KREND Kilwaughter Chemical Company Limited

EFFLORESCENCE INFORMATION

In the construction industry the term "efflorescence" is often used to describe white deposits or stains on building materials. Efflorescence is a general term and as such, covers a number of different deposits varying significantly in chemical composition and method of formation. To avoid confusion, it should be appreciated that:

1 There exist many kinds of efflorescence, several of which have little in common except the fact that they produce white colourations.

2 The processes which give rise to efflorescence on cementatious renders are generally not identical with those responsible for efflorescence on clay bricks.

3 Colour differences on Render surfaces are not always due to efflorescence. For example colour variations on new structures may be due to late/early scraping, too rapid hydration of render etc. On older structures, unsightly stains are often the result of the contrast in colour between washed and unwashed areas; areas washed by rain-water remain clean while unwashed regions pick up dirt.

On cement-based products, efflorescence normally takes one of three forms :

A limebloom;
B weeping;
C crystallization of soluble salts;

Of these, the most common is lime bloom.

TYPES OF EFFLORESCENCE

Lime Bloom

This is an occasional phenomenon particularly noticeable on coloured render and on coloured products made with Portland cement. It is a white deposit which is apparent either as white patches or as an over-all lightening in colour. The latter effect is sometimes mistakenly interpreted as the colour fading or being washed out.

The cause of lime bloom lies in the chemical composition of Portland cement. When water is added to cement, a series of chemical reactions added to cement, a series of chemical reactions takes place, which result in setting and hardening. One product of these reactions is "lime" in the form of calcium hydroxide. Calcium hydroxide is slightly soluble in water and, under certain conditions it can migrate through the damp render to the surface and there react with carbon dioxide from the atmosphere to produce a surface deposit of calcium carbonate crystals. This surface deposit is similar to a very thin coat of whitewash and gives rise to the white patches or lightening of colour mentioned previously. The surface deposit is normally extremely thin and this thinness is demonstrated by the fact that, when the render is wetted, the film of water on the surface usually makes the deposit transparent and the efflorescence seemingly disappears.

The occurrence of lime bloom on render tends to be spasmodic and unpredictable. Nonetheless an important factor is the weather. Lime bloom forms most readily when render becomes wet and damp for several days, and this is reflected in the fact that it occurs most frequently during the winter months. In particular, an extended period of rain, snow which lies for some time, and damp foggy days are conditions most likely to bring on a severe outbreak. Although drying winds are often suggested as likely cause, they are probably not a major factor.

Lime bloom is not visible on damp render and so only becomes apparent with the onset of drying weather. Thus the drying weather does not necessarily produce the lime bloom; it may only make visible a deposit which had already formed, but could not be seen because the render was damp.

Render is normally only liable to lime bloom early in its life. In general render which has been in service for a year without being affected can be considered immune. Lime bloom is a temporary effect, and given time, usually disappears of its own accord. It is purely superficial and does not affect the durability or strength of the render.

Lime Weeping

This can best be described as an incrustation or build-up of white material. It usually occurs at joints or cracks where water emerges from the interior of concrete substrate on to the surface. Lime weeping is closely related to lime bloom. Water moving across or through concrete

dissolves lime and eventually deposits this lime as calcium carbonate. However, unlike lime bloom, the calcium carbonate is not deposited as a thin surface layer, but builds up to form thick incrustations in localized areas. Lime weeping is a process very similar to that which produces stalactites and stalagmites in caves in limestone rocks.

Although the first signs will probably be present from early in the life of a structure, lime weeping is mot likely to be noticed on older structures where the incrustation has built up to a significant thickness. Unlike lime bloom, lime weeping is normally a permanent feature, not likely to disappear of its own accord.

The presence of lime weeping does not normally give rise to concern about the durability of a structure. It is, however, an indication that water is flowing through the substrate and this may be undesirable. For example, in a bridge, the water flow may be contaminated with de-icing salts which could be deleterious to steel reinforcements.

Crystallization Of Soluble Salts

This type of efflorescence, which corresponds to that normally observed on clay brickwork, is relatively rare on render. It usually takes the form of a fluffy deposit and tends to occur either on render which has been made with sea-water or on retaining walls.

Unlike lime bloom and lime weeping, the deposit is not calcium carbonate but instead consists of soluble salts not normally present in render. These soluble salts can originate from contaminants present in the original render mix, e.g. sodium chloride introduced by using sea-water as mixing water. Alternatively they may have migrated in the render from external sources, eg substrates, ground-water in contact with walls or foundations. They are drawn to the surface and deposited at places where water evaporates from the render.

