XYPEX
VIETNAM

INTRODUCTION

Since developing its unique technology for the waterproofing, protection, and rehabilitation of concrete structures, XYPEX CHEMICAL CORPORATION has pursued a strategy aimed at expanding its position from a global perspective. The result has been consistent growth record within the international marketplace, and today, Xypex products are being used in over 70 countries worldwide.

The quality, reliability and uniqueness of the Xypex technology have played a major role in contributing to its expansion within the global market. Briefly described, Xypex "*Concrete Waterproofing by Crystallization*™" is a non-toxic chemical treatment, based on concrete technology, that offers several advantages over other available systems. The active ingredients in Xypex cause a catalytic reaction which generates a non-soluble crystalline formation of dentritic fibres within the pores and capillary tracts of concrete. This crystalline formation becomes an integral part of the concrete structure and permanently seals it against the penetration of liquids from any direction. Not only will the chemical reactions take place at the surface of the concrete or immediate adjacent area, but they will continue deep into the concrete structure over time. The extent of the migration and the time factor will depend on the presence of moisture, the concrete constituents, and the physical properties or the concrete such as cement content, density, compaction and temperature.

Because the crystalline formation becomes an integral part of the concrete itself, the integrity of the Xypex treatment is not dependent on its adhesion ability to the concrete surface as is the case with most conventional coatings. The Xypex system can therefore be applied to underground structures from the "inside" (negative side) even against strong hydrostatic pressures. Also, since the Xypex treatment is highly resistant to most aggressive substances, the concrete and reinforcing steel are protected from oxidation and the effects of harsh environments, thus extending the life of the structure.

Xypex's unique formula is now developed into a range of products to suite different application needs. In addition to the Concentrate and Modified that is used in standard coating application and leak repair, the Concentrate Admix C-Series is formulated for premix concrete, shotcrete, or cement render when coating application is not feasible. Also, for fast track project, the Concentrate-DS Series is formulated as a dry shake powder that is power trowelled into "green" concrete slabs, and is available with or without a floor hardener. All the Xypex formulations applied under different methods achieve the same results of its in-depth penetrating crystalline waterproofing and concrete protection. The difference simply offers the flexibility in choices for the value engineering per project requirements.

In addition to its crystalline products, Xypex also manufactures a range of products for concrete repairs. To enhance its system further, Xypex is now introducing a new high technology Flexible Cementitious Membrane (FCM) after extensive research and testing for over 10 years. The FCM is developed especially for concrete or non-concrete masonry substrate, moving cracks, thermal expansion joints, & for design specifications requiring elasticity. For more information and technical support, please kindly contact Vinh Hiep Hung Co., Ltd at 464 Nguyen Dinh Chieu St., Dist. 3, HCMC, Email: vhhco@hxypexvietnam.com or contact@xypexvietnam.com for English support. Please check Xypex Chemical Corporation's website at www.xypex.com for more updates.

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FREQUENTLY ASKED QUESTIONS ON XYPEX

WATERPROOFING CONCRETE

1. What is the "Xypex Concrete Waterproofing by Crystallization" process?

The Xypex process involves waterproofing by crystallization, whereby the addition of Xypex to concrete, with water as the catalyst, reacts to generate a non-soluble quartz like crystal which grows in the bleed tracts and capillaries forming within the concrete. The reaction is the equivalent of a secondary hydration process that fills naturally occurring voids with a solid mass. In this manner, concrete becomes impermeable to the penetration of liquids.

2. How does XYPEX work?

When a cement particle hydrates, there is reaction between water and the cement that causes it to become a hard solid mass, but there are also chemical by-product given off which are lying dormant in the concrete. With Xypex there is a second set of chemicals. When the by-products of cement hydration is combined with the Xypex chemicals under the presence of moisture, a chemical reaction takes place forming a non-soluble, dendritic, crystalline structure. This crystalline structure can only take place where *moisture* is present and thus Xypex tends to form this crystalline material in the bleed water tracts, capillary tracts and shrinkage cracks in concrete. Wherever water goes, Xypex will form.

3. How do Xypex Chemicals react within concrete?

The waterproofing effect of Xypex is due to two reactions: one chemical, and one physical. When Xypex is being used as a coating for waterproofing or other remedial work on existing concrete structures, in order to get the chemicals from the coating into the concrete, it relies on the physical reaction, *osmosis*. Osmosis is when a solution of high density will migrate through a solution of lower density until the two equalize.

4. Is the Xypex process ongoing?

Since the process is *catalytic*, the crystalline structure can *re-activate* many years after the original application, to seal, or re-seal many defects which might occur in the concrete at a later time providing cracks do not exceed approximately 1mm width. Please note, however, that Xypex crystalline products are not flexible, and as such are not applicable to sealing moving structural cracks on a stand alone basis. A new high technology Xypex Flexible Cementitious Membrane system has been developed to fill this void.

5. How is Xypex applied?

Concrete can be treated with Xypex by any of the 3 methods below with equal effectiveness:

a. Within the concrete in the initial mix, using Concentrate Admix *C-2000* or *C-1000*.
b. Applied over a finished concrete structure on the outer surfaces, at any period of the structures' life, using *Concentrate* and/or *Modified*.
c. Applied to green concrete as a dry shake powder and then trowelled into the concrete, using *Concentrate-DS1* or *Concentrate-DS2*. The DS2 incorporates a floor hardener.

6. How long does it last?

Xypex application, unlike most other systems, is *permanent*. The fibrous crystalline formation, due to its unique non-organic composition, will not deteriorate under normal conditions.

7. Is a Xypex coating waterproof?

A coating of Xypex Concentrate and/or Xypex Modified is never a waterproof in itself. The coating is only the carrier of Xypex chemicals that are drawn from the coating into the matrix of the concrete during the initial process. If required, the Xypex coating itself may be removed after 5 to 6 weeks as the crystalline growth is already deep into the concrete by this time.

