32. Pull-off adhesion test of Brantho-Korrux ”3 in 1” according DIN EN ISO 24624

Substrate	Coating	Value	0-Value	Remarks
Steel ST37	BK ”3 in 1”	11,3 13,1	11,9 N/mm^2	Cohesion fracture (B)
Aluminium, degreased	BK ”3 in 1”	11,2-12,9	11,8 N/mm^2	Cohesion fracture (B)
Alu + BK ”3 in 1”	BK ”3 in 1”	8,1- 8,3	8,7 N/mm^2	Cohesion fracture (B)
2 pack Epoxy	BK ”3 in 1”	9,9-10,6	10,3 N/mm^2	Cohesion fracture (B)
Epoxy + BK ”3 in 1”	BK ”3 in 1”	7,9- 9,6	8,9 N/mm^2	Cohesion fracture (B)
2 pack PUR	BK ”3 in 1”	9,1-11,2	10,2 N/mm^2	Cohesion fracture (B)
PUR + BK ”3 in 1”	BK ”3 in 1”	8,0- 9,3	8,8 N/mm^2	Cohesion fracture (B)
2 pack Acrylic	BK ”3 in 1”	8,6-10,4	9,6 N/mm^2	Partly loss of adhesion
Acrylic + BK ”3 in 1”	BK ”3 in 1”	7,4- 9,9	8,5 N/mm^2	Partly loss of adhesion
Alkyd resin	BK ”3 in 1”	7,8- 8,8	8,4 N/mm^2	Cohesion fracture (B)
PVC coating	BK ”3 in 1”	8,0- 9,7	8,8 N/mm^2	Cohesion fracture (B) Partly in the PVC coating Partly in BK ”3 in 1”
Steel + BK ”3 in 1”	2-C. Epoxy	2,8- 3,3	3,1 N/mm^2	Cohesion fracture (B)
Steel + BK ”3 in 1”	2-C PUR	2,8- 3,3	3,1 N/mm^2	Cohesion fracture (B)

Rating:

The minimum adhesion strength of 2 N/mm^2, recommended for maintenance of steel construction, is clearly surpassed by BK ”3 in 1” for all tested substrates; the measured values are equal to a pull-off force
of approx. 90 kg/cm^2 painted substrate. In practically all tests Brantho-Korrux ”3 in 1” showed excellent adhesion to the substrate, at extreme forces the coating film showed a cohesion fracture (when overcoated with 2-component products the optimal cohesion is reached after at least one week).

Test results after more than 10 years experience in practise

with corrosion resistant, metal protective coating

Brantho-Korrux ”3 in 1”

INSTITUT FÜR KORROSIONSSCHUTZ DRESDEN GmbH
Privatwirtschaftliche Forschungseinrichtung
(independent research laboratory)

TÜV PRODUCT SERVICE

Corrosion protective
Free of heavy metals
Free of mineral acids

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Roosendaal The Netherlands

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30. Experience with Brantho-Korrux ”3 in 1” on various plastics

We are willingly to supply, upon request a detailed table, comprising a wide variety of plastics. The table also contains recommendations for the surface preparation.

By far the best results are obtained on hard plastics, alike:

ABS ((passenger car grills), GRP (lorry roof boxes, switch-(cup)boards, PS (cheap sheet-moulding-compound articles, PC (Plexiglas), Hard PVC (window frames, pipes), Hard-PUR (front spoilers for lorries, busses and trains) and many others.

We advise you not to apply the coating on the following plastics:

Soft-PUR (spoilers), soft-PVC (sheeting and covers), PE and PP (plastic buckets, rain-butts, compost-butts, etc.).

Brantho-Korrux ”3 in 1” offers excellent durability on all tested and in daily praxis used insulation-foams. An excellent adhesion is obtained when **Brantho-Korrux ”3 in 1”** is applied on the foam, but also the opposite, if **Brantho-Korrux ”3 in 1”** is used as anti-corrosive primer and serves as bond between the substrate and the foam.

