Presented to: ACSE Date: 26 MAY 2022

AGENDA

Chapter 1: (20 minutes)

Penetron product range suitable for water treatment plants.

- Penetron crystalline technology and how it works.
- Common applications of the Penetron system.
- Concrete test results with Penetron Admix.

Chapter 2: (15 minutes)

• Penetron system in concrete exposed to Biogenic Sulfuric Acids.

 Extended support to clients – Repair of defective concrete and protection of the newly poured.

Chapter 3: QUESTIONS AND ANSWERS

Hacene Balen



Presented to: CLIENTS AUSTRALIA Date: 26 MAY 2022

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Chapter 3: OULSTION

Hacene Balen

PRODUCT RANGE

Proven Performance

	WATERSTOPS		SEALANTS
PENETRON ADMIX SB	PENEBAR SW-55	PENETRON COATING	PENESEAL PRO RTU
PENETRON BIOMIC	PENEBAR SW-45	PENEPLUG	PENESEAL FH PS
	PENEBAR PRIMER	PENECRETE MORTAR	PENEGUARD
	STD PVC HYDROSTOPS	WATERPLUG	SUPERCURE HR
	SPECIAL PVC HYDROSTOPS	BLOCKSEAL MEMBRANE	SUPERCURE HR-30
		INDUSTRIAL SELF-LEV	SUPERFILM AA
		INDUSTRIAL SL PRIMER	
		PENETRON V/O PATCH	
		PENETRON CR-90	
		UPLUG	
		PENETRON ARC	

PRODUCT RANGE

Proven Performance



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Penetron crystalline technology and how it works.

Hacene Baleh

MAIN REASONS FOR CONCRETE DETERIORATION





- Biogenic Sulfuric Acid
- Biodeterioration
- Microbially Induced Corrosion (MIC)

PENETRON® SYSTEM How does Penetron Crystalline work?



ADVANTAGES OF THE PENETRON® SYSTEM

Main points to retain

- Penetron is a Technology & System dealing with any concrete >16MPa (Resi., comm., mining, tunnels, marine, bridges, precast,...)
- Integral waterproofing system.
- Protects concrete for life.
- Resistance to high hydrostatic pressure (20 Bars / 200m).
- Resists chemical attacks (pH 3 –11).
- Allows concrete to breathe and blocks moisture ingress.
- Reduces chloride penetration, sulphate and carbonation.
- Self-heals cracks up to 0.5mm.
- Approved for use in potable water applications (AS-4020).
- Fully compliant with the AS-1478.1-2000.

PENETRON CRYSTALLINE IN ACTION On actual projects in Sydney



PENETRON ADMIX TRACER

Making Invisible Crystalline Technology Visible

MICROSCOPIC IMAGES OF THE CRYSTALS

Formation of crystals in progress

Magnification x100.0



Magnification x500.0



PENETRON CRYSTALLINE IN NEW CRACKS Within one week





HOURS

PENETRON ADMIX LAB TESTS

Penetration of water under pressure - NBR 10.787/94 (April 2007) Lab: IPT (Technological Research Institute of Sao Paulo State), Brazil



4 weeks after start of water pressure



Applied water pressure:

	1 st and 2 nd day	:	0,1 MP
•	3 rd day	:	0,3 MPa

4th to 7th day

0.7 MPa

20 MPa concrete



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TYPICAL APPLICATION DETAILS



PENETRON SYSTEM TYPICAL APPLICATION DETAILS



WATER TANK TREATMENT

PENETRON SYSTEM TYPICAL APPLICATION DETAILS



SEWAGE TANKS

TYPICAL APPLICATION DETAILS



PVC Walls Penetron Admix SB Penebar SW Waterstop

PVC WALLS IN BASEMENTS

TYPICAL APPLICATION DETAILS



Shotcrete Walls

Penetron Admix SB Penebar SW Waterstop PVC Hydrostops

SHOTCRETE IN BASEMENTS

TYPICAL APPLICATIONS

PENETRON ADMIX IN MARINE

Because of the high chloride level in the sea water and the air, every precast element was treated with Penetron Admix.

