KRYSTALINE WATERPROOF CONCRETE

Advantages of Krystaline Admixtures in Water Treatment Plants

Waterproofing concrete and enhancing its durability and sustainability are the most important reasons for using Krystaline Admixtures in concrete in wastewater treatment facilities.

The concrete used in wastewater infrastructure is subject to some of the harshest environments including chemical attack, abrasion, erosion, chloride ion induced corrosion and, subject to region, even freeze/thaw deterioration. Once the deterioration process begins it will only accelerate as the degradation advances.

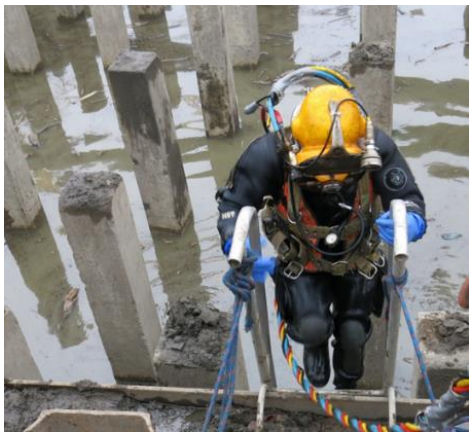
The key to long term sustainability of concrete in a harsh environment is prevention. The Krystaline hydrophilic internal C-S-H technology added to the concrete as an admixture will provide effective long-term protection resulting in increased durability and sustainability in wastewater treatment plants.

The use of Krystaline admixtures will assist the end goal of sustainable, durable and waterproof concrete.

Krystaline advantages during the wet mix that affect durability include:

Standard dosing quantities of Krystaline admixtures are consistent between differing concrete mixes. This reduces potential errors during the mixing process that would affect the concrete over time. A durable concrete requires quality mixing therefore reducing the risk of error, which reduces the risk of durability loss. See Krystaline technical datasheets for exact product dosage by admixture.

Krystaline admixtures have the added benefit of functioning as water reducing, set retarding and plasticizing (or super plasticizing subject to which admixture is used and the water/cement ratio) admixtures in the concrete. Water may be reduced by 4 to 18% without additional admixtures. See Krystaline technical datasheets for possible water reduction by admixture.



Krystaline admixtures have natural viscosity modification abilities to keep concrete homogenous and consistent at both high and low slumps. This provides an ability for the concrete to be transported and placed without segregation or related problems. Krystaline admixtures have been used in concrete pours below water without additional viscosity modification materials (see project reports where Krystaline concrete was poured underwater).

The use of Krystaline admixtures allows for lower water/cement ratios without future deterioration caused by autogenous cracking of the concrete. While this technically falls into physical properties, the determining factor is found at the mix design phase. Given the capability to increase waterproofing abilities, strength and many other characteristics of the concrete including the ability to self-heal cracking, using Krystaline admixtures allows the use of lower water/cement ratios without the problems associated with them.

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Krystaline advantages during the placing that affect durability include:

Krystaline admixtures assist in maintaining the concrete slump and flow. Subject to concrete mix design, it is possible to maintain the slump and flow characteristics without additional plasticizer allowing transport time and placing (several tests are available).

Krystaline admixtures maintain flow abilities for pumping at lower pressures for placing on site. The increased consistency created with the Krystaline admixtures requires less pump pressure to flow at an equal slump than concrete without Krystaline.

Krystaline admixtures inhibit segregation in high slump environments and can be effectively vibrated. In SCC concrete where high flow is required, Krystaline admixtures keep consistency and reduce segregation issues. (see SCC technical advisories and various applications of SCC concrete)

Krystaline advantages for the physical abilities that affect durability include:

Krystaline admixtures notably reduce early age cracking. Krystaline admixtures reduce the drying shrinkage and reduce autogenous cracks in concrete. Krystaline technology also reduces wetting expansion (please refer to USIL and BBA testing).

