PROTECRETE®
CONCRETE'S BEST SOLUTION

Why Densifier works and sodium silicates do not

A technical explanation of how PROTECRETE's Densifier is very different from sodium silicate products

All look-alike products do not perform alike even though they are making similar claims. How can you tell which one to believe?

We will explain in the following paragraphs how our product, PROTECRETE Densifier, a silicate, is different from the current popular sealers on the market (which are **sodium** silicates). Because it *is* different, it also *acts* differently, and that's why Densifier is able to penetrate 4 to 6 inches or more when the look-alikes can only sit on the surface.

About silicates

Silicates are plentiful in nature, constituting the greater number of the minerals that compose the crust of the Earth. They are compounds containing silicon (next to oxygen, Earth's most abundant element) with oxygen and a metal. Man-made silicates are used for a wide variety of purposes, from glass making to water treatment, plus the major ingredients of Portland cement are silicates.

Silicate materials are used as waterproofing agents in concrete because of their solubility in water. The waterproofing concept ideally is: water soluble silicates contact and react with certain common ingredients which are always available inside Portland cement concrete (such as one or all of the available hydroxide materials, soluble calcium compounds or free and unused alkalis) to form insoluble precipitates. This process allows the Densifier to densify and waterproof the concrete at the same time with a single application.

The fact is, with the exception of the Densifier, most, *if not all*, silicate products formulated and marketed to date, begin to react with the ever present calcium hydroxide residue immediately upon contact with the concrete's surface. This generates a thixotropic, sparsely distributed crystalline precipitate gel, which very much hinders or prevents further silicate solution penetration. The resultant hydroxide precipitated gel is not of uniform composition. It consists of variable-sized pores, ranging from very small to very large. This causes the precipitate to only be temporary at best. As water migrates through the gel's larger pores, the gel erodes and eventually will fail. How quick will depend on the volume of water and its driving force passing through the concrete. The silicate solution's immediate surface reaction can also cause ineffective, incomplete thixotropic gel to be generated. Since the reaction begins immediately upon contact with the concrete's surface, there is a tendency for there to be more silicate solution available in the application than there is hydroxide material in the concrete to react with. This causes varying portions of the thixotropic gel deposited inside the concrete to not be completely reacted, becoming what is considered an incomplete gel. Incomplete gel contains reaction sites that remain available for reactions. These unfulfilled reaction sites will eventually react with atmospheric carbon dioxide and form carbonates. The carbonates then can eventually migrate to the surface and cause damage to the concrete that it was meant to protect.

There are some silicate solutions, such as Densifier, that are able to penetrate very deeply into concrete and form precipitate, a gel-like compound, in the pores upon contact with the always present free unused alkalis. However, type and uniformity of this internally produced compound can vary greatly, and can be the most important factor as to whether the silicate solution became beneficial to concrete or not, and to what degree. Unlike Densifier, some silicate products form gel that will absorb internal moisture and begin swelling and continue swelling whenever moisture becomes available. This can produce extreme internal pressures and stresses, even to a point where concrete's integrity could be damaged quite severely (similar to an alkali-aggregate reaction).

PROTECRETE Densifier is successful in overcoming such problems and is a superior product very beneficial to concrete. Since Densifier goes into concrete as a unique precision-blended colloidal liquid, its internally generated compound or precipitate, is designed to be very superior when compared to other existing look-alike products. The precipitate packing density is very precise and creates pore networks of extremely uniform-sized porosity with pore sizes smaller than a molecule of water, or free moisture. As Densifier's precipitate is being formed, it involves special ingredients to cause polymer cross linking and branching, encouraging polymer particle and strand connection. It creates extraordinarily strong polymer chains, which provide the extra strength and durability to truly become permanent and insoluble. Furthermore, the polymer chain and pore configuration cause Densifier gel compound's residual water or free moisture to remain in a stretched position with a density similar to that of ice. Should a hard freeze occur, this water or moisture does not expand further to cause freeze-thaw cycle damage, as does the gel compounds of some look-alike products. Look-alike products, making similar claims, usually only form shallow, weakly linked short chain gel polymer compounds. They may or may not hold up for an appreciable length of time. They are entirely dependent on the harshness of the concrete installation's surrounding environment. Plus, there is always the possibility that incomplete gel may migrate back to the surface, creating surface traction problems in products other than PROTECRETE Densifier.

