Corrosion and Damage Caused to Glass surfaces in Hot, Humid Climates

Architects and glass suppliers spend much time, effort and money in establishing and fulfilling industry performance standards for glass – such as solar energy reflectance (g-value), light transmittance (t-value) and heat gain or loss (U-value) – only to see the performance drop. This loss of performance can easily occur in hot, humid climates where exterior glazing is exposed to condensation, materials of construction and windblown sand – causing corrosion, chemical attack and physical damage to glass surfaces.
Andreas Ruthe of TCM Asia Co., Ltd. points out that glass is frequently taken for granted but requires protection against surface corrosion like any other building surface. Andreas explains why especially in a hot, humid climate glass requires surface protection, and why requirements under such aggressive conditions are beyond the reach of temporary surface protectors and the new “self-cleaning” glasses. What? Condensation on the exterior surface of windows, instead of the interior, and windblown sand sticking to the glass like cement? Anyone living in hot, humid climates such as Asia, or visiting during summer months, will recognize this phenomenon – condensation literally dripping from the outside of architectural glazing in air-conditioned houses, offices and hotels, with sand and salt spray from the sea adhering to the condensation then baking onto the glass in hot sunshine.
Exterior condensation, with or without the sand, is also apparent in other areas of the world where high performance glass is used, such as energy efficient insulating glass (IG) units with a low emissivity (low-E) coating.
Even in northern climates, for example, the exterior of high performance glass can attract condensation in summer evenings or early mornings under conditions of high humidity, clear nights and little wind current.
What may not be so apparent, because glass is so often taken for granted, is the rapid decline in glass performance against industry standards when glass is exposed to hot and humid conditions. Frequently these performance standards are forgotten soon after a building construction contract is signed, even though the standards may not be met soon afterwards – due to chemical and physical damage to the glass surface before, during and after construction.
Specifiers of architectural glazing are increasingly aware that the surface of glass is “raw” and, like any other material of construction, should be protected against surface degradation. Today there is no reason to take glass for granted, or to overlook or ignore the need for glass surface protection.
Technology now exists that enables glass to maintain its performance standards and keep its promises.

The Performance Standards and Promises of Architectural Glass

Architectural glass performance standards – such as solar energy reflectance (g-value), light transmittance (t-value) and heat gain or loss (U-value) - are based on new, virgin glass. At this stage of its life, glass is bright and sparkling, easy to see through and easy to clean – promising clarity, visibility and cleanliness. Above all, new glass promises performance! During the design and selection of glazing for a building, architects and engineers spend much time, effort and money in making calculations to meet glass performance standards. These calculations are important in determining the effects of climate, internal heat gains, lighting requirements – artificial and natural – and energy costs. Unfortunately, these calculations are likely to be valid only at the very beginning and mainly in theory. In reality, the calculations are not achieved under actual conditions of exposure because of glass surface destruction caused by corrosion – mainly from natural weathering including moisture corrosion and chemical attack by alkalinity – and by physical damage by airborne sand and other contaminants. Unprotected glass is a high maintenance building material. It requires frequent and sometimes intensive washing. Unprotected glass can be difficult, if not impossible, to clean and keep clean. The overall cost of routinely washing unprotected high-maintenance glass is an incredibly large amount of money worldwide. As a result of chemical and physical attack, unprotected glass can quickly and easily break its promises of clarity, visibility and cleanliness – particularly under the aggressive conditions of a hot, humid climate.

The Main Causes of Glass Surface Degradation

According to definitions of the British Standards Institution (BSI), the causes of degradation in a substrate include natural weathering and chemical attack. Natural weathering is the result of sun, rain, frost and atmospheric pollution – including the effects of ultraviolet (UV) radiation, infra-red heat, oxidation, moisture corrosion, and airborne contamination. Chemical attack comes from many sources and can be either acidic or alkaline. Of all the effects of natural weathering, corrosion is the most detrimental to glass. Surface corrosion is caused by the two biggest enemies of glass – moisture and alkalinity. Either separately or together, these two enemies are highly aggressive to glass and can easily damage and stain its surface within a very short time. Moisture, including condensation, can attack and dissolve the surface of glass. The term alkali is believed to derive from the Arabic "al-quali" and, although its original

source and meaning are unclear, alkalinity can also attack and dissolve the surface of glass. In combination, moisture and alkalinity can cause severe glass surface corrosion and staining. At first, the surface corrosion caused by moisture and alkalinity is microscopic, but with continued exposure the glass becomes physically damaged and takes on an “etched” appearance that becomes more and more noticeable. The surface of unprotected glass loses its “sparkle”, becoming dull in appearance and increasingly difficult to clean and keep clean. As time goes on, sometimes within a relatively short period, the surface becomes chemically stained and physically etched and damaged. Frequently, when exposed to moisture and alkalinity in combination, the glass easily reaches a point where the surface corrosion cannot be cured. Glass surface corrosion can significantly affect light energy or radiation which is important to maintenance of glass performance standards. When light or radiant energy strikes a surface it is either absorbed, reflected or transmitted. Therefore, the building designer’s calculations must take these factors into consideration, frequently without realising that performance standards are at risk of dropping from the time that glazing is being fabricated. Further reductions in performance are likely during transport, storage, installation and use.