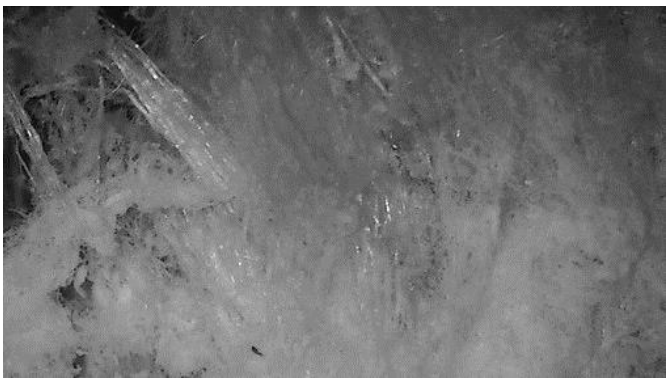
Krystaline admixtures increase the compressive strength of concrete (even when water reduction was not used) and will often increase the compressive strength of the concrete by 30% or more subject to mix design (a wide variety of testing is available).

Krystaline admixtures increase the tensile strength of concrete (even when water reduction was not used) and will often increase the tensile strength of the concrete by 20% or more subject to mix design (please see USIL testing).

Krystaline admixtures increase the flexural strength of the concrete (even when water reduction was not used) and will often increase the flexural strength of the concrete by 30% or more subject to mix design (please see BBA testing).

To understand the advantages in using Krystaline technology for long term concrete protection, it is important to understand how Krystaline technology functions.

Krystaline technology increases C-S-H growth while lowering the CH (Portlandite) within the concrete during both the short-term and the long-term hydration process. The growth of non-soluble C-S-H (an important concrete binder) increases consistently whenever the concrete is subject to water or humidity within the concrete's pore structure. DTA analysis has shown that the use of Krystaline admixtures can achieve an increase of more than 22% of C-S-H growth (at 28 days) within the concrete, reducing the pores and capillary network and reducing the specific pore area, the total pore volume and the average pore diameter.



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The ability of Krystaline to stimulate the development of C-S-H crystals in the concrete also translates into improved interfacial zones, increased concrete strength and increased waterproofing abilities.

The reduction of CH in the concrete when using Krystaline admixtures (as proven with DTA testing indicating as much as a 23% reduction) provides additional benefits such as lowering the effects of sulphate ion reacting with the CH to create gypsum thus lowering the concrete's reaction to carbonation over time (please refer to MTL report).

Krystaline advantages for protection against chemical deterioration that affect durability include:

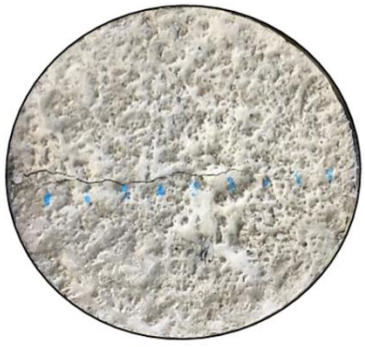
Waterproofing

Krystaline admixtures waterproof concrete and have been proven in independent testing to reduce water penetration by as much 92% (see BBA certification testing). Additionally, this process continues over time and whenever the concrete becomes wet or humid the Krystaline admixture within the concrete will continue to reduce permeability (62% reduction of permeability between 28 day results and 90 day results, please see USIL testing).

Self Healing of Concrete

One of Krystaline's greatest advantages is the ability to autogenously seal cracking in concrete. Testing indicates that Krystaline will increase the ability of concrete to auto-seal by as high as 128% above normal concrete. This means that a 0.5 mm crack will self-heal in approximately 28 days on average within a basic concrete. In low water cement ratio concretes, this timeline should be accelerated subject to the mix design (please see IDIEM testing).

Before



After

The very nature of Krystaline technology to enhance the hydration of C-S-H crystals and gels even years after the concrete has been placed makes it the perfect product to self-heal cracks in the presence of water.

Before

After

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Freeze/Thaw
Krystaline admixtures have been tested for freeze/thaw environments using both the accelerated method and ultrasonic decrease method and, in both cases, Krystaline not only passed the test maximum, but possessed capability to continue beyond the testing capacity (please see the USIL testing).

Chloride Ion Penetration
Due to the ability of Krystaline to substantially reduce water penetration into concrete, Krystaline also has the ability to reduce the penetration of water bourne contaminants such as chloride ions into the concrete. Krystaline admixtures reduce the penetration of chloride ions. In testing Krystaline admixtures showed reduction of 28% in 56 days using a standard 0.50 w/c ratio concrete (please see the American Concrete Engineering test).