The splash zones could now resist the severe concrete deterioration.



Sydney Seaplane Terminal at Rose Bay, NSW.

TYPICAL APPLICATIONS

PENETRON ADMIX IN MINING

PENETRON ADMIX was used to construct the foundation slabs of the processing plant and storage bunker, and the pile caps of the logistics building.



Mining complex in Solikamsk, Russia

TYPICAL APPLICATIONS

PENETRON ADMIX IN MINING & WATER TREATMENT

Treat concrete tanks to treat the acidic discharge water from 3 local mines and remove the toxic pollutants from the mine water before it is funneled into local rivers (Chloride, salts).



Advanced Water Treatment Facility Mannington, WV, USA

TYPICAL APPLICATIONS

PENEPLUG, PENETRON & PENECRETE MORTAR REMEDIATION

Repaired 1km worth of cracks in the concrete floors and walls in all storage tanks to ensure the long-term durability and sustainability of the concrete structure even in harsh environments.



Gold Coast Desalination Plant, QLD

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Chapter 3: OUESTION

Hacene Baleh

TEST RESULTS OF B80 B2, C2, AND CONTROL

			TABLE	E 3: Test Resul	ts			Mahaffey Associates				
- HAS	TRIAL MIX NUMBER			1A	1B	2A	2B	2022				
	Міх Туре				•	1		L L Ord T				
A SAME	Date mixed/Cast	Chl	oride I	on Dif	tusion	– Base	ed on F	ick's 2 nd Law				
	Mix Designati B80) mix (]	B2 exposi	ure)	Without	t Activati	on: From	n 100 years to 137 years				
	compressive s				With Ac	ctivation:	From	n 100 years to 170 years				
	Mar	ine mi	x (C2 exp	osure)	Without	t Activati	on: From	n 100 years to 135 years				
	Water Permea				With A	ctivation:	From	om 100 years to 295 years				
			28 (activation)	15	10	3	1	A THE WERE				
	Chloride Ion Diffusion	x10 ⁻¹² m ² /s	56	1.77	1.46	0.94	0.85	LAD H.				
		x10 11173	56 (activation)	1.94	1.41	1.23	0.85					
Carlon Carlo	Resistivity	kΩcm	28	34.2	39.4	77.9	90.3	CARL A T				
	Accelerated	200	28	4.8	4.1	-	-					
	Carbonation		28 (activation)	4.9	3.8	-	-					
. Y. 7.	Chloride lon Content	%	-	0.009	0.007	0.006	0.007					
5.53	Sulphate Ion Content	%	-	0.44	0.43	0.36	0.37					

WESTCONNEX TUNNEL IN SYDNEY – 3A & 3B

Hanson Concrete Test Results



Property	Т	est method	Age or deflection	Unit	Requirement		Result	States and a state of the state								
								Property	Test Method	Age or Deflection	Unit	Requir ^{mt}	Result			
Density		AS1012.12	28 days	kg/m ³	≥2250		2407	Early age	restinetiou	6Hr	MPa	2.5	3.28			
Permeability		DIN 1048	28 Days	mm	≤25		9	Compressive		12Hr	MPa	4	9.18			
Shrinkage (Maximum)		AS 1012.13	3 weeks / 8 weeks	μm	560 / 800	D∳	470 / 600	Strength	Spec. note 1	24Hr	MPa	8	15.00			
										7	MPa	30	62.50			
Devenueter		To at weath ad	Value		tesult C				Cast Sample: AS1012.8.1 or AS1012.9	28	MPa	40	80.60			
Parameter		lest method	value	K			ertificate	Compressive		90	MPa	>40	95.00			
Asid saluble ablavida iau								Strength		7	MPa	>26.1	46.17			
Acid soluble chloride ion (kg/ m³)	content	Calculation	≤ 0.4	0	370 C		alculation		Cored Sample:	28	MPa	>34.8	70.17			
									AS1012.14	90	MPa	>34.8	83.33			
Sulphate Content (% by r acid soluble SO ₃)	mass of)	Calculation	≤ 4.0 %	1.	89 %	Ca	alculation			XX						