8. How deep can the chemicals of a Xypex coating penetrate into concrete?

Xypex crystals will penetrate up to 0.45 meter deep into the concrete from an external specified application subject to moisture presence and quality of concrete. Growth rates are approximately 50mm for the first three weeks and 10mm per week thereafter depending on presence of moisture. Tests by Nikki Shoji Central Laboratory in Japan have shown Xypex crystalline growth is over 30cm per year through samples photographed using a scanning electronic microscope.

9. What are the advantages to using Xypex over membranes?

a. Xypex does not require dry weather, surface priming or leveling prior to application.
b. Xypex does not require a dry surface, in fact a wet surface is necessary.
c. Xypex can not puncture, tear, rupture, or come apart at the seams.
d. Xypex does not restrict site access or require protection during backfilling, placement of steel, wire mesh or other materials.
e. Xypex does not require costly sealing, lapping and finishing of seams at corners, edges or between membranes.
f. Xypex is inorganic, it will not deteriorate and is unaffected by ultraviolet rays.
g. Xypex is chemical ressistant, it does not require protection mortar when it is applied in tanks.
h. Xypex can also repair concrete defects, its chemical composition is compatible to concrete.
i. Xypex has no risk of a system failure associate with loss of adhesion, film thickness, negative moisture & shrinkage cracks. It can be easily identified and spot repaired.

10. Are there additional benefits using Xypex?

a. Yes, self-healing capacity for micro-shrinkage cracks up to approximately 1mm in width.
b. Yes, corrosion protection.
c. Yes, neutralize chloride ion activity.
d. Yes, chemical resistance.
e. Yes, reduced carbonation.
f. Yes, prevent alkali aggregate reaction.
g. Yes, gains in concrete strength.
h. Yes, reduce water cement ratio.
i. Yes, accelerated design strength.

11. Can a Xypex treated structure withstand high hydrostatic pressure?

Yes, after moist curing and setting, Xypex becomes a *solid integral membrane* that waterproofs and protects the concrete structure. When it is applied from the negative side of the hydrostatic

pressure, its chemicals can penetrate against high hydrostatic pressure and crystallize inside the structure, thus withstanding extreme hydrostatic pressure from any direction.

12. How does it stand up to harsh condition?

Xypex is not chemical specific, it is pH specific. When applied in accordance with its Standard Specifications, Xypex functions at 100% efficiency within the following conditions:

pH	-	3.0 to 11.0, in constant contact.
	-	2.0 to 12.0, in periodic contact.
Temperature Range	-	-32 ^{O}C to +130 ^{O}C constant.
	-	-185 ^{O}C to +1530 ^{O}C periodic.
Humidity	-	No effect.
Ultraviolet	-	No effect.
Oxygen Level (Oxidisation)	-	No effect.

13. Is Xypex Non-Toxic?

Yes, Xypex is approved for use on structure that contain potable water or foodstuffs by many certified laboratories and government agencies, a partial list is enclosed below for reference:

Authority	*Location*	*Approval Date*
NSF International	Ann Arbor, MI., USA	Aug. 26, 1998
Quality Assurance & Testing Centre 3	HCMC, Vietnam	April 16, 1997
National Sanitation Foundation (Int.)	North America	May 20, 1995
Health Department of Western Australia	Perth, Australia	August, 1995
National Research Centre	Egypt	May 14, 1994
State Health Institute	Czech Republic	June 06, 1992
Sydney Water Board	Sydney, Australia	Jan. 10, 1990
Mairie De Paris	France	July 17, 1989
Institute of Standards & Industrial Research	Singapore	Sept. 02, 1986
Water Research Centre	United Kingdom	June 25, 1986
Bostock Hill & Rigby	United Kingdom	June 11, 1986
Ministry of the Environment	Toronto, Canada	Sept. 18, 1984
Ministry of Public Welfare	Japan	Oct. 18, 1982
Health Services of Norway	Norway	Aug. 05, 1982
New York Dep. of Health	Albany, N.Y., USA	Mar. 24, 1982
Agriculture Canada	Ottawa, Ontario, Canada	Oct. 16, 1981
Virginia Dept. of Health	Richmond, Vancouver, Canada	Jan. 16, 1981
Federal Service of Public Health	Switzerland	Jan. 10, 1980

14. How long have XYPEX products been used in the world market and how is it compared with other crystalline barrier products?

Xypex is the Canadian manufacturer of crystalline barrier products since 1969. Comparing to other products claiming similar performances, Xypex's unique formula is much more potent. Its chemicals react with free lime, mineral salts, mineral oxides, un-hydrated and partially hydrated cement particles. By reacting with a broader spectrum of constituents, Xypex provides a superior fixed crystalline structure that stands up more effectively to both hydrostatic pressure and aggressive chemicals. Because of its proven self-healing capability by many prestigious laboratories worldwide, Xypex recommends its crystalline barrier products for concrete roof application, whereas other 'crystalline', 'capillary' or 'block pore' barrier manufacturers are reluctant to recommend their products for the same. The phrase "*Concrete Waterproofing by Crystallization*" is a registered Trademark of Xypex, which serves as an indication that Xypex is the original manufacturer of

crystalline barrier product. To this date, Xypex remains to be the only crystalline barrier manufacturer who can provide convincing photograghic evidence through scanning electronic microscope on the crystalline formation of its products. By 2001, Xypex products are already used in over 70 countries worldwide.

