Application of de-icing salts or fertilizers

b. <u>Sources of Water</u>

Water serves as the vehicle by which the soluble compounds are transported to the surface, where they accumulate as the water evaporates. The primary sources of moisture are direct rain water, surface water from run-on areas, and groundwater.

c. <u>Migration Pathways</u>

When the source of the soluble compound is the product itself, migration pathways include cracks in the product, or pores in the surface of the product.

Migration pathways can also include the joints/spaces between units, especially in the case of retaining walls where water is flowing through the wall, or in the case of pavers when water is coming up between the pavers.

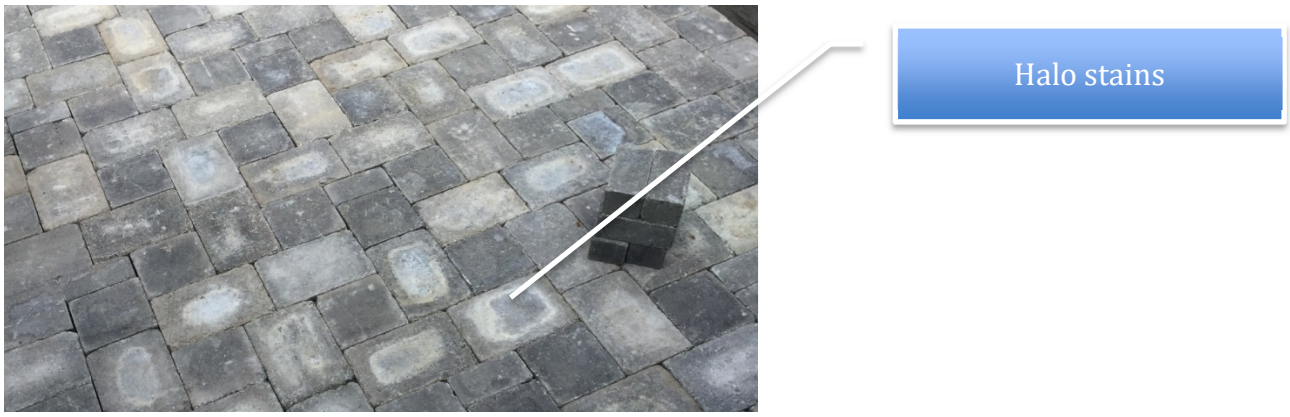
d. <u>Driving Force</u>

Efflorescence is particularly affected by temperature, humidity and wind. In the summer, even after long rainy periods, moisture evaporates so quickly that comparatively small amounts of efflorescence are brought to the surface. Thus, efflorescence is more common in the winter when a slower rate of evaporation allows migration of salts to the surface. In spring, condensation frozen within the concrete product may be released by warm weather allowing for further solubilizing of compounds and their migration to the surface. With the passage of time, efflorescence becomes lighter and less extensive unless an external source of salts or recurrent water migration is present.

2. TYPES OF EFFLORESCENCE IN CONCRETE PRODUCTS

a. Storage Efflorescence

Storage efflorescence occurs due to the evaporation of excess production water out of the product while it is still packaged. Because most products are covered or wrapped with plastic sheets, and tightly packaged, the excess water can be slow to evaporate and as such will leave the soluble compounds on the surface of the products. The resulting efflorescence is also known as storage stain or halo stains, both of which are shown below. Storage efflorescence typically does not worsen over time and can be cleaned. However, in rare instances it can start to crystalize making it almost impossible to clean; in this case, the product should not be installed.



b. <u>Primary Efflorescence</u>

Primary efflorescence usually appears when the product is first exposed to atmospheric conditions (i.e. just after the installation is completed), and is typically a uniform light haze throughout the face of the pavers/walls. Some identify this as "early age" efflorescence as it is due to the release of the excess calcium hydroxide near the surface of the product. How long primary efflorescence will be present is subject to the absorptive properties of the product, the amount of calcium hydroxide present, and atmospheric conditions (temperature, humidity and wind).

Left is pavers with Primary Efflorescence, right is pavers after weathering

Over time, the available calcium hydroxide that is accessible at or near the surface will be depleted and no further primary efflorescence will occur. Repeated wetting and drying cycles are needed for this to take place. A common statement made by manufacturers is that primary efflorescence will disappear after 60 days; this statement is misleading as the timeline is subject to the number of rainfall (weathering) events. If, for example, installation takes place during the dry period of the year, the next cycle of wet weather may not be for several months. Artificial watering of the area using a water sprinkler can help speed the process up during these dry periods, as long as the area is allowed to dry between water applications.

c. <u>Secondary Efflorescence</u>

Secondary efflorescence are heavier more prominent localized deposits. These deposits are due to leaching of salts from between the units, and are referred to as "late age" or recurrent efflorescence; when appearing as white streaks (more specific to retaining walls) the staining is referred to as "lime run".