Subject tests were composed and carried out carefully, however, they are no warrantee for the results in every single application. All users should test the suitability for specific cases. Above results are to be used as an orientation, and should avoid time consuming testing and misuse of the product.

31. Adhesion of Brantho-Korrux ”3 in 1” on previous, old coatings

Tested according DB (German Rail) TL 918300 Page 93 T2 item 4.1 (Cross-cut/ pull of method)
and according DIN EN ISO 2409 (Cross-cut adhesion test with Tesa tape test)

	Result	
Previous coating	Cross-cut	Cross-cut adhesion test
Alkyd resin	No failure	Gt 0
PVC-combination	No failure	Gt 0
2 pack Epoxy	No failure	Gt 0
2 pack Polyurethane	No failure	Gt 0
2 pack Acrylic	No failure	Gt 0-1
Brantho-Korrux ”3 in 1”	No failure	Gt 0

29 Test results

Brantho-Korrux ”3 in 1” on moist steel

Test	Test results on Steel 37, blasted to Sa 2½		
Cross-lapped brush application dry film thickness 60 – 100 µm	Dry substrate, slight condensation	Moist substrate	Moist/wet substrate
Drying according DIN 53150 at 20º C and 65% relative humidity			
T 1*	20 min.	30 min.	45 min.
T 2*	75 min.	2 hrs.	2 hrs.
T 3*	3 hrs.	4 hrs.	3 hrs.
T 4*	< 24 hrs.	< 36 hrs.	< 36 hrs.
Adhesion Acc. DIN 53151	Gt 0	Gt 0	Gt 0
Corrosion resistance according DIN 53167 Salt-spray test (without undercutting)	480 hrs.	480 hrs.	480 hrs.
Resistance to condensation (2-coat application) acc. DIN 50018	30 cycles	30 cycles	30 cycles
Surface inspection	Homogeneously semi-gloss Uniform free of errors	Semi-gloss free of errors slightly unequal	Surface disturbances due to small craters

Rating:

According this test, **Brantho-Korrux** ”3 in 1” may be used as a heavy duty corrosion resistant coating on slightly damp substrates. Dependable on temperature and relative humidity slight deviations in drying times will occur.

* Explanation:
T 1 = tack free, T 2 = dry to touch, T 3 = dry to handle, T 4 = fully cured.

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1. Cross cut adhesion test according DIN EN ISO 2409

(also according previous DIN 53151)

… an empirical test for judging of the adhesion, the brittleness and cohesive properties (7 days respectively 4 weeks after application of the coating film)

Substrate, Dry film thickness	Cutting distance	Value	Result
Pickled steel panels			
50 µm, 100µm, 150 µm, 190 µm	1 mm	Gt 0	best possible result
,, ,, ,, ,,	2 mm	Gt 0	,,
,, ,, ,, ,,	3 mm	Gt 0	,,
Blasted steel panel, C Sa 2½ Average blast profile RA 12,5			
80 µm, 120µm, 150 µm	1 mm	Gt 0	best possible result
80 µm, 120µm, 150 µm, 240 µm	2 mm	Gt 0	,,
,, ,, ,, ,,	3 mm	Gt 0	,,
Manually prepared steel panel, C St and P St 3			
80 µm, 240µm	2 mm	Gt 0	best possible result
,, ,,	3 mm	Gt 0	,,
Smooth steel panel			
60 µm, 120 µm, 160 µm	1 mm	Gt 0	best possible result
,, ,, ,,	2 mm	Gt 0	,,
,, ,, ,,	3 mm	Gt 0	,,
Hot dip galvanised steel panel			
50 µm	1 mm	Gt 3	not acceptable
120 µm	1 mm	Gt 1-2	good
120 µm	2 mm	Gt 1	(very) good
Aluminium panel, (Al Mg 3 and Al 99,8)			
40 µm	1 mm	Gt 1	(very) good
80 µm	1 mm	Gt 0	best possible result
80 µm	2 mm	Gt 0	,,
Copper, brass, stainless steel			
60 µm, 80µm, 120 µm	1 mm	Gt 0	best possible result
,, ,, ,,	2 mm	Gt 0	,,
Polystyrene, glass			
30 µm, 60 µm	1 mm	Gt 0	best possible result
PVC-profiles, GRP panels			
40 µm	1 mm	Gt 1	(very) good
60 µm, 80 µm	1 mm	Gt 0	best possible result
60 µm, 80 µm	2 mm	Gt 0	,,