15. Is there a difference applying Xypex to new concrete as compared to old concrete?

Yes. The greener the concrete, the higher the efficiency of crystallization. Test conducted by Japan Xypex on 1-2 months old normal 300-700 kgf/cm^2 concrete detected Xypex crystal penetration at 5-10cm depth after 2-3 weeks, whereas, on 2-3 hours old normal 300-700 kgf/m^2 concrete, Xypex crystal penetration is detected at 25-36cm depth after 2-3 weeks. However, it is best to apply Xypex 24 hours after the concrete is placed in order not to absorb the moisture before the concrete reach its initial set. For well saturated old concrete, Xypex crystalline growth will also penetrate deep after a longer time frame.

16. Can Xypex waterproofing system be applied to concrete or clay masonry wall?

Yes. The standard coating method may be applied to concrete masonry wall even when it is a basement condition with high negative hydrostatic pressure.

For clay masonry wall, the standard coating may be applied to the cement render as long as the cement render is 2 ~ 3 parts sand to 1 part cement at 15mm or thicker. The higher the cement content, the more effective. An alternative option would be to plaster with an integral waterproofed render dosed with Xypex Concentrate Admix C-2000 or C-1000 and applied over a key coat of cement slurry mixed with Xycrylic Admix for increase adhesion. This application is recommended for above grade condition only, and is not recommended where there is constant negative hydrostatic pressure. Xypex's new *Flexible Cementitious Membrane* (FCM) system is designed especially for basement masonry walls & moving cracks. The FCM can be used as an independent system or in conjunction with integral waterproofed render for sealing construction joints, corners, and wall coves where slight movement is anticipated.

17. Is there a difference in Xypex's waterproofing to the roof and the basement?

As long as the structure is concrete, the effect of using Xypex products will not differ between civil engineering structures and building structures. Conventional waterproofing materials face the problem of durability in the case of roof waterproofing, and the necessity of double wall construction in the case of basement waterproofing. When using Xypex, brush or spray application on the concrete roof is sufficient but the maximum slump of the conrete should be at 12cm. However, standard requirement of expansion joint much be followed. For Basement, the double wall construction for the basement is not necessary when treated with Xypex.

18. What is the uniqueness of the Xypex protection to concrete?

When moisture escape from the newly placed concrete or when concrete is subject to thermal stress, micro shrinkage cracks are unavoidable. The merit of Xypex's crystalline system will reactivate its resealing ability upon the presence of moisture inside the cracks. With this built in *early detection and early remedy* capability, micro cracks are sealed and prevented from further deterioration normally caused by moisture together with other harsh environmental elements.

19. What alternative application is recommended to protect concrete at depth?

For new construction, Xypex can be sprayed or coated over the reinforcing steels before placing the concrete. Xypex crystals will grow from the inside of the concrete to the outside upon presence of moisture and by-products of the cement hydration. In the case to protect existing concrete from corrosion when repairing from the negative side, holes can be drilled deep into the concrete at predetermined spacing then follow by inserting Xypex Concentrate Dry-Pac deep into the holes. This will greatly reduce the time required for Xypex crystalline penetration to a required depth.

20. Can Xypex be applied to concrete containing Pozzolanic or Fly Ash materials?

Yes, Xypex can be applied to concrete containing up to 10% Fly Ash, pozzolanic, supplemental cementing materials, it will achieve 100% efficiency.

21. Are there any limitations re the nature of the concrete for Xypex to be effective?

The only limitation on Xypex is that it requires a10% minimum cement content per cubic meter in order to have enough by products of cement hydration available for the Xypex chemicals to react. Furthermore, the concrete must not be dosed with other waterproofing or repellent admixtures that would also occupy the pores and capillary tracts thus preventing the Xypex crystalline growth to fill the pores and capillary tracts completely. This is because other waterproofing or repellent admixture may not be solid or insolvable, when under extreme hydrostatic pressure or exposure to harsh environment or chemicals, these materials may deform or deteriorate and allowing the water to leak through.

22. Does Xypex chemicals increase the salinity of concrete?

The active chemicals in Xypex coating or admix combine with the soluble salt complexes in concrete to form new insoluble crystalline structures. This does not change the chemical or pH value of the concrete nor does it make the concrete more or less saline. The chemical nature of the concrete is maintained, the physical nature re the porosity is modified in that it is now waterproof.

23. What are the basic differences between Xypex verses conventional coatings?

Conventional coating can be thought of as a 'bandage' protection over concrete, whereas, Xypex can be thought of as an 'injection' treatment to concrete. The conventional coating does not improve the quality of concrete, when the coating fails, the concrete will leak. Experience have shown that spot repair to coating system is not effective because leaks are often difficult to locate and it often requires using more than one or different materials. It usually leads to an entire system overhaul in order to ensure better protection.

In the case of Xypex, the quality of concrete is improved and the Xypex chemicals remain domain inside the concrete. There is no coating thickness required, thus eliminating possibility of a coating failure. When shrinkage cracks occur, its crystalline growth will reseal the cracks upon contact with moisture. When there is structural crack, leaks and spot repair can be easily located and executed without sacrifice on quality to the system as a whole because the Xypex repair material is the same waterproofing material. It is a repair, waterproofing, and protection system for concrete.

24. Under what circumstances is use of Xypex not recommended?

a. When dealing with the rare case of calcium aggressive raw water environments, there is a limit what Xypex can do in this situation. The Xypex crystalline structure will plug up the capillary tracts and block intrusion but the effect of calcium aggressive water takes place across the surface of the concrete, not just the capillaries. Upon contact with concrete, this type of water physically leaches out the calcium from concrete and this is what causes the deterioration. Use of an inert material such as thermal plastic, epoxy or polyurethane coating is better.
b. In concrete that is dosed with organic waterproofing admixtures, Xypex can not develop 100% efficiency in penetrating the pores and capillary tracts that is already occupied by other organic gels. Upon extreme hydrostatic pressure, these organic gels will deform therefore giving way for the water to seep through. This cause a 'sweating' appearance on the concrete.