Lining shotcrete with Penetron Admix & micro-synthetic fibres to enhance Fire Resistance

N B

WESTGATE TUNNEL VIC

BORAL concrete Test Results



Ny (1)		TYP	BELOV	*	- C		-(2-P03		B	luild so	mething VOL1) grea	a ^w C OF PER	MEA	ABLE VO	DIDS	BOI	RAL	Γ
SOP 14 (C2-PI	»4) /CO	MPRESS	SIVE ST	RENG	TH O	F CON	ICRE	TE C	YLIN	IDE	RS								
	Deta	ails of Sa	ampled	Conc	rete	Con	crete	Spe	cim	ens	and	Re	sults						
	Date & Tin Batched Truck No Load / F	ne Time Sampled Time Moulded Prog. Load	d Plant Code 1 Docket No Product Code	Grade(MP Agg(mm Slump/S Design	'a) Air(%)) Compac Super(mm) Measure	Specimer t Ident. d	Dimer (m Avg. Diamete	nsions im) er Height	Density (kg/m³)	Curi Initial (hrs) (ng T Std (days) (ype of Cap	Date of Ag Test (da	je Stre ys) (M	ngth Marks F IPa) N	Fail Loc Mode	ation & Rem	arks	
03—Ş	10/02/20	12:10	N/A	S50	2.0	L1579A	99.9	201	2340	27	1	G	12/02/20	2	17.0	NS	Sampling A	S 1012.1 CI	òa
	12:00	12:15	L1579	14	XV	L1579B	99.9	201	2360		2	G	13/02/20	3	29.5	Ν	VRA50A8	emp. (°C): 2	trop
	N/A		N/A 1	180/N/A	220/N/A	L1579C	100.1	201	2340		3	G	14/02/20	4	44.0	N	VIVEOUEO	MINO - I ene	uon
					1	L1579D	100.1	201	2340		6	G	17/02/20	7	57.5	N			
1					L	1579E	99.9	201	2360		30	G	12/03/20	31	82.5	N	1		
					L	1579F	100.2	202	2340		30	G	12/03/20	31	82.0	1	N		
					Ľ	1579G	100.0	200	2340		55	G	06/04/20	56	87.5		Ν		
					L1	1579H	100.1	200	2340		55	G	06/04/20	56	84.0	Е	N		
					11	5791	100.3	201	2360		90	G	11/05/2	0 9'	1 83.5	E	N		
					1.1/	5701	00 Q	203	2340		90	G	11/05/2	0 9	1 86.0	-	N		
						57014	55.5	200	2040		140			.0 .0	00.0				
					L15)/9K	100.2	201	2340		119	0	3 09/06/2	20 1	20 89.5)	N		
					L15	79L 1	100.1	201	2340		119) (3 09/06/	20 1	20 89.0	0	Ν		
TAILS			502 1221		<u>Σ</u>			<u>85</u>	-		3.32		14 2/03/2	2020	300	210	0 20	290	5
DRIVEN PILE -				The second second							1	2	21 9/03/2	2020	340	312	2 31	6 320	د
	\sim	\sim	ELEVATION - UZ-P ELEVATION - C2 STALE	103 (AS SHUWN)		\sim	ſ	EOR C(-12		28 16/03/2	2020	348	324	4 32	4 330)
		(1: 100		0.007				AP	3A		35 23/03/	2020	368	344	4 34	4 350)
			ALLEY AND	JACOBS			urban	BRIDGE OVER I	MARIE		QUE		12 30/03/	2020	384	300	0 30 4 36	0 3/1 22 27	
			PERALS DR. N. YOURS ADD V AND	IS161001		west cate	unnel II V.Y	D.T.					19 0/04/2	2020	400	304	1 30 2 38		
				ES.	CAP	PIN(G BF	EAN	/IS /	AN'	DC	\mathbf{O}	LUM	NS	436	40	4 41	12 42	

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- protection in a second second

Chapter 3: OUESTIO

Hacene Baleh

Biodeterioration of Concrete



Microbially Induced Corrosion (MIC) takes place when sulfuric acid, produced by a family of bacteria, eats away the cement paste leaving the aggregate and reinforcement steel exposed.