28. Resistance to condensation and moisture

In combination with increased exposure, alike salt (Sodium Chloride) and exhaust fumes (Sulphur dioxide) according DB TL 918 300

	Dry film thickness according DIN: 240 µm			
	Surface preparation			Required result acc. DB TL918 300
	Sa 2½	St 2	St 3	
1. 20 Cycles NaCl test				
every 2 h. –15° C saturated NaCl-solution plus 22 h constant condensation climate				
- Degree of blistering	m 0 / g 0	m 0 / g 0	m 0 / g 0	m 0 / g 0
- Degree of corrosion	Re 0	Re 0	Re 0	Re 0
- Undercutting at scratch	0 mm	0 mm	0 mm	< 3 mm
- Loss of adhesion	0 mm	0 mm	0 mm	< 3 mm
- Cross-cut adhesion	Gt 0	Gt 0	Gt 0	Gt < 1
2. 30 Cycles DIN 50018 KFW 2,0 S				
Condensation - varying climate including 2% Sulphuric dioxide atmosphere				
- Degree of blistering	m 0 / g 0	m 0 / g 0	m 0 / g 0	m 0 / g 0
- Degree of corrosion	Re 0	Re 0	Re 0	Re 0
- Undercutting at scratch	0 mm	0 mm	0 mm	< 3 mm
- Loss of adhesion	0 mm	0 mm	0 mm	< 3 mm
- Cross-cut adhesion	Gt 0	Gt 0	Gt 0	Gt < 1

23. Elongation (E-Modul-test)

…a high flexibility means a minimum of stress and subsequently means long service life of the coating.

”After a comparative test of 12 one-component coatings, Brantho-Korrux ”3 in 1” belonged to the very best materials tested, both before and after weathering.” (Test values 353/2060)

24. Pencil hardness test, scratch resistance (according Wolff-Wilborn)

… in order to test the surface hardness (Pencil hardness, Testing apparatus Type 291, Angle 45º, Pressure 7,5 N)

Degree of hardness: 6 H

25. Sward Rocker Hardness test

…in order to establish the surface hardness (Model 240)

Sward hardness value: 6.9

26. Loss of gloss by weathering

…in order to relatively establish the gloss-retention, wearing, weathering resistance scrub-resistance and wash resistance. (Measured with a refracto-meter according DIN 67530 respectively ASTM D 523, Measuring angle 60º , 6 weeks exterior weathering)

Degree of gloss before weathering:	54.1
Degree of gloss after weathering:	47.3
Loss of gloss:	6.8
Loss of gloss (percentage):	12.6%
Best value in comparison with eight primers and topcoats for coating aluminium)	

27. Colour change by weathering

…in order to test the long-term colour retention and weathering resistance (measuring method: DIN 5033 and CIE-Standard; Calculation acc. DIN 6174, DIN 6167; Measuring geometry 0º/45º, Standard light source C)

SE: 2.14
Yellowing: 1.13

2. Salt-Spray test according DIN 53167

in conjunction with DIN 50021 SS

… accelerated test with exposure in order to investigate the corrosion resistance of a coating system
(after a 3 weeks drying period after date of application)