25. Concrete is water tight by theory, why should it still need waterproofing?

There are many site conditions and technical factors that prevent the concrete to be perfect as compare to a laboratory experiment. Even if the concrete is perfectly handled and placed, by its nature, temperature, hydration, improper curing, structural movements or exposure to the environments over time will development micro-shrinkage cracks. Micro-shrinkage cracks can also develop from restraint shrinkage forces around aggregates at 0.1 to 100 μm and that will increase with greater applied loads. Even if there is no micro cracks, water can still leak through the capillary tracts which is .01 to 0.1 μm. These are the residue of the originally water filled spaces and these effect the permeability of the concrete matrix.

CONCRETE DURABILITY AND PROTECTION

XYPEX products protect concrete in several ways:

1. Impermeability against liquids.
   - 50mm thick Xypex treated concrete has withstood hydrostatic pressure equivalent to 123.5 m head water. *This limitation is due to the testing apparatus, not the limit of Xypex*.
   - Xypex treated concrete is impervious to: water, chlorinated water, diesel, petrol and other petroleum products.
2. As the crystals are silica, which is a mineral and not an organic product, Xypex significantly increases the chemical resistance of concrete. Numerous tests have shown that Xypex treated concrete is not affected by a wide variety of aggressive chemicals.
3. Xypex protects concrete against chloride attack. The growth of Xypex crystals into the concrete will encapsulate the reinforcing steel. The concrete becomes impermeable and prevents further entry of chlorides, or other chemicals.
4. Xypex crystalline growth within the concrete reduces carbonation in concrete by a factor up to 40%.
5. The filling of capillaries within the concrete significantly increases the compressive strength. In Admix treated concrete, the increases in strength can be 20% to 50% depending on the design mix.
6. Xypex Concentrate Admix C-2000 promotes an extended hydration process within concrete thereby achieving its design strength at around 7 days.

OTHER XYPEX CONCRETE REPAIR PRODUCTS

1. **Flexible Cementitious Membrane (FCM)** is a two part system, including a latex-acrylic polymer component and a cementitous powder component designed for masonry structure, moving cracks, construction joints, and where elasticity is required.
2. **Patch'n Plug** is a fast setting non-shrink hydraulic grout for repairing concrete cracks and holes against water pressure. It can be used with Xycrylic Admix to increase bonding strength.
3. **Megamix I & II** is a new system of concrete repair for coating over concrete blocks and recapping over defective concrete surfaces that will increase its waterproofing capability.
4. **Xycrylic Admix** is a cement mortar fortifier designed for patching and resurfacing floor underlayments, spray and fill coats, industrial cement floors, highway and bridge deck repair. Imparts excellent water, chemical, weather resistance and reduces shrinkage cracks.
5. **Restora Top** products feature fast setting, with very high early strength and suitable for the repair of concrete roads and pavements, factory floors and other high wear areas.

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SUMMARIES OF XYPEX COATING TESTS

1. Evaluation of Water Tightness – GOST 12730.5-84. Moscow, Russia, Sept. 22nd, 1997

Public Corporation Orgenergostrol, Center of Technology and Quality, Nuclear Power Stations Engineering – Central Construction Laboratory. Moscow, Russia.

Concrete cylinders were cast 150 mm x 150 mm with a design water tightness of W2 or 2 atmospheres according to Russian Standards GOST 12730.5-84. Samples were treated with Xypex Concentrate at the rate of 1 kg per 1 m^2. GOST 12730.5-84 test procedures are utilized to determine "water tightness" or ability of a product to make concrete impermeable. The test methodology is similar to the European DIN 1048 procedures. Water pressure was applied to the negative side (opposite surface to the Xypex treatment) of the cylinder samples and the pressure was increased in increments over time.

Test Results: *The samples withheld the pressure of 12 atmospheres*.

2. Repairing of Heavily Cracked Reinforced Concrete Bridge Deck. Japan, Sept., 1996

Technical paper titled "Repairing of Heavily Cracked Reinforced Concrete Bridge Deck Slab From Underside", jointly presented by: Shigemichi Mori of The Construction Bureau of Chubu District of The Ministry of Construction; Yuzuru Kuramoto, Minoru Emilio Takagi of Japan Xypex Inc.; Moichi Horie of Aichi Institute of Technology; and Shushi Tanimoto of Tenox Inc., at the 51st Annual Meeting of the Civil Engineering Society of Japan. This report is documented with Scanning Electronic Microscope photographs taken at magnification of 1,000 times. Compressive strength test is per Japanese Standards JIS-A-1107 test procedure.

……This method using Xypex Concentrate has been employed in over a thousand applications. Most of these cases have been in a static environment without vibration or movement, but this test was on a dynamic moving structure……The Hokutoh overpass bridge on National Route 23 was built in 1972 ……with 40,000 large sized cars representing about 40% of the total traffic crossing the bridge everyday……Therefore many cracks measuring 0.1 to 0.2 mm in width have appeared in all directions of the concrete deck……Xypex Concentrate was applied to one of the sections, the other section was left untreated for reference purposes……"

"……In the group of samples to which Xypex Concentrate was applied, there are some specimen with initial leakage but the water flow gradually decreases and finally ceases……."

"……the Xypex Concentrate samples show on average a 28% increase in compressive strength compared to the reference……"

"……An increase of 'cement' crystals can be observed in the void of cracks in Xypex Concentrate treated sample……"

"From this experimental investigation, it was clear that the Xypex Concentrate crystalline treatment was effective in improving the durability of the concrete deck plates that are stressed by continuous and repeated load. It was confirmed that the cement crystals are increased in the cracks of the concrete bridge deck and hence a waterproofing effect has resulted……".

