TECHNOBUILD PCI

Penetrating Corrosion Inhibiting Admixture (PCI)

Double or triple the Service Life of Concrete Structures.
Pro Active Protect.

TECHNOKOTES PCI (Penetrating Corrosion Inhibitors) technology protects reinforcing metal in concrete from corrosion. PCIs rehabilitate existing concrete structures and extend the life span of new structures. Often, corroding rebar in deteriorating concrete is the cause of costly repairs, financial losses, injuries and deaths, but TECHNOKOTES has the corrosion solution. TECHNOKOTES PCI products for concrete maintain structural integrity, rehabilitate vulnerable structures, and alleviate environmental concerns. **A unique feature of PCI is that the inhibitor will migrate a considerable distance through concrete to protect embedded ferrous metals**.

Causes of Corrosion:

Reinforcement in new concrete is generally protected from corrosion due to the high alkaline nature of the concrete itself. The high pH of the concrete (usually greater than 12.5) causes a passive oxide film to form on the steel. Environmental factors can affect this protective oxide film and induce the formation of corrosion cells. Once corrosion starts, some parts of the reinforcement become anodic, discharging iron ions (current) into the electric cell. Steel areas that receive this current are the cathodic areas of the corrosion cell. This is where hydroxide ions are formed. Iron and hydroxide ions react to form iron hydroxide, FeOH, which further oxidizes to form rust. Once started, the rate of corrosion is affected by the concrete's electrical resistivity, moisture content, and the rate at which oxygen migrates through the concrete to the steel. As rust formation continues, it can take up to four times the volume originally occupied by the embedded reinforcement, causing cracking and spalling of the concrete.

Chlorides:

Chloride ions can penetrate the passive oxide film on the reinforcement. They combine with Fe ions to form a soluble iron chloride complex that carries the iron into the concrete for later oxidation (rust). Once chlorides reach a level of about 0.15% (water soluble chloride by mass of cement) in the concrete, corrosion starts. Concrete can be exposed to chlorides from several different sources, including chloride containing set accelerators, de-icing salts, seawater, and airborne salts.

Carbonation:

Carbonation is the process by which carbon dioxide in the air reacts with hydroxides in the concrete such as calcium hydroxide, to form carbonates. This reaction significantly lowers the pH. When the pH of concrete surrounding embedded reinforcing steel drops below 12, the protective oxide layer is lost, and the corrosion process begins.

Acid Rain/Industrial Pollutants:

Acids attack concrete by dissolving the cement paste and calcareous aggregates. They also reduce the pH of the concrete, allowing the corrosion process to begin. Pollutants such as sulphate attack the concrete by reacting with hydrated compounds in the hardened cement paste. These reactions can lead to disintegration of the concrete, making embedded reinforcement more susceptible to corrosive attack.

Once a concrete structure is built, it's impossible to coat the reinforcing steel with fusion-bonded epoxy to protect it from corrosion. Cathodic protection is ineffective unless the steel reinforcement is electrically continuous.

TECHNOKOTES PCI, however, can be easily added to new concrete or used for rehabilitation and will not delay construction or increase construction costs other than the small cost of the material. **Unlike standard inorganic inhibitors, TECHNOKOTES PCIs do not have to come in contact with the reinforcing steel upon application because they can migrate to the steel and protect it.**

When specified in new construction, TECHNOKOTES PCI line of concrete admixtures offers reinforcing steel superior corrosion protection against carbonation and chloride attack.

Comparison of TECHNOKOTES PCI Admixtures to Other Inhibitors:

Feature	TECHNOKOTES PCI Inhibitor	Calcium Nitrite
Environmentally friendly, derived from renewable resources	True	False
Used in small quantities—less than 3 liter/m3	True	False
Required dosage rate is not affected by expected chloride exposure	True	False
Ability to migrate through concrete in a vapour phases at ambient temperatures	True	False
Does not increase shrinkage compared to a control	True	False
Does not require adjustments to concrete mix design (chemical or water)	True	False
Does not affect concrete resistivity	True	False
Does not accelerate concrete set time	True	False
Has approval to meet Standard (contact w/potable water)	True	False
Spills can be flushed with large quantities of water down drain	True	False

How Does PCI Technology Work?