Dry film thickness	Rating after exposure DIN 53167 – Undercutting	DIN 53210 – (surface)-rust	DIN 53209 – Blistering	DIN and ISO 2409 Cross cut adhesion
After 96 hours				
40 µm	0 mm	Re 0	m 0 / g 0	Gt 0
60 µm	0 mm	Re 0	m 0 / g 0	Gt 0
80 µm	0 mm	Re 0	m 0 / g 0	Gt 0
After 120 hours				
40 µm	0 mm	Re 0	m 1 / g 2	Gt 0
60 µm	0 mm	Re 0	m 0 / g 0	Gt 0
80 µm	0 mm	Re 0	m 0 / g 0	Gt 0
After 240 hours				
40 µm	3-4 mm	Re 0	m 2 / g 4	Gt 0
60 µm	1-2 mm	Re 0	m 1 / g 4	Gt 0
80 µm	0 mm	Re 0	m 0 / g 0	Gt 0
120 µm	0 mm	Re 0	m 0 / g 0	Gt 0
180 µm	0 mm	Re 0	m 0 / g 0	Gt 0
After 480 hours				
60 µm	1-5 mm	Re 0	m 2 / g 3	Gt 0
80 µm	1 mm	Re 0	m 0 / g 0	Gt 0
120 µm	0 mm	Re 0	m 0 / g 0	Gt 0
180 µm	0 mm	Re 0	m 0 / g 0	Gt 0
After 600 hours				
80 µm	1 mm	Re 0	m 0 / g 0	Gt 0
120 µm	0 mm	Re 0	m 0 / g 0	Gt 0
180 µm	0 mm	Re 0	m 0 / g 0	Gt 0
After 740 hours				
80 µm	3 mm	Re 0	m 1 / g 4	Gt 0
120 µm	2 mm	Re 0	m 1 / g 4	Gt 0
180 µm	0 mm	Re 0	m 0 / g 0	Gt 0
After 1000 hours				
240 µm	0 mm	Re 0	m 0 / g 0	Gt 0

Rating:
If applied in sufficiently dry film thickness Brantho-Korrux ”3 in 1” offers excellent corrosion resistance.

3. Chip-/splinter test according DIN 53155

…in order to establish the flexibility of coatings. Tests were carried out on steel, aluminium and galvanised steel.

Coating film	Result	Rating
40 µm d.f.t., after 2 days	1.2	Very flexible; Not weak or tattered Also not friable/brittle
80 µm d.f.t., after 2 days	1.2	
40 µm d.f.t., after 21 days	1.3	Not sufficiently flexible anymore
80 µm d.f.t., after 21 days	1.2	Very flexible (see above: after 2 days)

4. Mandrel bending test according DIN EN ISO 1519

…in order to establish the flexibility of coatings (resistance against checking or peeling), when painted panels are bent 180º around a mandrel.

1 mm steel plate, 12 mm mandrel: No damages at 60 µm, 120 µm or 180 µm dry film thickness
0.3 mm steel plate, 4 mm mandrel: No damages at 80 µm respectively 240 µm dry film thickness

5. Erichsen penetration test according DIN EN ISO 1520

…in order to establish the flexibility of a coating.

No damage (fracturing, checking or peeling) at 60 µm, 120 µm 180 µm or 240 µm dry film thickness up to a penetration of 9.5 mm, for technical reasons (metal fracture) test stopped.

6. Corrosion-condensation-resistance-test in changing climates containing sulphur dioxide according DIN 50018-SFW 0.2 S

…in order to test the corrosion resistance in humid climates.

No damage after 30 cycles at 150 µm dry film thickness and up

See also Item 28 on page 10

19. TÜV Approval U 98 02 14153 001

Examination carried out and Certificate provided regarding:
Corrosion resistance, environmental compatibility, user friendliness and quality assurance.

Fundamentals:
TÜV PG 049, DIN 50021, DIN 53151, DIN 50017, DIN 50017 T1 (supporting), DIN 53210, RAL-UZ 18 (supporting).

20. Health & Safety rating

a) regarding the legislation of food stuff

Tested according the following directives and requirements of the Federal Ministry of Health in Germany:

1. XL-lacquers and coatings for foodstuff reservoirs and -packaging.
2. Coating materials for the application of paint films for production equipment, including equipment and machines that may have contact with victuals due to their function.

