



IPA INJECTION TECHNIC SYSTEMS and SOLUTIONS

Cracks and cavities in structures are a generally present problem in construction engineering. Faulty-parts of this type can impair the stability as well as utilization of the building and can clearly shorten the „life-expectation „ of a structure.

The injection-systems of IPA offer proven and innovative solutions. For more than thirty years IPA was engaged in the development and improvement of injection-systems. Competent advice and practical experience gives you security in application of IPA injection-systems.

The IPA injection-systems include:

- Sealing injection of leakage in structures also according to ZTV Riss 93
- Sealing injection against water under pressure also according to ZTV Riss 93
- Coupling injection with dry cracks to achieve or restore the strength of parts of the structure or the entire structure.
- Coupling injection with moist cracks
- Coupling injection in masonry by closing or filling cracks and cavities to increase the strength and / or to seal the structure
- Sealing acrylic-resin-gel injections
- Preventive sealing of construction-joints by injection-hose method

The investigation of the cause for damage is normally the beginning of the designing of sealing works or repairs. Only if the causes for damage are known, the selection of the matching injection-system can be decided effectively.

Epoxy-systems are selected when high strength is the objective.

Coupling injections of structural parts with inferior strength are more and more carried out with mineral injection-systems, which can be adjusted by the selection of the cementing agents, aggregates and additives according to the requirements.

A sealing injection of defective parts,



which are continuously under movement (e.g. highway bridges), takes place with PU-resins, which harden to a permanently elastic end product. The various solution-possibilities are described in the following with the IPA injection-systems. These are completed by the broad service-performances of IPA technicians during damage-investigation, planning of repair works and their execution.

IPA Injection Systems

Sealing		Cementitious	
Waterstopping	Flexible	Coupling	coupling
<i>IPAPUR VM</i>	<i>IPAPUR IF</i>	<i>IPANOL IH</i>	<i>IPA Injection Mortar W</i>
<i>IPAPUR VM1k</i>	<i>IPAPUR IF/Z</i>	<i>IPAPOX IH/E</i>	<i>IPA Injection Mortar THS</i>
<i>IPAPUR VM/Z</i>	<i>IPAPUR SP</i>	<i>IPAPOX IH/L</i>	<i>IPA Injection Slurry</i>
		<i>IPAPUR IS</i>	<i>IPA PM Powder</i>

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Sealing Injection

System IPAPUR IF

IPAPUR IF - a 2-comp. PU injection resin, seals cracks and defective parts - permanently flexible.

Typical defects

Cracks, cavities and defective parts, water bearing (without pressure) moist or dry with crack width larger than 0,1

System IPAPUR IF		
Component	Product	Quantity
Injection Material	IPAPUR IF	0,5-1kg/rm
Injectors	IPA Injection packer Ø 12mm	2 pc per width of structure
Injection machine	IPA HDL 4	
Tämpering	IPANOL IH + IPATIX Tixotropic	0,5kg/rm 0,05kg/rm
Plug Mortar	IPA NEX stopfmörtel	acc. to application
Cleaner	IPA Aktivreiniger	

mm

Objective of the procedure

Sealing, closing and coupling with limited elasticity

Method

- Determine orientation of crack or cracks
- Place 13-mm dia. drill holes alternating at either side of crack so as to pierce it as centrally as possible; space drill holes approx. 15-20 cm.
- Blow out the drilling fines



- Fill cracks more than 0.3 mm wide using IPATOP SM patching mortar
- Tension the IPA injection packers.
- Thoroughly and homogeneously mix components I and II of IPAPUR IF.
- Screw check valve nipple on to the lowest packer and use an IPA high-pressure injection machine to inject until resin appears at the next open injection packer above .
- Screw check nipple on to the next packer and continue injecting.
- Once the packer on top has been reached, reinject all packers once more; immediately remove any leaking resin.
- Conclude any injection job by removing



IPAPUR IF Advantages

- @ Absolutely solvent free
- @ Low viskose
- @ No shrinkage
- @ Permanently elastic, no longterm hardening
- @ Low foaming in contact with water
- @ High elasticity
- @ Long potlife
- @ Suitable in contact with potable water

the packers, if necessary, neatly filling the drill holes.