The corrosive effects of carbonation and chlorides cause a breakdown of the natural passivating layer on steel in concrete. PCI's provide protection because of their ability to migrate to the depth of the metal, and form a protective, molecular layer on steel when they come into contact with it.

1. PCI move as a liquid into the concrete matrix. In new construction, PCI is admixed either with the batch water or directly into a mixer. For existing structures, PCI applied to the surface is drawn into the concrete via capillary action—the concrete acts like a sponge, drawing PCI inside.

2. PCI move in a vapour phase throughout the concrete pore structure. This movement is governed by Fick's Law, meaning molecules move randomly throughout the matrix from areas of high concentration to areas of low concentration.

3. When PCI comes into contact with steel, it has an ionic attraction to it, and forms it's protective, molecular layer. PCI's affinity to the metal is stronger than water, chlorides and other corrosive contaminants.

4. Independent testing has confirmed that PCI can absorb onto metal to a depth of 75-85 nm, forming a layer that is between 20 and 100 Å thick. In the same testing, chlorides were shown to penetrate only 60 nm deep. This confirmed the ability of PCI to displace chlorides on the metal surface and provide protection even in their presence.

PCI Product Application Guide

	Condition of Structure	Objectives & Requirements	PCI Protection	Features and Benefits
Stage 1 New Concrete	• Aggressive Environment • Insufficient Concrete Cover	• Extend useful service life • Protect from premature corrosion • Preserve the natural appearance of the concrete	• PCI 200 series admixtures can double to triple the time to corrosion initiation, and once corrosion starts, they can cut rates by more than 5 times compared to a control	• Low Dosage Rate • Certified to portable water requirement • No affect on concrete mix design • No affect on concrete properties • Can double the service life of many new structures
Stage II Existing Structures, No Visible Corrosion Damage	Carbonation Start of Rust • Concrete structures without protective coatings • Aggressive environment • Initiation of corrosion • No spalling or cracking	• Slow the rate of corrosion • Protect against possible concrete damage • Protect against further corrosion due to carbonation and/or chloride penetration	• Application of a PCI 220 Series surface applied product by spray, brush or roller • Followed by an application of an anti-carbonation coating such as PCI Architectural Coating OR application of a sealer such as PCI 218, 219, 221, or 222	• High coverage rate • Minimal or no concrete removal • Non-destructive • Extends the time to next repair of the structure • Fewer coats means lower labour costs than competitor products • Can be 10 times less costly than a Stage III repair! • PCI 220 Series meets portable water requirement
Stage III Existing Structures, Visible Corrosion Damage	Carbonation Rust • Concrete surface with visible corrosion damage (i.e. spalling and cracking), repairs are necessary • High level of chlorides at depth of reinforcement	• Repair of damaged surfaces • Long term protection against future exposure of contaminants • Enhanced protection against the continuing damage of latent corrosion • Reduced risk of ring-anode (insipient anode) effect	• Cleaning of exposed reinforcement with TECHNORUST, or use of TECHNOCLIN • Application of TECHNOKOTES PCI 223 grout to exposed reinforcement and repair area • Application of TECHNOKOTES PCI 239 repair mortar • Application of TECHNOKOTES PCI 238 Finish repair mortar • Application of TECHNOKOTES PCI 220 to entire surface area • Application of TECHNOKOTES Coating or Sealer	• Aesthetically pleasing restoration of structure to a safe condition • Complete repair and protection against latent corrosion damage • Can more than double the life of the repair (based on G109 testing) • PCI 220 Series is certified to meet portable water requirement

TECHNICAL SERVICES

For more information concerning the working, application and compatibility of **TECHNOBUILD PCI** treatments with or without other products or technologies, contact the Technical Department of TECHNOKOTES.

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