Sulphate reduction
External sulfate attack: External sulphate attack occurs where sulphates dissolved in water penetrate into the concrete. A reduction of permeability in the concrete also reduces the penetration of external waterborne sulphates into the concrete. Since Krystaline can dramatically reduce the concrete's permeability it also reduces penetration of external sulphates into the concrete (based on various depth of penetration tests).

Internal sulphates: Internal sulphates occur where sulphates are incorporated into the concrete when batched. This problem can be reduced using Krystaline admixtures due to the combination of reduced calcium hydroxide (portlandite) in the concrete during hydration thereby reducing the quantity of ettringite that forms, and reduced penetration of water into the concrete thereby reducing any additional sulphates from entering and stimulating additional ettringite growth. DEF (delayed ettringite formation) for example requires a high temperature, and water together with the CH component in the concrete. Since Krystaline reduces the portlandite and waterproofs the concrete, the potential for DEF is blocked.

The effects of water for the creation of ettringite is important. We need to consider that an ettringite molecule requires 32 molecules of water. For ettringite to form, a wet condition is necessary. (see various depth of penetration testing and MTL report).

ASR (Alkali Silica Reaction)
ASR is closely linked to DEF. ASR requires contaminated aggregates and water to cause the development and expansion of a silica gel around the aggregates, resulting in expansion and spalling of the concrete. Krystaline admixtures prevent ASR by preventing the ability of the water to cause the expansive action around the aggregate. (see various depth of penetration tests)

Wet Dry Cycles
Krystaline admixtures works well in wet dry cycles. The C-S-H developed during the wet cycles is solid and will not wash away when another wet cycle arrives unlike products that function using CH crystals. The ability to prevent penetration of water in tidal areas for example, together with the ability to generate stronger crystalline and waterproofing abilities, result in further hydration with every wet cycle. Each wet cycle will assist Krystaline to hydrate the concrete, further generating additional C-S-H content and even stronger abilities to autogenously seal any cracks that may occur in the concrete.

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Carbonation
Krystaline's ability to lower the calcium hydroxide (CH) in the concrete and the ability to stop water ingress provides excellent resistance to the development of carbonation over time. For carbonation to occur there must be CH to react with the carbon dioxide to form calcium carbonate and there must be water present. Since Krystaline reduces calcium hydroxide and stops the water, the effects of carbonation are reduced (see MTL report).

Qualifies for PRAH
Krystaline admixtures qualify under ACI's PRA designation as PRAH due to the abilities to stop water under hydrostatic conditions and to self-heal concrete cracking.

Points to consider:

As can be noted, Krystaline admixtures provide benefits during the wet mix, the placing and most importantly will contribute to the **Physical Durability** and **Chemical Durability** extending the life of the concrete.

- Krystaline admixtures are in-depth waterproofing admixtures.
- Krystaline admixtures function at a set dose and are not modified.
- Krystaline Admixtures function as plasticizing/water reducing/set retarding and possible super plasticizing admixture.
- Krystaline admixtures are proven crystalline technology admixtures.
- Krystaline admixtures may provide increased air entrainment.
- Krystaline admixtures increase compressive/tensile/flexural strengths of concrete.
- Krystaline admixtures increase the physical and chemical durability of the concrete but are considered a waterproofing cost not a concrete cost.
- Krystaline admixtures reduce the number of open pores on the concrete surface.
- Krystaline admixtures reduce the drying shrinkage of the concrete.
- Krystaline admixtures reduce wetting expansion of the concrete.
- Krystaline admixtures lower the calcium hydroxide crystals within the concrete.
- Krystaline admixtures increase the C-S-H crystals within the concrete.
- Krystaline admixtures are PRAH qualified as defined by ACI.
- Krystaline admixtures provide increased ability to withstand freeze/thaw environments.
- Krystaline admixtures reduce the capillary absorption of the concrete.
- Krystaline admixtures are stand-alone waterproofing systems. No membranes needed!
- **Krystaline admixture treated concrete is more durable and sustainable than reference concrete.**

KRYSTALINE: THE OPTIMAL SOLUTION FOR SUSTAINABLE WASTE WATER INFRASTRUCTURE

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