System alternatives:

IPAPUR SP a fast reacting elastic two component Pu injection-resin, mixing ratio 1:1 by volume, is used for waterproofing injections with 2 comp. injection machines. Due to IPAPUR SP's immediate plugging reaction in contact with water, a water stopping preinjection with IPAPUR VM is often not necessary.

IPAPUR SP/L System like IPUR SP with longer pot time - for single component injection machines.

Injections according to ZTV

Riss

If a permanently flexible injections, according to ZTV Riss is required IPAPUR, IPAPUR IF/Z will be used (Test Report from Technical university of Braunschweig and Essen is available upon request)

Table of Polyurethane Injection Resins

Product name	IPAPUR VM	IPAPUR VM1K	IPAPUR VM/Z	IPAPUR IF	IPAPUR SP/L, SP	IPAPUR IF/Z
Density kg/L bei 23°C	1,10	1,13	1,128	1,08	1,1	1,05
Viscosity mPas	280	300	300	170	180	180
Mixing Ratio	9:1	1-komponentig	1-komponentig	3:1	SP/L 3:1 SP 1:1	1:1
Shore A-Hardness	50-60	50-60	55	45	50	50
Pot Time at 23°C	2h*, 10s**	2h*, 40s**	2h*, 45s**	90min	SP 10min SP/L 30min	70min
Lowest Application Temperature	2°C	5°C	8°C	5°C	5°C	8°C

* Pot Time in hours ** Reaction starts immediately after contact with water

Sealing Injection Water under pressure

System IPAPUR VM/IPAPUR IF

With the system IPAPUR VM/IPAPUR IF, cracks and defective-parts under hydraulic water pressure are sealed in an elastic way.

IPAPUR VM serves as water-stopping-system.

System IPAPUR VM/IPAPUR IF

Component	Product	Quantity
Injection Material	IPAPUR VM	0,25kg/rm
	IPAPUR IF	0,5-1kg/rm
Injectors	IPA Injection packer Ø 12mm	2 pc per width of
Injection machine	IPA HDL 4	
Tämpering	IPANOL IH + IPATIX	0,5kg/rm 0,05kg/rm
Plug Mortar	IPA Plug Mortar	
Cleaner	IPA Aktivreiniger	

Typical defects

Cracks, cavities and faulty-parts, under hydro-water-pressure with crack width over 0,1mm

Objective of the procedure

Sealing, closing and coupling with limited elasticity

Typical applications

Seal against pressure-water

- in tunnel-construction
- in excavations
- in the below-grade
- at water reservoirs

Processes

The water-stop-system IPAPUR VM consists of resin (Comp.I) and the accelerator (Comp. II). By variation of the mixing ratio the foaming reaction in contact with water can be adjusted from a few seconds to some minutes.



Before the injection the Comps. I and II have to be mixed with electric stirrer intensively.

The following procedure for injecting cracks under water pressure is recommended:

- Drill 13 mm holes on alternating sides along the crack, spacing them (depending upon crack width) every 15 -20 cm and angling them approx. 45° so as to have the boreholes pierce the crack at points corresponding to about half the thickness of the wall.

- Use pressurized water or an air gun to flush or blow drilling fines out of the holes.

- Fill cracks having a width of more than 0,5 mm. To do so, use IPATOP SM or IPA cement-based filler; with high water-pressure, add IPANEX R

- Tension the IPA injection packers.



- Once the filler has cured, place a check valve on to the lowest valve and start injecting.

- Begin by injecting IPAPUR VM, which will foam if in contact with water, using a IPA high-pressure injection machine to do so.

- Upon foaming inject the Polyurethane Resins IPAPUR IF through the same valves or packers in order to close the open-celled pores of the IPAPUR VM foam.