Where soluble salts are present as contaminants in the render mix, efflorescence often becomes apparent as the render initially dries out. Where the salts originate from an external source such as ground-water, the rate of build-up of efflorescence depends upon many factors including the permeability of the concrete and the concentration of salts in the ground-water.

In some cases, the efflorescence periodically disappears and reappears with changes in weather conditions. Deposits of soluble salts on the surface do not harm render. However they may be an indication of potential problems, e.g.

1 If the salts are sulphates, there may be a possibility of sulphate attack of the render.
2 If the salts are chlorides, their presence could, in certain circumstances, bring about corrosion of steel in reinforced concrete, substrates or render carriers.
3 If the render is weak and porous, salts may also be crystallizing under the surface, a condition which could give rise to disruptive stresses and spalling.

PREVENTION AND REMOVAL

Prevention Of Lime Bloom

For over a hundred years the problem of lime bloom on render has been recognized and considerable effort has gone into finding ways of preventing it. Nonetheless there still exists no generally acceptable, guaranteed, preventative measure. However, there are steps which can be taken to minimize the risk of its occurrence.

However, carbonation need not necessarily result in a change of colour. If the calcium carbonate produced by carbonation is deposited below the surface, it is not visible and does not affect the appearance of the render. Only when it is deposited on the surface does it hide the under-lying colour and give rise to the white colouration known as “lime bloom” or “efflorescence”.

Prevention of the lime bloom on render requires measures which discourage a calcium carbonate deposit from forming on the surface, and there are several different approaches which may achieve this.

Alterations To The Concrete Mix

A reduction in the fines or silt content of the aggregates will sometimes result in a coarser and more porous surface texture to a render and this can be beneficial in encouraging the calcium carbonate to form below the surface. However, consideration must also be given to the effects upon strength and durability. Alternatively, the

beneficial by making the render less permeable and reducing migration of lime on to the surface. The inclusion of a waterproofer into the mix is also beneficial.

K Rend is manufactured taking these points into consideration, to minimise the probability of lime bloom. However, when subjected to certain weather conditions, we have experienced lime bloom.

Control Of Curing

Render which has been well cured is less liable to lime bloom. Unfortunately, however, conditions conducive to good curing can also be ideal conditions for formation of lime bloom. The aim should be to keep the humidity high, but not so high that lime bloom occurs. With on-site methods of curing, problems also occur. Spraying with water or the use of damp hessian are not to be recommended where lime bloom would be a problem. Even the use of polythene sheeting for curing can often result in a patchy lime bloom unless it is possible to arrange for the polythene to be slightly separated from, and not in direct contact with the render surfaces. Spray-on curing membranes are preferable, but these can also affect the surface appearance.

Surface Treatments

Various surface treatments are available which will reduce the tendency for lime bloom to form. Firstly, there are water-repellant materials such as silicones. These are applied to the surface of render and encourage water to run off rather than remain on the surface. By preventing water from remaining on the surface, the conditions conducive to lime bloom are avoided. Secondly, polymer coatings on the surface of render can be very effective in preventing lime bloom. Such coatings seal the surface and prevent the lime bloom from coming out. Acrylic-based coatings are often used and may be either clear or pigmented. These are generally satisfactory, but occasionally can result in an unacceptable glazed appearance to the render. Also, clear coatings are less durable than pigmented ones. When coloured coatings are used, it has to be accepted that they will eventually weather off, and so their colour must match closely that of the underlying render if unacceptable patchiness is not to result when they are lost from the surface. It is preferable to apply the coatings by spray rather than brush, since brush-applied coatings tend to show up the brush marks as they weather off. By the time the coating is lost, the render should normally be mature enough to be no longer susceptible to lime bloom. N.B. Some coatings are unsuitable for use on render due to its alkalinity, and some water-based paints can make efflorescence worse. Kilwaughter Chemical Co Limited have a range of these products, and would be pleased to advise as to their use.

Finally, treatment with acid is often used to remove lime bloom. It has been found that acid treatment can also act as a preventative measure if applied before bloom has the chance to form. Surface treatment of concrete products may interfere with the bond between the products and mortar and this can have an undesirable side-effect. This is not, however, a problem with acid treatment.