Architectural Glass Surfaces at High Risk of Surface Damage by Corrosion

Any unprotected glass exposed to moisture and/or alkalinity is at high risk of surface corrosion. The speed and severity of glass surface degradation, with the resulting drop in glass performance, depends largely on the levels of moisture, coming from rainfall and condensation, and alkalinity from materials of construction and cleaning products – before, during and after construction. Moisture attack is one of the most common causes of glass surface damage and glass that remains wet, or even damp, for relatively long periods of time is highly vulnerable.
Equally serious is attack by alkalinity from water with high mineral content, such as hard tap water, seawater and alkaline cleaning products. When moisture and alkalinity are together, the surface damage can be quick and irreversible. Glass at high risk of surface damage by moisture and alkalinity includes architectural glazing in hot, humid climates.

Particularly at risk are:
• glass canopies, conservatory roofs and other sloped glazing – where moisture generally remains on the surface longer than on vertical glazing and the glass is exposed to building run-off or windblown sand;
• both sloped and vertical glazing – during construction when exposed to high humidity and cement dust or mortar – after construction by moisture and alkalinity;
• windows in seaside buildings – moisture, both liquid and vapor, from rainfall, sea water and sea spray – also alkalinity from lime scale in the sea water and sea spray;
• skyscrapers or tower blocks – where moisture vapor and contamination from airborne contaminants can be severe, adding to already high cleaning costs and greatly reducing light transmission and visibility.
Surface corrosion can quickly and easily damage unprotected glass in all of the above installations - before, during and after construction.

Eight Important Criteria for Surface Protection of Architectural Glass

Because of the aggressiveness of glass surface corrosion and the damage it causes to architectural glazing, it is important that any surface protection technology meets the following criteria:
1. suitable for application either in the factory or on-site;
2. resistant to degradation by weathering, including ultra-violet (UV) radiation;
3. resistant to adhesion or chemical attack by all types of contaminants including -
• organic substances, such as atmospheric pollution from motor vehicles and industrial plants;
• inorganic substances, such as lime scale and metal oxides.
4. water-repellent or hydrophobic, since moisture attacks the glass surface;
5. durable or long-lasting, since architectural glazing can be difficult to access and costly to maintain;
6. possible to re-apply on-site if damaged or worn away;
7. provide a recommended after-care programme for routine maintenance;
8. easier to clean and lower in maintenance than unprotected glass.
Above all, any glass surface protection technology must be “fit for purpose” under the actual conditions of exposure.

Which Surface Protectors will fit for Purpose in Hot, Humid Climates

Temporary glass surface protectors, such as reactive silicone fluids, are hydrophobic and easily reapplied but not resistant to all types of contaminants and are not considered as durable. Some are not resistant to weathering, and they tend to migrate to other surfaces, causing problems with adhesion. Others are not UV-stable. Architectural glass promoted as “self-cleaning” is based on a metal oxide coating that is applied to float glass during its production

process.This coating, titanium dioxide (TiO2), attracts moisture (hydrophilic) instead of repelling it (hydrophobic). According to the manufacturers, rainfall or rinse water “wets out” and spreads across the glass surface, carrying away organic contaminants - such as traffic pollution and bird droppings – that have been oxidised or broken down by a ‘photocatalytic’ reaction triggered by ultraviolet (UV) rays from sunlight. This chemical reaction process clearly requires sunlight but it also needs water, which can be either rainfall or hosing down the glass, to both oxidise and wash away organic contaminants. According to the manufacturers, the oxidation process does not break down inorganic contaminants such as limescale or metal oxides. Of course sunlight is plentiful in an area such as Asia, but in this type of climate rainfall is normally seasonal and less frequent, hosing down architectural glazing with water is an opportunity in high dry season but just over night exterior condensation is unlikely to be sufficient for washing away contaminants. The “self-cleaning” technology is hydrophilic or water-attracting, which defeats the purpose of protecting the glass surface against moisture attack, and it works only on organic substances and not inorganic. Before if could be only applied to glass when manufactured, but in 2008 the first after installation solution comes on the market.

The ‘Prevention’ and the ‘Cure’

To prevent glass from being damaged by surface corrosion, all you need to do is keep the surface from coming into contact with moisture and alkalinity. Covering the glass with a plastic sheet is not practical in the realworld, so the next thing to consider is simply applying a film of oil, polish, wax, silicone fluid or other form of temporary protection. However, these options are short-term at best because they do not attach firmly to the glass surface, migrate to other substrates and can allow corrosive substances to penetrate.

A solution with higher performance and greater durability is needed to protect glass against chemical attack. Similar to specifiers for architectural glazing, glass processors and fabricators are increasingly aware that the surface of glass is “raw” and, like any other material of construction, should be protected.

TCM Asia Co., Ltd. has a portfolio of high tech surface protection solutions for glass renovation, protection and maintenance. TCM Asia solutions offer both, the ‘prevention’ and the ‘cure’ for glass surface corrosion - unless the glass has become damaged to the “point of no return”. Clearly the most cost-effective solution is ‘prevention’ and, keeping in mind that there are no cures for many types of surface degradation.

Please download for further product information’s the glass protection catalog from

www.tcm-asia.com/katalog.html

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