- Upon curing, remove packers if any, and close remaining boreholes

System-alternatives

IPAPUR SP a fast reacting elastic two component Pu injection-resin, mixing ratio 1:1 by volume, is used for waterproofing injections with 2 comp.

IPAPUR IF IPAPUR VM	@ Absolutely solvent free
ADVANTAGES	@ Low viskose
	@ Permanently elastic, no longterm hardening
	@ High foaming factor
	@ Foaming starts immediately after contact with water
	@ Long pot time
	@ Stops water under pressure
	@ Suitable for potable water

injection machines. Due to IPAPUR SP's immediate plugging reaction in contact with water, a water stopping preinjection with IPAPUR VM is often not necessary.

IPAPUR SP/L System like IPAPUR SP with longer pot time - for single component injection machines.

IPAPUR VM1K single component foaming-injection-resin, reacts immediately in contact with water

Injections according to ZTV Riss 93

Injection resin IPAPUR IF/Z

IPAPUR VM/Z serves as a water-stop-system.

Test Report TU Braunschweig and TU-





Bonding Injection

System IPANOL IH

Component	Product	Quantity
Injection Material	IPANOL IH	0,5-1kg/rm
Injectors	IPA Injection packer Ø 12mm	2 pc per width of
Injection machine	IPA HDL 4	
Tämpering	IPANOL IH + IPATIX Tixotropic	0,5kg/rm 0,05kg/rm
Plug Mortar	IPA Plug Mortar	
Cleaner	IPAPOX Reiniger	

System IPANOL IH

With IPANOL IH, a 2-component injection-resin on epoxy-base cracks and defective parts are sealed by a rigid bonding injection

Typical defects

Cracks, cavities and faulty-parts, water-leading, moist or dry, with crack widths over 0,1mm

Objective of the measure

Procedure for a rigid bonding injection of a composite-cement floor having cracks and hollow space in between:

- Determine and mark the hollow-parts and cracks in the cement floor
- Drill into the hollow-parts with min. two 13mm borings (2nd borehole is for pressure release)
- Place 13 mm dia. drill holes alternating



at either side of crack so as to pierce it as centrally as possible; space drill holes approx. 15-20 cm.

- Blow out the boring dust with a compressed air-pistol
- Screw check valve nipple on to the packer and use an IPA high-pressure injection system to inject premixed IPANOL IH until resin appears at the next open injection packer.
- Screw check nipple on to the next packer and continue injecting.
- Once the all packers have been injected, reinject all packers once more; immediately remove any resin protruding.

After hardening of the resin (approximately 12h), the injection-packers are to be removed and the borings if necessary will be closed with patching mortar.

System-Alternatives IPAPOX IH/E

For finest cracks (until 0,03mm) and for low pressure injection with surface packers. IPAPOX IH/E also serves as a primer for coatings on moist substrates

IPAPOX IH/L

Very low-viscous injection-resin with long pot-time.



IPANOL IH Advantages

- @ Absolutely solvent free
- @ Low viskose
- @ High adhesion on moist and wet substrates
- @ High shear- and compressive strength
- @ Good penetration into voids and cracks
- @ Good adhesion on dry and wet concrete and steel even underwater
- @ Suitable in contact with potable water

The pot time can be adjusted by accelerator-addition to the requirements. It is applicable with low temperatures (0°C) and as a binding system for the redevelopment of sewage pipes with the inliner method.

IPAPUR IS/IPA SILICATE INJECTION RESIN

For rock consolidation, consolidation and sealing of excavations, for tunnel sealing against high water pressure

Table of Injectionsresins on Epoxybase

Product name	IPANOL IH	IPAPOX IH/E	IPAPOX IH/L	IPAPUR IS	IPAPOX IH/R
Density kg/L bei 23°C	1,08	1,08	1,07	1,10	1,12
Viscosity mPas	270	170	270	350	500
Mixing Ratio	3:1	3:1	3:1	2:1 (Vol. Teile)	2:1
Pot time at 23°C	40min	40min	60min	45min	15min
Compressive Strength N/mm ²	89,4	77,8	75	50-60	80
Flex. Strength N/mm ²	31,8	75,6	45	25-30	30
Adhesive Strength N/mm ²	6,28 ¹ , 4,22 ²	Break in concrete	Break in concrete	2,0	Break in concrete
	¹ Dry glueing ² Moist glueing				