AIRPORT PAVEMENT SURFACE MAINTENANCE STUDY

PROTECRETE Densifier
Performed at Dallas Fort Worth International, May, 1990.
Excerpted from a document originating at a reputable unbiased testing laboratory,
(Testing laboratory name is kept undisclosed pursuant to initiator's request).

The information presented in this document is based on an Airport Pavement Surface Maintenance Study performed at DFW International by ARE Engineering Consultants, Austin, Texas in May of 1990.

All products were installed in mid-July, 1989 with the exception of number 13, which was a later addition and placed in early August, 1989. The products were permitted to cure briefly before the test program began. The sampling and testing program included skid testing using the Mu-Meter to be accomplished three times: Summer, 1989; Winter, 1989; Spring, 1990. Tests performed in the laboratory on surface sections of 4″ diameter cores included permeability or water absorption, sand blast abrasion and indirect tensile strength, before and after freeze-thaw cycling. All of the tests were performed on the initial core samples. The test program on the second set of cores was limited to permeability or water absorption and indirect tensile strength. The following summarizes the results of the test program carried out:

Product No.	Product Name	Skid Resistance	Water Absorption	Surface Hardness
01	Chemtrete BSM-40	YES	NO	YES
02	Chloride Seal	N0	YES	NO
03	Consolideck Saltguard	YES	YES	YES
04	Sil-Act ATS 42	YES	YES	YES
05	Hydrozo 650	YES	YES	YES
06	**PROTECRETE**	**YES**	**YES**	**YES**
07	Ashford Formula	NO	YES	YES
08	Consolideck SX	YES	YES	YES
09	Sil-Act ATS 22	YES	YES	YES
10	Chemtrete BSM-20	YES	NO	YES
11	Enviroseal 40	YES	YES	YES
12	Enviroseal 20	YES	YES	YES
13	Aquron	YES	NO	NO

All 13 products are shown and the table above shows where a product failed to deliver acceptable performance. Of the 13 products, six failed in at least one phase of the experiment. The skid resistance is considered the most significant as it relates directly to aircraft operational safety and from a skid resistance criterion, Chloride Seal and the Ashford Formula should not be used on airfield pavement at DFW. Three products failed to reduce the amount of water absorbed into the concrete surface, these being Chemtrete BSM-40, Chemtrete BSM-20 and Aquron. Three products also failed to increase the surface hardness, these being Chloride Seal, Enviroseal 20 and Aquron. Based on the results of the limited field and laboratory program, it is recommended the following products be considered acceptable for use at DFW: (a) Consolideck Saltguard, (b) Sil-Act ATS 42, (c) Hydrozo 650, (d) PROTECRETE, (e) Consolideck SX, (f) Sil-Act ATS 22, (g) Enviroseal 40.

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PRODUCT TECHNICAL INFORMATION:

Product:	Product Name:	Product Description:
01	Chemtrete-BSM 40	Clear, Alkyltrialkoxy silane (40%) Denatured ethyl alcohol carrier
02	Chloride Seal	Clear Proprietary product formulation
03	Consolideck Saltguard	Clear Oligomeric siloxane (10%)
04	Sil-Act ATS 42	Clear, Alkyltrialkoxy silane (40%) Anhydrous isopropanol carrier
05	Hydrozo 650	Clear, Proprietary blend of silane, siloxanes, sterates and aluminum compounds Blended solvent carrier
06	**PROTECRETE**	**Clear, Hydrosilicate catalyst in a Colloidal silicate base**
07	Ashford Formula	Clear Proprietary product formulation
08	Consolideck SX	Clear, Oligomeric alkyl-alkoxy siloxane (20%), Mineral spirits of alcohol carrier
09	Sil-Act ATS 22	Clear, Alkyltrialkoxy silane (20%) Anhydrous isopropanol carrier
10	Chemtrete BSM 20	Clear, Alkyltrialkoxy silane (20%) Denatured ethyl alcohol carrier
11	Enviroseal 40	Clear, Alkylalkoxy silane (40%) Water is carrier
12	Enviroseal 20	Clear, Alkylalkoxy silane (20%) Water is carrier
13	Aquron	Clear, Proprietary catalyst in sodium silicate solution

After all permeability, absorption and sandblast abrasion tests were completed on the concrete specimens, they were tested for tensile strength using the splitting tensile test. The tensile strength of a four inch cylinder, two inches long, is very dependent on the aggregate distribution. All of these samples represented the top two inches of pavement. Although no strong conclusions are anticipated from the tensile tests, the results are included.