Biodeterioration of Steel



Acidithiobacillus Ferrooxidans (i.e. iron eating bacteria) eats away at the exposed reinforcement steel.



Biodeterioration Process



Anaerobic vs. Aerobic Biofilms



Aerobic Biofilm

- Consists of Sulfur Oxidizing Bacteria (SOB)
- $H_2S + 2O_2 + Thiobacillus \rightarrow H_2SO_4$
 - > < 3% O₂ (below water) = No Thiobacillus
 - > 5 10 $\frac{10}{6}$ O₂ = H₂SO₄ forms (ideal conditions)
 - $> 18\% O_2 = No concentration of H_2S$

Anaerobic Biofilm (0.3 – 1.0mm thick)

- Consists of 3 layers
 - 1. Neutral layer on concrete
 - 2. Sulfur Reducing Bacteria layer (SRB)
 - 3. O_2 containing layer in contact with sewage.

H₂S: Sulfuric gas

 $H_2SO_{4:}$ Biogenic Sulfuric Acid





Biodeterioration of Concrete

Anaerobic vs. Aerobic Biofilms







BioMIC Testing

Modified ISO 22196 Test Methods

Verifying the antimicrobial effectiveness of BioMIC against Thiobacillus bacteria.

1. Concrete samples were aged to reduce surface pH, creating suitable conditions for bacterial growth.

- 2. Tests started when pH 6.5 (+/- 0.5)
- 3. Samples inoculated with T. novellus were incubated for 24 hours.
- 4. Sample surfaces were tested.



BioMIC killed 99.9% of the Biogenic acid producing, Thiobacillus bacteria within 24 hours

Protection Range: Penetron System





Penetron Admix + BioMIC Shotcrete Application





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Chapter 3: OULSTIONS

Hacene Baleh

REPAIR OF WET CRACKS - Typical

STEPS

1. Repair the dry & damp cracks first, then move to the wet ones.

2. Cut 20W x 35D key minimum in a dove-tail shape along the cracks.

3. Apply 15mm **PENEPLUG** to stop the water leak within 30 seconds.

4. Brush PENETRON slurry over PENEPLUG and the inside of the key.

5. Fill the rest of the key with **PENECRETE MORTAR**.

SAN BEARD SHE SHOW SHE

6. Finish the repair with one coat of **PENETRON** slurry.

NOTE: For dry cracks, no need to use **PENEPLUG**.











CONCRETE DAMPNESS & DURABILITY REPAIR

STEPS

1. If there are any cracks, remediate them first following the steps in the previous slide.

2. Clean the wall or slab with high pressure water.

3. Mix **PENETRON** powder with water, just enough to apply within 20min.

4. Brush 2 coats of **PENETRON** slurry over the entire wall or slab on damp substrate.

5. Apply water for 2 weeks to accelerate the growth of the crystals within the concrete.









PENETRON SYSTEM TYPICAL APPLICATION DETAILS

Penetrating Waterproofing Sealant PENESEAL PRO RTU

Sealing of high trafficable Walkways PENESEAL PRO RTU

ROOFTOPS, BALCONIES, SWIMMING POOLS, WALKWAYS

Head Contractor

THANK YOU

Any Questions? Let's discuss your projects

We provide Warranties

Presenter:

Hacene Baleh

National Technical Manager B.E, M. Eng, C.Mgnt, MIEAust <u>Hacene@Penetron.com.au</u> 0427 286 998 Presented to: ACSE 26 May 2022