Bonding Injection Water under pressure

System IPAPURVM/IPANOL IH		
Component	Product	Quantity
Injection Material	IPANOL IH	0,5-1kg/rm
	IPAPUR VM	0,25kg/lfm
Injectors	IPA Injection packer Ø 12mm	2 pc per width of
Injection machine	IPA HDL 4	
Tämpering	IPANOL IH	0,5kg/rm
	IPATIX Tixotropic	0,05kg/rm
Plug Mortar	IPA Plug Mortar	
Cleaner	IPAPOX Cleaner	

System IPAPUR VM/IPANOL IH

With IPANOL IH, a 2-component injection-resin on epoxy-base, cracks and defective parts under hydraulic pressure are sealed by a coupling injection. IPAPUR VM serves as water-stopping-system.

Typical defects

Cracks, cavities and faulty-parts, pressure-water-leading, moist or dry, with crack width over 0,1mm

Objective

Sealing, closing and rigid coupling

Typical applications

- Sealing against pressure-water
- in the tunnel-construction
- in excavations
- in below construction
- at reservoirs of liquids

Procedures

The water-stop-system IPAPUR VM consists of resin (Comp.I) and the accelerator (Comp. II). By variation of the mixing ratio the foaming reaction in contact with water can be adjusted from a few seconds to some minutes.

- Determine and mark orientation of cracks.
- Drill 13 mm holes on alternating sides along the crack, spacing them (depending upon crack width) every 15 - 20 cm and angling them approx. 45 ° so as to have the boreholes pierce the crack at points corresponding to about half the thickness of the wall.
- Use pressurized water or an air gun to flush or blow drilling fines out of the holes.

- Fill cracks having a width of more than 0,5 mm. To do so, use IPATOP SM with high water pressure, add IPANEX R.
- Tension the IPA injection packers.
- Once the filler has cured, place a check valve on to the lowest valve and start injecting.
- Begin by injecting IPAPUR VM, which will foam if in contact with water, using a IPA high-pressure injection machine to do so.
- An subsequent injection with IPANOL IH using the same valves or packers in



order to close the open pore-structure of the Pu-foam is necessary to achieve a durable effective sealing and to get a bonding connection.

- When you injected the highest valve, you have to reinject beginning with the lowest valve. Afterwards all leaking resin is immediately to be removed. IPAPUR VM and IPAPUR IF will be injected with IPA-HDL-4 –high pressure injection pump.
- The injection-works are completed by removing the injection-packers and if necessary the drill holes have to be patched.

IPANOL IH
IPAPUR VM
Advantages

- @ Absolutely solvent free
- @ Low viskose
- @ Coupling injection with high adhesion on wet
- @ High foaming factor
- @ Foams within seconds after contact with water
- @ Suitable even under water
- @ Stops water under pressure
- @ Suitable in contact with potable water

System-alternatives

IPAPOX IH/E

For finest cracks; primer on moist substrates

IPAPUR IS/IPA SILICATE INJECTION RESIN

For rock-injections, tunnel consolidation and sealing of excavations against pressure-water with 2K injection-machineries

For rock-injections, consolidation and sealing of excavations against pressure-water with 2K injection-machines.





Injection of Masonry

System IPA mortar-injection Objective

In order to increase stability, or because of other constructive requests, cavities and cracks in masonry have to be closed.

System IPA Injectionsmortar		
Component	Product	Quantity
Injection Material	IPA Injection-	1,5-2kg/rm
Injectors	IPA Injectors Ø 25mm IPA Fittings 3/8 "	4 pcs/rm
Injection machine	IPA Worm conveyor press	
Tämpering	IPA Cement Patch	4 kg/rm 4 kg/rm
Plug Mortar	IPA Plug Mortar	
Cleaner	Water	

seal and connect the masonry, so that the bearing strength is restored.