Secondary efflorescence is induced by poor moisture control design or incorrect installation that traps moisture. This can be due to poor drainage behind a retaining wall or below a paving stone, improper sloping around the hardscape, constant

wetting of the hardscape from irrigation systems, or sheet drainage from non-absorptive surfaces onto the hardscape.

Secondary efflorescence

The most effective way to stop secondary efflorescence from continuing to occur is to remove the source of water. Possible solutions include:

- If water is accumulating at surface in a paver installation, this is likely due to improper surface grading. This will require lifting of the pavers, re-grading of the area to provide proper drainage, and relaying of the pavers.
- If water is trapped between the pavers in an aggregate base installation, this is likely due to the use of improper bedding material (e.g. limestone screenings that have high fines content). This may require lifting of the pavers, replacement of the bedding material with a proper aggregate that conforms to ICPI recommendations, and relaying of the pavers.
- If water is trapped between the pavers in a concrete overlay installation, this is likely due to improper drainage practices. Drain traps, or drain holes through the concrete base, are required at regular intervals to allow water that gets into the bedding layer to escape. Consult with an Oaks Sales Representative if this is the case as a more thorough examination of the installation will be needed to determine required remedial actions.
- If water is leaking out between retaining wall units, this is either due to improper installation of the drainage system behind the wall, or clogging of the drainage outlets. The first step is to find the drainage outlets for the wall and make sure they are not blocked/damaged; the second step is to consult with the installer to ascertain how the wall was constructed. Remedial action may be as simple as cleaning out the drainage outlets, or may involve installation of drainage works (e.g. swales or French drains) behind the wall

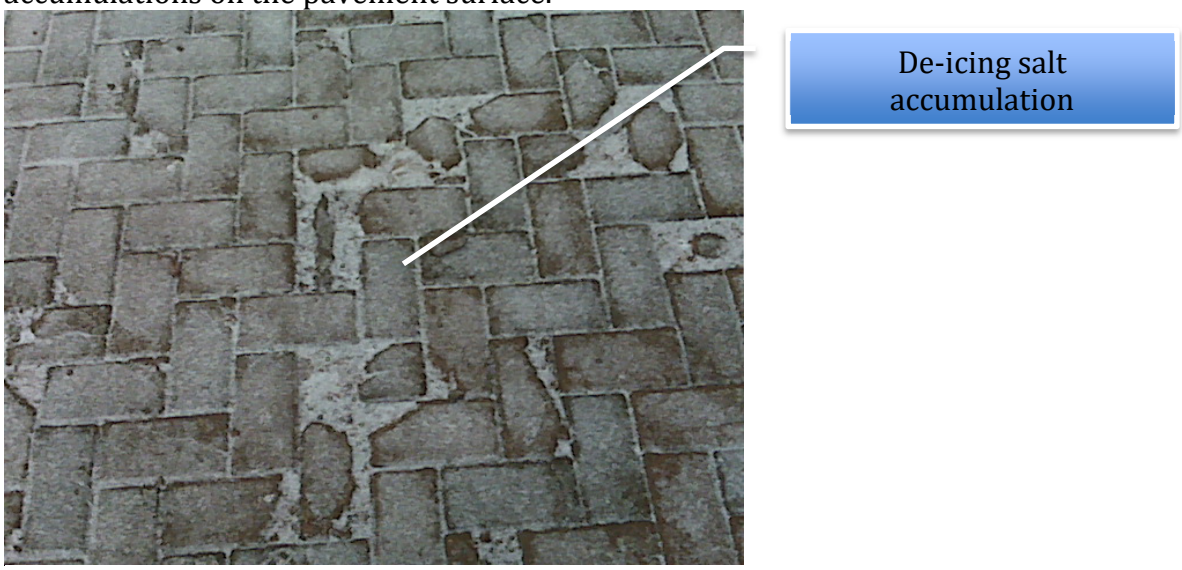
to divert any surface water away from the back of the wall, or even complete wall reconstruction (especially in the case of high groundwater).