3. Resistance to Acid Attack Test. Japan, 1996

Technical Report for North-East District Committee of Civil Engineering Society of Japan titled "Chemical Durability of Cement Crystal Increasing Agent Applied Concrete by Ryuichi Oikawa of Department of Civil and Environmental Engineering, IWATE University. Japan.

Xypex-treated mortar and untreated mortar were measured for acid resistance after exposure to a 5% H2SO4 solution for 100 days. A measurement of the corrosion ratio for the Xypex-treated sample was 0.117, while the untreated sample measured 0.210. Xypex suppressed concrete erosion to 1/8 of the reference samples.

4. Evaluation of Water Tightness Test – GOST 12730.5. Moscow, Russia, June 14th, 1995

Public Corporation Orgenergostrol, Center of Technology and Quality, Nuclear Power Stations Engineering – Central Construction Laboratory. Moscow, Russia.

Concrete cylinders were cast 150 mm x 150 mm with a design water tightness of W2 or 2 atmospheres according to Russian Standards GOST 12730.5. Samples were moist cured for 28 days and then treated with 2 coats of Xypex modified to a thickness of 1mm per coat. Control samples were also moist cured for 28 days. GOST 12730.5 test procedures are utilized. The test methodolgy is similar to the European DIN 1048 procedures. Water pressure was applied to the negative side (opposite surface to the Xypex treatment) of the cylinder samples and the pressure was increased in increments over time. Test results for the untreated control samples produced the design water tightness index of 2 atmospheres. The samples treated with the Xypex Modified had the following "water tightness" indices:

3 days - 4 atmospheres	14 days - 8 atmospheres
7 days - 7 atmospheres	28 days - 8 atmospheres

5. Impermeability and Resistance to Pressurized Water Tests. Czech, July, 1994

Institute of Civil Engineering Technology and Testing. Presov Branch Office, Czech.

Test meets requirements of Czechoslovak State Industrial Standard CSN 73-1209 and CSN 73-1321. Tests were conducted on:

Gasoline	Diesel
Transformer Oil	Silage Juices
Pressurized Water	

"……it is possible to state that the coating material Xypex applied on a concrete surface enhance its resistance and it provides an effective protection (on all the liquids tested)……"

"……confirm the creation or growth od a crystalline formation of dentritic fibres which prevent the molecules of water from passing but allow the passing of air so that the concrete can breath……"

"……confirms the effectiveness of the coating material Xypex against pressurized water at a maximum pressure of 0.8 Mpa and 1.2 Mpa."

6. Permeability and Resistance Test to Crude Oil. Czech, August, 1994

Institute of Civil Engineering Technology and Testing. Presov Branch Office, Czech.

"……Xypex applied to concrete surfaces enhances their resistance and it provides an effective protection against permeability and effects of crude oil."

7. Test of Sealing Cracks & Repairing Leak by Brushing Method. Japan, June 1st, 1993

Kajima Building Research, Japan.

The purpose of this test is to confirm the effectiveness of Xypex Concentrate for sealing leaks in tunnel lining concrete. The test was performed at Kajima Building Research, Dept. No. 1, Lab. No. 1, with the attendance of The Department of Construction from Tokyo City Hall.

"With both samples, the leakage stopped in the end. Thus the effectiveness of Xypex in sealing leakage was confirmed……Xypex was proven to be durable enough for actual field use, since the leakage was stopped at 4.0 kgf/cm^2 (3.0 x 10^5 Pa) of pressure."

8. Permeability and Resistance to Exposure to Diesel Oil, Czech, February 15th, 1993

Czech University of Technology in Prague No. 02/93KI (Klokner Institute).

Xypex coated cylinders exposed to diesel oil and transformer oil under pressure of 14 kpa showed surface treatment stopped the penetration of diesel oil and/or transformer oil through the concrete.

9. Growth of Xypex Crystals in Concrete, Japan, September, 1992

Technical paper titled "An Enhancement in the Nature of Concrete with a Multiplicative Crystal Type Concrete Materials", presented by Yasuo Mitsuki, Member of the Faculty of Engineering, Hosei University, Japan, at the 46th Annual Meeting of the Civil Engineering Society of Japan. This report is documented with photographic evidence of Xypex crystal growth taken with Scanning Electronic Microscope, provided by Nikki Shoji Central Laboratory in Japan.

"……the applied ingredients penetrate and diffuse into concrete for a long time after application……and fills up the cracks and voids inside the concrete with multiplied crystals".

"……although the concrete itself has no permeability Xypex has penetrated and diffused into the concrete with a speed of over 30cm per year."

10. Concrete Freeze-Thaw Test, JIS-A-6204, Japan, December 25th, 1990

Building Material Test Center, Japan

The resonating frequency of both untreated and Xypex treated concrete samples were measured throughout 435 freeze/thaw cycles. At 204 cycles, the Xypex-treated samples show 96% relative durability compared to 90% in the untreated samples. At 435 cycles, the Xypex-treated samples measured 91% relative durability compared to 78% in the untreated reference samples.

11. Diffusion of ^{137}Cs in Cement Mortar. Japan, November 21st, 1989

Japan Atomic Energy Research Institute. JAERI-M89-211 (Low Level Radioactive Waste)

Test perform according to Japanese Industrial Standards - JIS-A-1202 (Specific gravity), JIS-A-1108 (Tri-axial compressive strength), JIS-A-1129 (Measurement of length change), and European Standards DIN 1048 (Permeability test method).

Treatment of cement mortar with Xypex coating was found to be effective to reduce diffusion of ^{137}Cs in the cement mortar. Xypex treated samples and untreated samples were subjected to a 5% H_2SO_4 solution for 100 days. A measurement of the "corrosion ratio" (ie. Ratio of final to initial mass) for the treated sample was 11.7%, while the untreated sample was 21.0%.