Selection of the injection-material

An important factor during the design of the composition of the injection-material is the selection of the binders. The wall- or plaster-mortars of older buildings, like churches etc. often consist of high degrees of gypsum, which in contact with ordinary Portland cement can initiate the deleterious expansion due to sulphate/cement reaction, that can totally destroy the structure.. In order to take the proper selection of the

IPA Injection Slurry Advantages	
	@ Good ability of penetration into cracks and voids
	@ Low viscose
	@ No shrinkage
	@ Long pot time
	@ High flexible and compressive strength
	@ No segregation
	@ Good adhesion on mineral substrates
	@ Physiologically harmless
	@ Increase of mortar quality by addition of IPANEX or IPANOL IH



injection-grout, it is advised by IPA to plan masonry -, mortar - and plaster-analyses in assistance with the IPA laboratory-service.

Application-areas:

- Filling of cavities and cracks in masonry, structures, vaulted culings, foundations etc
- Restitution of a uniform structure of a two sheeted masonry with inner insulation layer to prepare the installation of an additional horizontal-barrier by injection method.
- Filling of hollow building blocks for negative side waterproofing.
- Filling of porous concrete (for example To assure by controlling reaction time and scope of the boreholes a seedless primary sealing zone

Since masonry as generally known has inferior, compressive, flexible and shear strength, filling with mineral grouts normally is sufficient. It is aimed, to fill,



Table of IPA Injectionsmortars				
Produktname	IPA Injection mortar W	IPA Injection mortarTHS	IPA Injection Slurry	Injection mortar* with IPA PM Powder
Density kg/L at 23°C	1,85	1,6	1,65	1,8
Viscosity at 23°C	80s	80s	60s	80s
Pot time at 23°C	40min	60min	40min	45min
Compressive Strength N/mm ²	38	18	40	40
Flexible Strength N/mm ²	7	4	8	8
Volume Change %	+3-5	+3%	0	+3-5%
*Mortar with 50kg cement 50kg Sand 0,1-0,4mm and 1kg PM Powder				



Injections with Acrilique Gels

System IPACRYL GEL		
Component	Product	Quantity
Injection Material	IPACRYL GEL	0,5kg/rm 10-20kg/m ²
Injectors	IPA Injectionspacker Ø 12mm	2pcs per width of structure
Injection machine	IPA 2 comp. Injectionsmaschine	
Tämpering	IPANOL IH + IPATIX	0,5kg/rm 0,05kg/rm
Plug Mortar	IPA Plug Mortar	
Cleaner	Water	

concrete made of crushed brick as aggregate) for the consolidation and/or sealing

- Filling of cavities under concrete-plates, caused by settlement or flushing out.

Procedures:

Injection-materials:

IPA supplies the additive IPA PM POWDER for site-mixed grouts or ready mixed injection grouts.

Crack Injection at Masonry

After the course of the crack, the width of the wall and the crack are determined the holes for the IPA Injection Valve Ø 25mm will be drilled. Then the injectors are installed and the injection begins. Dry cracks, should be preinjected with DURIPAL. The crack filling injection takes place with pure cement suspensions with IPA PM Powder admixture or with IPA injection grouts.

Pre-injection with fissured masonry to prepare the installation of horizontal barrier by injection method

By analyses, the scope of the fissures is determined in the masonry. According to demanded height, the area is bored linear or in an adequate raster. After the boring dust was blown out, the injectors are installed. The filling of the cavities takes place in accordance with the above mentioned procedure.

When the injection-material gets stiff , the borings are opened with a steel bar for the subsequent injection of either Jektipal or Jektipal EM12 as a horizontal barrier to prevent damp rising

humidity.

System-alternatives

IPATOP LIQUID, IPANEX, IPANOL IH IPANEX or IPATOP Liquid can be added to reduce the viscosity of injection grouts at the same W/C level. Segregation is substantially reduced, with improved pumping properties.