Avoiding Conditions Conducive To Lime Bloom

Young render is particularly susceptible to lime bloom and so there can be justification for taking special precautions early in its life. With site conditions, practical considerations usually mean that protecting the render from rain and dew for a few days is difficult. Ideally, protection should be offered. However, the protection should not be in direct contact with the render so that it can trap a film of water between it and the render, as this could result in white patches where the protective sheet touches the render.

Unless adequate provision can be made for ventilation, polythene sheeting of coloured render is not recommended, since condensation inside the film can result in unsightly patches of lime bloom .

REMOVAL OF LIME BLOOM/EFFLORESCENCE

Lime bloom is usually a transient phenomenon and can be expected to disappear with time. The major factor influencing its duration is the environment to which the render is exposed. Where the render is fully exposed to the weather, rainwater (which is slightly acidic) dissolves the deposit and the lime bloom typically disappears in about a year. In more sheltered locations, removal by natural means may take considerably longer. If immediate removal is required, this can be achieved by washing with diluted acid. This is a relatively simple operation, but care should be taken on two accounts.

Firstly, acids can be hazardous and appropriate safety precautions must be taken. Secondly, acid attacks render and over-application to a render surface can result in acid etching, which will alter the texture and appearance.

Generally, an 8% solution of commercial grade of hydrochloric acid is used. The acid concentration can be adjusted to suit individual circumstances; a less concentrated solution will require more applications to remove lime bloom but will be less likely to result in an acid etched appearance.

Before the acid is applied, the surface should be dampened with water to kill initial suction. This is best achieved by the use of a steam cleaner on cold but pressurised spray (this prevents the acid from being sucked into the render before it has a chance to react with the surface deposit).

The acid is applied by spray using a "killaspray" type garden spray and a typical application rate is one litre of acid 5-10 square metres. Following application of acid, the surface of the render is immediately power washed at approx 70 deg C. Often one wash with acid is sufficient, but in more stubborn cases the treatment is repeated as necessary until the lime bloom disappears.

When carrying out acid washing, always start with a trial on an inconspicuous area. Operatives should wear protective clothing, at the very least rubber gloves and goggles. Precautions should be taken to prevent acid from coming into contact with metals and other materials which may be adversely affected. Acid is neutralised within seconds of coming into contact with render; consequently when acid washing is used on render products there is no risk of acid burns to users of such products. The attack on render by acid, even in the case of severe over-application, is limited to a thin surface layer and there need be no cause for concern that acid washing will affect properties of the render other than the surface appearance. Whilst there can be no guarantee, experience suggests that lime bloom is unlikely to recur following its removal with acid.

Prevention And Removal Of Lime Weeping

Lime weeping is a white deposit produced at points where water emerges from the surface of render. Its prevention involves design and workmanship which eliminate the leakage of water. Lime weeping is often encountered when water seeps through a construction joint. This can be avoided if steps are taken during construction to achieve a good bond across the joint. Several techniques are available.

Earth-retaining walls are particularly prone to lime weeping. Where appearance is critical, they should be designed and constructed with the same care taken to avoid leaks through joints and cracks as is taken with water-retaining structures. Weep holes should be provided to allow controlled flow of water from the back to the front and these weep holes should project and shed water clear of the render face.

Where lime weeping is present in existing structures, it can be removed by mechanical hacking using a hammer and chisel. Provided this is done carefully, the brittle incrustation can usually be knocked off without damaging the under-lying render. Unless measures are taken to prevent further migration of water through the concrete substrate, lime weeping will usually recur.

Prevention And Removal Of Deposits Of Soluble Salts

Salts crystallizing on the surface of render may originate either from impurities present in the water used to mix the render or from ground-water in contact with render. Efflorescence resulting from contaminations present in the render mix is often a result of using sea-water as mixing water. The use of sea-water should be avoided in all situations.

Ground-water does not migrate very easily through good quality render and soluble salts from ground-waters do not often crystallize on render surfaces. In situations where precautions are considered necessary, a bitumen (or similar) damp-proof membrane should be used to separate the render from the ground-water.

These deposits are often soft and fluffy and in many cases can be removed by using a dry bristle brush. Should this fail, the next treatment to try is to combine brushing and washing with water. should this also fail to remove the deposit, the surface should be washed with acid as described above. In all cases, trials on an inconspicuous area should be carried out to determine the most effective treatment.