12. Slant Shear Test. Canada, August 12th, 1987

Hardy BBT Limited. British Columbia, Canada.

The object of the study was to determine the ability of Xypex Concentrate to bond new concrete to old. The ASTM C882-78 "Bond Strength of Epoxy Resin Systems Used With Concrete" test procedure was followed, except that the Xypex Concentrate was used as bonding agent.

13. Permeability Test. Ireland, July 26th, 1985

Institute for Industrial Research and Standards, Ireland.

"It can therefore be concluded that the application of 'Xypex' waterproofing compound resulted in a significant improvement in the resistance to water penetration of the concrete slabs tested……"

"Comparative tests illustrate the relative performance of the treated samples vis-à-vis the untreated samples improve further with time."

14. Durability of Marine Structures – Vancouver Sea Bus Terminal. Canada, 1985-1994

All Seas Enterprises Ltd. British Columbia, Canada.

Long term durability analysis of repairs of concrete marine structures treated with Xypex, reports favorably on under water inspection for deteriorations.

15. Concrete Block Permeability Test – DIN 1048. Germany, March 3rd, 1985

Amtliche Materialprufanstalt fur Steine und Erden (Official Institute for Material Testing of Stones and Soils). Clausthal-Zellerfeld, Germany.

"The hydrostatic pressure to be applicated according to DIN 1048 to the side opposite the coating was increased by 1 bar every 48 hours. By the time a pressure of 4 bar was reached, no penetration of moisture through the coating was to be stated…..did not show any damages nor water permeability of the Xypex Concentrate coating."

16. Chemical Resistance Test – Certificate No. 8103-1045. USA, June 24th, 1983

Pacific Testing Laboratories. Seattle, Washington State, USA.

Pacific Testing Laboratories meets the requirements of ASTM E-329 and is inspected periodically by the National Bureau of Standards. As a reference of their work, they are responsible for concrete & steel quality control testing for Washington Public Power System's nuclear stations at Hanford, Washington.

Test based on (modified) ASTM C-267-77. Studies were conducted on:

Hydrochloride Acid	Ethylene Glycol	Brake Fluid
Transformer (Mineral) Oil	Toluene	Pool Chlorine (Undiluted)

ASTM Designated C-267-77 "Chemical Resistance of Mortars" was modified for use in this project, utilizing seven different chemical solutions specified by the client. Total exposure time was 84 days (12 weeks) after specified curing. Untreated specimens were also subjected to the chemical resistance studies for comparison purposes.

Results of these studies indicated that exposure of Xypex treated specimens to various solutions did not reveal any significant ill effects on the Xypex coating. The compressive strength results following the chemical exposure period indicate an average 17.13 percent increase in strength of Xypex treated specimens over untreated, with the lowest result showing a 13.2% increase (Pool Chlorine) and the highest a 29.4% (Ethylene Glycol).

17. Water Impermeability of Concrete Test - ONORM B 3303. Austria, May 10th, 1983

Technologisches Gerwerbemuseum (Industrial Museum of Technology), Federal Higher Technical Education & Research Institute, Vienna, Austria.

Xypex-treated concrete samples were pressure tested to a maximum 7 bars (70 m water head) for 10 days. Test revealed that while 25 ml of water had penetrated the untreated samples, zero ml had penetrated the Xypex-treated samples. Test specimens were then broken and showed water penetration to a depth of 15 mm on untreated samples but no measurable water penetration on the Xypex-treated samples.

"……the test specimens showed no penetration of water."

"……the so far executed tests demonstrate that the concrete test specimens coated with Xypex have impermeability to water superior to uncoated ones."

18. Permeability Test – Certificate No. 8206-5010. USA, Sept. 21st, 1982

Pacific Testing Laboratories. Seattle, Washington State, USA.

Test was performed strictly per Army Corps. of Engineer's Specifications CRD-C-48-73.

"The results of the tests showed thet Xypex treated samples totally sealed themselves by the process of catalytic crystallization up to a pressure of 405 feet (123.5 m) of head water (175 PSI)" – *that was the limit of the testing apparatus*.

"The Xypex treated samples also exhibited leakage at each stage of increased water pressure but consistently followed decreasing leakage patterns approaching zero."

(This confirms Xypex is permanently catalytic as it proved the Xypex crystals re-activate at each stage of increased pressure.)

19. Permeability Tests. Canada, August 9th, 1982

Warnock Hersey Professional Services Ltd. Vancouver, Canada.

"……concrete samples treated with Xypex does not show any permanence of leakage in the permeability tests up to a pressure of 180 psi."

20. Water Impermeability of Concrete Test – DIN 1048. Germany, March 25th, 1980

Bautest – Corporation for Research & Testing of Building Materials, Augsburg, Germany.

Twenty cm thick Xypex-treated concrete samples were pressure tested up to 7 bars (70 m water head) for 24 hours to determine water impermeability. While the reference specimens measured water penetration up to a depth of 92 mm, Xypex-treated samples measured water penetration of zero to an average of 4 mm.

21. Permeability of Concrete Block Test. July 1st, 1980

Laboratories for Preparation and Methodology. Luzernerstrasse, Beinwil am See.

"This shows the Xypex coating results in a material – specific imperviousness that is closed to 7 x 10^6 times higher than that of the cement concrete block."

"The concrete block has a very low imperviouness. However, when covered with Xypex, compared to other concrete bound building materials, the imperviousness can be considered to be good."

22. Freeze-Thaw & De-icing Chemical Resistance Test-ASTM C 672. USA, August 7th, 1979

Twin City Testing and Laboratory Inc. Minneapolis, USA.