The indirect tensile strength tests for the treated specimens are compared to the average strength of the untreated control sections before and after freeze-thaw exposure. The specimens were replicates. About one-half of the products, numbers 1, 2, 3, 8, 9, 10 and 12, show no significant difference. Of the remainder, only two showed substantial decreases in tensile strength after freeze-thaw exposure, these being numbers 7 and 11. It is believed that this is inconclusive because samples 4, 5, 6, and 13 show substantial increase (number 6 from 650 to almost 900psi) in tensile strength after freeze-thaw exposure. Therefore, it is believed that no conclusions can be drawn from the tensile test results as the sample-to-sample variability is probably greater than any effect of the surface sealers. To truly check the effects, a very large experiment would be required along with an analysis of variance which was beyond the scope of this project.

AASHTO T-259-80

**RE: PROTECRETE DENSIFIER Standard Method of Test for
Resistance of Concrete to Chloride Ion Penetration AASHTO T-259-80.
Excerpted from a document originating at a reputable unbiased testing laboratory,
(Testing laboratory name is kept undisclosed pursuant to initiator's request).**

On October 3rd, 1992, two 4 inch diameter by 3 inch deep cores were drilled from parking garage slabs. The first core was from the P3 floor slab placed on September 16th, 1992, and the second core from the P1 floor slab placed September 29th, 1992 pour. DENSIFIER had been applied to these concrete slabs on the same date as placement at a coverage rate of 200 square feet per gallon.

After drying of the cores in laboratory air for 28 days, a light sandblast was done to the top surface of the cores to simulate wear from vehicular traffic. Exterior dams were applied to the top surfaces of the cores and a 0.5 inch deep solution of 3% sodium chloride was applied on November 4th, 1992.

Test specimens were subjected to continuous ponding of the chloride solution for 90 days. Appendix A presents "Standard Method of Test for Resistance of Concrete to Chloride Ion Penetration AASHTO Designation: T-259-80 (1990)". This is the procedure we have followed.

1.0 RESULTS:

SAMPLES TAKEN FROM FLOOR SLABS

	P3, Slab Pour 09/16/92	**P1, Slab Pour 9/29/1992**	**Composite Baseline Sample***
Sample Depth	*% of Water Soluble Chlorides by Weight of Concrete*	*% of Water Soluble Chlorides by Weight of Concrete*	
1.6 mm to 13 mm	0.11%	0.11%	< 0.01
13 mm to 25 mm	0.021%	0.12%	< 0.01

*** Prior to Chloride Exposure.***

2.0 DISCUSSION:

2.1 The values at the surface are below the ACI recommended limit of 0.15%, i.e. for reinforced concrete exposed to chlorides in-service.

2.1 The internal chloride values at 0.021 and 0.12% are considerably less than the allowance for reinforced concrete exposed to chloride-in-service (0.15% maximum) and in fact are approximately 1/3 or less than the value allowed for prestressed concrete.

2.3 See Appendix A which represents the ACI chloride limits.

3.0 REMARKS:

3.1 Results indicate PROTECRETE DENSIFIER acts as an effective chloride barrier.

DENSIFIER AND THE RESTRICTION OF VAPOR TRANSMISSION

How does an application of PROTECRETE Densifier allow concrete to breathe, yet prevent transmission of substances such as radon, methane or other harmful gases?

Part of the answer lies in the nature of gas transmission in PROTECRETE treated concrete. Some gases are soluble. Gases that have a low molecular weight are more soluble than gases with a high molecular weight. Also the way the electronic configuration of the gas combines with the electronic configuration of the residual PROTECRETE subsurface barrier created inside the treated concrete determines solubility.

As a compatible gas permeates the PROTECRETE treated concrete, and subsequently the precipitated waterproof subsurface barrier inside the concrete, it dissolves and emerges as a gas, re dissolves and re-emerges dependent upon the capillary pores (interstitial pores) and the gel pores (discontinuities) that may remain internally accessible to the gas. Oxygen with an atomic number of 8 and an atomic weight of 16 has a low enough molecular weight to diffuse, to dissolve and to move under partial pressure at any given temperature. All of its molecules have the same kinetic energy. The kinetic energy being the energy of motion. A large molecule will have a high mass component of energy and a low velocity component. A small molecule will have a high velocity component and a low mass component. This will affect reaction kinetics and thus solubility. It will also determine solubility at the surface and mobility through the substance media. In this case, PROTECRETE treated concrete.