With addition of 4% of IPANOL IH to the grout the compressive strength can be improved by up to 70% the flexible strength by up to 100%.

System IPACRYL GEL

The composition of system Ipacryl Gel is based on the 3rd generation of raw materials, which eliminates the disadvantages of former Gel types. The special characteristic of this injection material consists in the fact of its ability to bind water physically up to 50 % of its own weight. IPACRYL Gel can be injected to areas, always in contact to water. The viscosity of IPACRYL Gel, which is similar to water, allows the penetration of finest cracks and capillaries, inaccessible with other injection resins.. The reaction time can be adjusted to the requirements, from a few seconds to 1-2 hours.

Typical defects

Cracks, cavities and faulty parts under permanent contact to water.

IPACRYL GEL Advantages

- @ Absolutely solvent free
- @ Very low viscose
- @ No shrinkage
- @ Permanently elastic, no longterm hardening
- @ Volume increase in contact with water
- @ Elasticity
- @ Pot time adjustable
- @ Suitable in contact with potable water

Objective

Sealing, closing limited flexible bonding

Curtain Injections

Curtain injections are sealing procedures, which can be carried out safely with the newly developed IPACYL Gel. Curtain injections are waterproofings applied from negative side, but working as a positive side waterproofing. With this method, slabs walls or even overhead slabs can be sealed by injection method. With curtain injections IPACRYL Gel has the following functions:

- To push back or bind present water
- To shield consecutive injection material of present water
- To solidify the adjacent soil (secondary sealing zone))
- To permit the formation of a primary sealing zone





Injection Machines

IPA Screw Conveyor Pump

Sturdy electrically driven low-pressure-injection-pump with a remote control to regulate speed and forward and reverse direction, for low pressure injection (max. 20bar) of mortars, grouts and liquids, slurries and resins.

Two Component High pressure-injection-machine

The IPA-2K-Injection-Pump is a discontinuous variable injection machine for dosing, mixing and injecting of two component-materials. It was specially designed for injection of IPACRYL GEL and Ipa Silicate injection resin which



because of their extremely short pot-time of 30 seconds, cannot be applied in a 1-component-machine.

IPA HDL4 High Pressure-Injection-machine

High pressure pistons injection pump, with motor operated by compressed air - for injections of low to medium viscosity media like Polyurethane-resin, Epoxy-resin, acrylic resin with long pot-time (min. 20min).

Hand-injection-pistol

Small compressed air driven, high pressure-injection pump for low-viscous injection-resins with long pot time.



IPA Injection machines

Product name	HDL4 High pressure injection	2 Comp. High pressure injection	Worm Conveyer Press	Handinjection-pistol
Motive power	Compressed air	Compressed air	220V current	Compressed air
Output pressure bar	30-400	0-150	0-20	20-350
Pressure ratio	42:1	28 : 1	-	50:1
Air requirement	250L/min	500L/min	-	50L/min
Delivery	2,5l/min	6L/min	0-12L/min	1,5ccm/stroke
Volume of delivery Container	6L	self priming pump	60L	1L
Weight kg	18	35	65	2,5

Preventive Sealing

Sealing of construction Joints by Injection Hose

Predimax injection system for preparation of waterproof, gastight and/or frictional-joint connections. Injection hose for pressing of materials for structural seals and/or materials for preparation of frictional-joint sealing (in connection with reinforcement assured by customers at building site). Predimax hose system for injection of materials containing plastic, ultrafine cement, foamed resin and acrylate.

The injection hose is delivered ready to meet structural conditions or shall be made ready at building site and then fixed to the ground by means of some hose clamps (do not tie to any reinforcement bars). Upon hardening of concrete, grout with the suitable components of building materials. A slotted envelope surrounds the inner hose. The pressing material passes to outside through the slots between the inner hose and the envelope.

Injection

With IPA high pressure injection HDL4 will be injected according to the requirements. Suitable injection materials are: IPAPUR IF, IPAPUR VM, IPANOL IH IPACRYL Gel, IPA Injektionsleim