Test in reference to ASTM C-62-76 "Standard Test Method for Scaling Resistance of Concrete Surfaces Exposed to De-icing Chemicals":

Xypex treated samples restricted chloride ion concentration to below the level necessary to promote electrolytic corrosion of reinforcing steel. Visual examination of untreated panels after 50 cycles showed a marked increase in surface deterioration as compared to treated panels.

23. USA Standard No. N69-1967 "Protective Coatings for the Nuclear Industry".

Pacific Testing Laboratoratories. Seattle, Washington State, USA.

After exposure to 5.76 x 10^4 rads of gamma radiation, the Xypex treatment revealed no ill effects or damages.

24. Hydro Sulphuric Gas Testing. U.K.

Fullstop Technology Limited. United Kingdom.

"……after 150 hours testing said to be solution of hydrogen sulphide 14% volume at 23°C +/- 2°C……There is no defect and no attack is present. A slight discoloration is visible on small area."

25. Half Cell Test – M6 Freeway (Spaghetti Junction), Burmingham, U.K.

Fullstop Technology Limited. United Kingdom.

Half cell test showed that value In Xypex treated areas reduced to an average level of 230 millivolts.

XYPEX
VIETNAM

SUMMARIES OF XYPEX ADMIX TESTS

1. Investigation of Concrete Slabs Modified w/ Xypex Admix. Australia, December, 1998

University of New South Wales, Building Research Centre-The Faculty of the Built Environment. NSW, Australia.

"In Conclusion, the slab concrete modified with Xypex water-proofing admixture is in a good service condition after a four-year exposure period in a severe marine environment. This is indicated by the defect-free appearance, a slow chloride diffusion coefficient and the insignificant half-cell potential gradient over the slab surface."

2. Comparing the combination of Xypex Admix & Superplasticised concrete to concrete containing either Xypex Admix or Superplasticiser for set time, strength, bleed, volume of permeable voids and drying shrinkage. Australia, March 12th, 1998

Boral Construction Materials, Materials Testing & Environmental Services, Greystanes, NSW.

Testing showed that all samples containing Xypex Admix only, compared favorably, and in most instances improved the above properties of standard Superplasticised concrete, as well as concrete containing both Xypex Admix and super plasticiser.

3. Singapore Art Centre: The Esplanade-Theartres On The Bay. Xypex Admix Testing for Public Works Department. Singapore, March 24th, 1997

Test conducted by: Setsco Services Pte. Ltd., Singapore
Test supervised by: Taywood Engineering Ltd., Singapore

a) Test Aims

1. To determine the rate of water permeability through non-Xypex Admix treated concrete and Xypex Admix treated concrete at seven (7) bars at seven (7) days of water pressure
2. To determine if the addition of Xypex Admix and reduction of cement in a concrete mix could achieve design strength of accepted concrete mix.
3. To determine if Xyoex Admix treated concrete would exhibit a reduction in differentials in temperatures during hydration.

b) Setsco Results

XYPEX PERFORMANCE TEST ON G40 CONCRETE

Type of Test	Control G40 (410 kg/m3 cement content) Mix Results	Xypex in G40 (355 kg/m3 cement content) Mix Results
Water permeability at 7 days	No leakage occurred up to 4.2 bar. Water leakage occurred at 7 bar	No leakage occurred up to 7 bar
Average CUBE Compressive Strength		
At 1 day	18.5 N/mm^2	20.5 N/mm^2
At 3 days	31.5 N/mm^2	30.0 N/mm^2
At 7 days	41.5 N/mm^2	37.0 N/mm^2
At 28 days	54.0 N/mm^2	46.5 N/mm^2
At 56 days	58.0 N/mm^2	49.0 N/mm^2
Average CORE Compressive Strength		
At 7 days	39.5 N/mm^2	38.5 N/mm^2
At 28 days	42.0 N/mm^2	45.0 N/mm^2
Scanning Electron Microscopy (SEM) test	Normal concrete Matrix noted	Xypex crystals noted
Maximum Temperature	77 ^oC	69 ^oC
Temperature difference	23 ^oC	18 ^oC

c) Taywood Engineering Assessment of Results

The assessment of results are summarized as follows:

1. The Xypex mix appears to successfully restrict the water ingress under head pressure.
2. The Xypex mix shows comparable compressive strengths to the control mix, but with lower cement content.
3. Lower cement content has a beneficial effect on thermal gradients in large pours.
4. The inclusion of xypex in concrete does not appear to adversely affect the early strength gain, stripping times, etc. to any significant extent based on the data presented.

4. Water Permeability of Concrete – DIN 1048. Chile, November 06th, 1996.

DICTU S.A, Department of Engineering and Construction Management, Strength of Materials Laboratory (RESMAT). Santiago, Chile.

Concrete samples 120 mm thick containing Xypex Admix were tested with the same size reference samples for water impermeability. Samples were subjected to pressure for 28 days. Water totally permeated the untreated samples but no water penetration was detected in any of the Xypex Admix-treated samples.

5. Chloride Penetration into Concrete Containing Xypex. Australia, March, 1996

Mahaffey Associates Pty Ltd. Sydney, Australia.

"……From this testing it is apparent that concrete containing Xypex Admix will have better chloride diffusion resistance than concrete made with type SL cement, particularly if the concrete is given 7 days curing. Further, Xypex treated concrete performs significantly better than both plain cement concrete and concrete containing a pore blocking additive when tested using a standard full immersion chloride ion diffusion test. This suggests that there are applications where the durability of concrete for marine applications can be enhanced by the use of Xypex Admix in the concrete.