Once the source of water has been properly addressed, cleaning can take place.

d. External Efflorescence

This is efflorescence resulting from external influences such as aggregates used in construction that have high "salt" content, and/or road salts or fertilizers that interact with the concrete to release additional salts – the latter is akin to osteoporosis of the concrete.

External efflorescence should not be confused with things like joint sand hazing (the sticking of a polymeric joint sand to the surface of the pavers) or de-icing salt accumulations on the pavement surface.



3. PROTECTING AGAINST EFFLORESCENCE

As mentioned previously, in order to form efflorescence four critical factors all must exist:

- A source of soluble compounds
- A source of water to dissolve and transport the soluble compound
- A pathway for the water laden with soluble compound to the surface
- A driving force for water migration

If you remove one of these factors then the efflorescence will not form. Understanding which one of these factors are dominating the potential formation of the efflorescence is key to permanently preventing it.

a. During Product Production and Storage

At minimum, products should meet the applicable CSA or ASTM criteria, as a quality product is less prone to water absorption. Specialty manufacturing processes like

face mix can create a much tighter face which reduces the absorption, while treatments (e.g. ColorBold) can prevent the penetration of water into the surface itself.

Although not common in hardscape products, admixtures can be added to the product that minimize the potential for efflorescence by limiting the movement of water through the concrete matrix.

During packaging, cover sheets or bags are placed over the top of the cubed material to prevent additional water from getting to the product.

b. <u>During Installation</u>

For pavers projects, select joint and bedding materials that are free of excess soluble compounds. Provide proper surface and subgrade drainage. Stabilized joint materials will help reduce the amount of water that percolates between the pavers, and is less prone to wash out (leaving voids for water accumulation).

For retaining walls, ensure proper drainage. Please note that the drainage system behind the wall is intended to handle small residual quantities of water that get behind the wall; it is always best to divert surface water drainage around the wall, and use blanket or chimney drains as needed to manage high groundwater.

All materials received at the construction project should be properly stored, including:

- Storing product on pallets to isolate them from the ground.
- Covering stockpiles to prevent excessive water absorption.

Particularly in the winter months, products should be properly cured prior to delivery to the site. Inadequate hydration of cementitious materials caused by early exposure to cold temperatures will result in a weak product that will be susceptible to premature deterioration.

c. <u>Post Installation</u>

Sealers can be applied to the surface of pavers or walls to prevent penetration of water through the face of the product. Ensure product is properly cleaned and dried first, as water trapped behind the sealer will cause water blushing (white discoloration behind the sealer); toluene or xylene will need to be used to re-emulsify the sealer and allow the trapped water to escape.

4. CLEANING EFFLORESCENCE

Before any effort to remove the efflorescence is undertaken, the reason for the efflorescence should be established.

Compared to other stains, the removal of most types of efflorescence is relatively easy. As stated previously, most efflorescing salts are water soluble and many will disappear with normal weathering unless there is some external source of salts.

In general, most efflorescence can be removed by dry-brushing followed by flushing with clean water. If brushing is not satisfactory, it may be necessary to use a commercial cleaners specifically designed for effective efflorescence removal (e.g. EaCoChem cleaning products). Cleaning should be done in accordance with the manufacturers' recommendations - adherence to their recommendations is extremely important to prevent damage to hardscape surfaces during cleaning.

Some general recommendations that apply to efflorescence removal chemicals:

- Before applying an cleaning solution, always wet the paver or wall surface with clean water to prevent the cleaner from being absorbed deeply into the product.
- Application should be to small areas of not more than 4 ft^2 (0.37 m^2) at a time, with a delay of about 5 minutes before scouring the salt deposit with a stiff bristle brush.
- Use a special acid cleaning brush. Do not use a wire brush as the filings of wire left behind could result in further staining as the steel corrodes.
- After this treatment, the surface should be immediately and thoroughly flushed with clean water to remove all cleaner.
- Since cleaner treatments may slightly change the appearance, the entire installation should be treated to avoid uneven discoloration or mottled effects.
- Adjacent plants, natural stone features, or surrounding materials may need to be protected during application.
- Cleaning should only be done when temperatures are above freezing.

One method of removal that should be avoided is the use of high pressure water jet; this can force water deeper into the product, with the water coming into contact with excess calcium hydroxide that would otherwise never have been reached.

As a last resort, a very light (brush) sandblasting can be used to remove the deposits. Brush sandblasting is sandblasting which is light enough that coarse aggregate is not exposed by the sand blasting. Sand blasting needs to be done with care, as it can alter the appearance of product by roughening the surface or exposing aggregate.