DENSIFIER AS AN ALTERNATE CURE METHOD ASTM C-309-91

Excerpted from a document originating at a reputable unbiased testing laboratory that is a member of: American Institute of Chemical Engineers, National Society of Professional Engineers, ASM International, Society of Petroleum Engineers AMIF, American Chemical Society, American Society of Testing Materials, American National Standards Institute and American Society of Quality Control.
(Testing laboratory name is kept undisclosed pursuant to initiator's request).

TEST PROCEDURE: Class A compound (PROTECRETE) was tested ASTM C-309-91.

RESULTS:

TEST/METHOD	PROTECRETE	SPECIFICATION
Water Retention (ASTM C-156)	0.47 kg/m2	< 0.55 kg/m2
Reflectance, White-pigmented (ASTM E-97)	60%	> 60%
Drying Time (ASTM C-309)	1.25 Hours	4 Hours
Long Term Settling, White-pigmented (ASTM D-1309)	8 Hours	± 4 Hours
Flash Point (ASTM D-56)	None	> 50° F

DISCUSSION: Sample passed ASTM C-309-91 test criteria for Class A curing compound.

ASTM D-5084

RE: PROTECRETE Densifier as a cure method-ASTM D-5084 comparison test.
Excerpted from a document originating at a reputable unbiased testing laboratory,
(Testing laboratory name is kept undisclosed pursuant to initiator's request).

The permeability testing of the untreated control sample was finished in just a few days since we were able to get four (4) consecutive readings within ±25% of the mean value obtainable. The PROTECRETE treated sample could not be finished because our lab has not been able to get four (4) consecutive readings ±25% of the mean value. Also, the values for the PROTECRETE treated sample are continuing to get lower permeability results, not staying consistent.

Both samples had five (5) pounds per square inch of confining pressure and head pressure during the tests. The control sample results in cm/s were two readings at 7.7×10^{-9}, one reading at 7.8×10^{-9} and one reading at 8.8×10^{-9}. In feet per day, the readings were three readings at 2.2×10^{-5} and one reading at 2.5×10^{-5}. The lowest and most recent reading for the PROTECRETE treated sample is 9.6×10^{-10} cm/s or 2.7×10^{-6} feet per day. From the results above, you can see that the PROTECRETE treated sample is 12% less than the control sample.

Please remember that the results of the PROTECRETE treated sample were not finished. They would probably be less permeable that what we have shown in this report.

D-5084 Test Explanation: This test was performed to demonstrate that PROTECRETE DENSIFIER was an effective cement paste enhancer, as well as a cure method solution. However, the D-5084 test was considered incomplete. The objective of this test was to learn how much difference there was in the hydraulic conductivity of an untreated control specimen of portland cement concrete as compared to a DENSIFIER-treated one, with both specimens originating from the same batch of concrete. The DENSIFIER-treated specimen ultimately, in the D-5084 test, kept growing in impermeability, and was left hooked-up to the flexible-wall permeator test apparatus for approximately 100 days to see how impermeable the DENSIFIER-treated specimen would become. Eventually no water whatsoever was able to pass into it, rendering the test incomplete since no hydraulic conductivity reading could be taken.

DIN 1048 WATER PENETRATION

PROTECRETE DENSIFIER

TEXT REPORT ASCERTAINING PROTECRETE DENSIFIER MEETS OR EXCEEDS
MINIMUM REQUIREMENTS OF THESE DIN STANDARDS

This report originated at an impartial laboratory for chemical and physical material testing that is a state authorized testing institute for construction materials.

This report is concerning the basic characteristics and effectiveness of the product, PROTECRETE DENSIFIER.

Applicant:

Applied Concrete Technology, Inc.
P. O. Box 4015
Arlington Heights, Illinois 60004 (USA)

Subject:
Applicant manufactures a concrete densifying sealer, restoration, and protection product on a colloidal silicate base under the name of PROTECRETE DENSIFIER. This product is used for densifying, sealing, insulating, and restoring concrete and mortar and with many other inorganic construction materials and structures.

Product Samples:
To conduct the tests applicant has provided us with three product samples. These samples have been tested by us for basic product characteristics on mortar and concrete.

Testing Program:
The main results will be given by the different tests concerning water penetration according to DIN 1048, which is to be measured at a water pressure of one (1), three (3) and seven (7) bar.