By observation of Xypex treated concrete used in the field, it is also apparent that the material has the ability to self-heal should cracking occur. This is a characteristic that is of the further benefit in concrete that is exposed to aggressive environments……"

6. Xypex Admix in Concrete. Australia, June 03rd, 1996

Boral Resources (Vic) Pty Limited. Australia.

"……the addition of Xypex at the manufacturer's specified dose rates will increase the compressive strength of our normal grade 32 concrete in the order of 16 Mpa……"

"……concrete containing Xypex becomes virtually impermeable."

"……results to hand indicate a possible reduction in shrinkage……"

7. JIS Chemical Durability Test. October, 1995

Japanese Utility Company, In-house Test Report. Tokyo, Japan.

Concrete samples containing Xypex Admix were tested against five samples containing other admixtures and against a control sample, to determine resistance to corrosion and deterioration caused by contact with aggressive chemicals. All samples were soaked in a 5% sulfuric acid solution at 20°C for six months. Various evaluations and measurements were assessed every month during the test period, including: photographic comparisons, relative dynamic modulus of elasticity, percentage change in length, weight and flexural rigidity. Although the Xypex Admix sample was subjected to acid conditions well outside its published range, the results confirmed Xypex with the best performance among the seven samples tested.

8. Compressive Strength of Cylindrical Concrete Specimens – ASTM C 39. USA, 1992

Kleinefelder Laboratories. San Francisco, USA.

At 28 days, the compressive strength test of the concrete containing Xypex Admix measured 7160 psi as compared to the reference sample at 6460 psi (a 10% increase).

9. Sulfuric Acid Resistance Test. USA, 1992-1993

Avile Engineering Corporation. Texas, USA. An independent materials testing laboratory meeting the requirements of ASTM E-329 and certified by American Association of Laboratory Accreditation.

Concrete samples containing Xypex Admix at different dosage rates (3%, 5%, and 7%) were tested against untreated control samples for Sulfuric acid resistance. After immersion in the Sulfuric acid, each sample was tested for weight loss on a daily basis until a weight loss of 50% or a definite response trend was obtained. The percentage weight loss of the samples containing Xypex Admix tested significantly lower than the control samples.

10. Permeability of Concrete Test. USA, June 25th – August 3rd, 1992

Aviles Engineering Corporation. Texas, USA.

Test apparatus modeled after Corps of Engineers Test No. CRD-C48-73. Tests conducted on cylinders control A and D, which were dosed at 3% Admix and 5% Admix respectively.

Test Results:

1. "After twenty four (24) hours of application of 150 psig applied Nitrogen pressure, the Standard (Control) Sample was observed to be moist and water had penetrated throughout the sample."
2. "After five (5) days (120 hours) of application of 150 psig applied Nitrogen pressure, no moisture was observed on Samples of Specimen A and Specimen D. After disassembling of the test apparatus, these two samples representing Specimen A and Specimen D, were cracked to allow visual observation and measurement of the depth of penetration of water into the test samples. Observations revealed a maximum depth of water penetration of 1.5mm into the the samples of Specimen A and Specimen D, with no apparent permeation of water into these samples. All tests for imperviousness to water were performed at a held pressure of 150 psig (350 water head)."

11. Permeability Test on Xypex Admix for Water, Gasoline, and Sulphuric Acid

Concrete Solidifications Inc. Texas, USA.

"Permeability tests were conducted as a comparison of Control (no Admix) to Admix enriched samples……Utilizing the standard "0.43 psi = 1 ft. Water Head Pressure", the following test and results were completed:

A. Impermeability to Water

1. Control (no Admix)	Pressurized to 43 psig (100 ft. water head) for 24 hours. Permeation 100% through Control Sample.
2. a. Moderate (w/ Admix)	Pressurized to 66 psig (153 ft. head water) for 72 hours. No permeation.
b. (w/ Admix)	Pressurized to 172 psig (400 ft. water head) for 120 hours. No permeation."

B. Impermeability to Gasoline

"Visual observation at the end of the recorded 14 hours revealed gasoline permeation throughout the entire untreated test sample and no permeation into the Admix added sample."

C. Acid resistance Test

Untreated cube, by visual observation, appeared to have a 10 fold degradation as related to the Moderate Admix added sample.

"……there appears to be considerable acid resistance displayed by the Admix added concrete sample, additional documentable tests are scheduled for completion."

12. <u>Resistance of Concrete to Harsh Environments-Ammonium Sulphate. Australia.</u>

Taywood Engineering Ltd. Perth, Australia.

Xypex Admix-treated concrete samples were immersed in an ammonium-sulpate solution and tested for “resistance in a harsh environment”. The performance of the Xypex-Crystalline-Technology was compared with five other concretes, including one containing a sulphate-resistant cement. Each of the test samples was cured for seven days and then placed in an ammonium-sulphate solution (132 g/l) for 180 days. The rate of corrosion was determined by measuring weight loss, and length change was noted on a weekly basis. The Xypex-Crystalline-Technology substantially improved concrete and tested very similar to the sulphate-resistant concrete. The Xypex Admix-treated samples also provided the highest level of protection as measured by change in length.

13. <u>Freeze/Thaw Durability Test – ASTM C 666. USA.</u>

Independent Laboratory. Ohio, USA.

After 300 freeze/thaw cycles, the Xypex Admix-treated samples indicated 94% relative durability.

14. <u>Compressive Strength of Cylindrical Concrete Specimens – ASTM C 39. Canada</u>

HBT Agra. Vancouver, Canada.

Concrete samples containing Xypex Admix at various dosage rates (1%, 2%, and 5%) were tested against an untreated concrete control sample. Compressive strength test results after 28 days indicated a significant strength increase in the samples incorporating Xypex admix. The compressive strength increase varied between 5% and 20% (depending on the Xypex Admix dosage rate) over that of the reference sample.