The concrete samples to be used in the test are to be prepared according to DIN 1045. The aggregate used was a mixture of sand which had previously been tested according to DIN 4226. After that, the aggregate was washed, dried, then separated into the different sizes of the sand/gravel mix. Then a mixture of different sizes according to Fuller was calculated and prepared in order to make sure an even concrete structure for all tests which is necessary to compare the results of the different test series.

The following concrete has been prepared for the samples:

VB 1- (Versushs-Beton = concrete for tests) Sieve line according to Fuller, prepared with 300 kg Portland cement DIN 1164-PZ 35°F per cubic meter of hardened concrete.
(Note: PZ 35°F = Portland cement, rapid hardening, causing after 28 days of curing a compressive strength of 35 N/mm2 = 5,000 psi)

VB 2 - Same as VB 1, but with blast furnace cement HOZ 35 L + moderate hardening.

VB 3 - Same as VB 1, both with Portland cement PZ 45°F - rapid hardening, minimum compressive strength after 28 days 45N/mm2 = 6,400 psi, used for concrete of strength class B 45 - minimum compressive strength - minimum of three following samples - 7,100 psi.

VB 4 - Same as VB 3, but with blast furnace cement HOZ 45 L = moderate hardening.

The four different samples have been manufactured according to DIN 1045 and controlled according to DIN 1048. These carefully prepared and absolutely compatible mixtures have been used for different tests. The necessary water-plates as well as the samples to test the concrete quality have been manufactured according to DIN 1048. The dimensions of the water-plates were 200 mm x 200 mm x 120 of the samples 300 mm sides.

The surfaces of the water-plates that were to be exposed to water pressure were prepared according to DIN 1048. The test specimens were then placed for 28 days in water (18 - 20°C), then taken out of the thermal bath and the prepared surfaces were treated with PROTECRETE DENSIFIER per manufacturers specification. After the first application was dry, this procedure was then repeated.

Then the test specimens were tested for water impermeability according to DIN 1048 (see separate explanation). The specimens were subject to water pressure of one bar for 48 hours, three bar for another 24 hours and finally seven bar for another 24 hours. (14.5 psi/43.5 psi/101.5 psi = 33.5 ft. water/100, 5/234.5).

After that, the water-plates were taken out of the testing-apparatus and split. At the split surfaces, the depth of water penetration was immediately measured and marked with a special marker.

List of Average Depth of Water Penetration

Concrete	Depth of Water Penetration in mm	
Type No.	With DENSIFIER	Without DENSIFIER
1	5.7	26.5
2	8.8	23.0
3	4.2	20.0
4	6.5	21.5
Average	**6.3**	**22.75**

This list of average values of all testing series makes it obvious with all four types of concrete tested, that PROTECRETE DENSIFIER reduces the depth of water penetration considerably and therefore insulates as manufacturer claim. The result of waterproofing depends to a large degree on correct application with a certain amount of care. Therefore the application should only be done by trained contractors that are willing to warranty their job.

REMARKS:

1. The test according to DIN 1048 is used to determine special qualities of concrete according to DIN 1045.
    a. waterproof concrete: maximum depth of water penetration no more than 50 mm = 2 inches.
    b. concrete with high frost resistance: has to be waterproof, water/cement ratio under 0.6 or air entrained.
    c. concrete with resistance to deicing salt has to be waterproof, water/cement ratio under 0.5, air entrained and minimum compressive strength required.
    d. concrete with high resistance to chemical attack: has to be waterproof, if subject to strong chemical attack maximum depth of water penetration 30 mm.

2. The lab has also established the following values on compressive strength for treated specimens (5000 psi design):

VB 1: 47, 2 N/mm2 = 6,720 psi VB 3: 50, 9 N/mm2 = 7,250 psi
VB 2: 44, 7 N/mm2 = 6,370 psi VB 4: 54, 5 N/mm2 = 7,750 psi

Impermeability to water:

- start of test usually when specimen is 28 days old.
- place specimen so that water pressure will act on specified surface and the other surfaces can be observed.
- water pressures:
    for 48 hours: 0.1 N/mm2
    next 24 hours: 0.3 N/mm2
    next 24 hours: 0.7 N/mm2
- establish whether a surface becomes wet outside the area exposed to water pressure and if possible at what pressure and after what time.
- stop test if water penetrates
- split specimen in the middle immediately after the test, e.g. similar to splitting tensile strength test (side of water pressure down).
- limit of water penetration becomes visible during the drying of split surface, mark it (side of water pressure down).
- calculate average of maximum depth of penetration from three specimens.