Result:
Brantho-Korrux ”3 in 1” remains within the health standards according the “Hygienic examination of the German law for victuals”.

b) Fast to salivation and perspiration according DIN 53160

”Fast to salivation and perspiration” and therefore suitable for painting coloured toys and playground equipment, on which subsequently may be chewed or sucked, and direct contact with the skin may occur.

21. Corrosion resistance quality

According extensive testing and examination of the Deutsche Bahn AG (DB = German Rail), Brantho-Korrux ”3 in 1” offers at least equal excellent corrosion resistance on manually prepared substrates as the ”ancient” approved red-lead coatings.
(Material no.: 672.05 according TL 918 200 T2).

22. Aggravated artificial weathering acc. DIN 53231

Xeno test apparatus 150 S, 1000 hours, 1000 W / m^2
Rel humidity 60 – 80 %, Synchronisation (versus black) approx. 65º C

Examined colours: RAL 3009, RAL 6011, RAL 5007, RAL 7035, DB 601

Colour difference, as prescribed, < 3.5 AE between exposed and non-exposed specimen.

17. Recoatability according DIN 53221

established at 20º C and 65% relative humidity

Primer	Topcoat	Interval time	Surface defects	Cross-cut adhesion test
”3 in 1”	”3 in 1”	½, 1, 2, 3, 6, 12, 24 hours	0	Gt 0
”3 in 1”	”3 in 1”	2, 7, 14, 30, 90 days	0	Gt 0
”3 in 1”	Edel-Lack	1, 2, 3, 6, 12, 24, 48, 168 hours	0	Gt 0
”3 in 1”	S-Glasur	3, 6, 12, 48, 168 hours	0	Gt 0
”3 in 1”	Nitro-cellulose	6, 12, 24, 48, 168 hours	0	Gt 1
”3 in 1”	2-c-Acrylic	Dependable on type, not within 24 hours	mostly 0	After 1 week Gt 0
”3 in 1”	2-comp.-PUR/Epoxy	Dependable on type, not within 24 hours (avoid speedy drying epoxies)	mostly 0	mostly Gt 0
”3 in 1”	1-c-PVC	½, 1, 3, 6, 12, 24, 48, 168 hours	0	Gt 0
”3 in 1”	DB page 75	½, 1, 2, 3, hours 1, 2, 7, 14, 30, 90 days	0 0	After 3 days Gt 0
”3 in 1”	DB page 77	½, 1, 2, hours ½, 1, 2, 7, 14, 30, 90 days	0 0	After 3 days Gt 0
Alkyd	”3 in 1”	At first after 1 week No problems with old alkyd	0	Gt 0
1-c-PVC	”3 in 1”	1, 6 hours.; 30, 180 days	0	Gt 0
2-c-PUR	”3 in 1”	3, 30, 180 days	0	mostly Gt 0
2-c-Acrylic	”3 in 1”		0	Gt 0

18. Recoatability with 2-component PUR and 2 component Epoxy coatings

Dry film thickness Brantho-Korrux ”3 in 1” : 80 µm, recoated after 7 days with 2-pack-PUR and 2-pack-EP and tested after 7 days:

- No wrinkling blistering or cracking
- Cross-cut adhesion value according DIN EN ISO 2409: Gt 0
- Pull-off adhesion according DIN EN ISO 2464:
  Values between min. 2.8 and max. 3.3 N / mm^2
  Average value: 3.1 N / mm^2

7. Abrasion resistance according DIN 53233, similar to ASTM 968-51

…Examination of the abrasion resistance of a coating with 4 x 5 kg (=20 kg) fused corundum.

Dry film thickness 80 µm, colour Brown-red, semi-gloss
Result: Valuation A (flat, coating film not removed, pore free).

8. Impact resistance (shot blasting test) according DIN 53154

…in order to establish the ability of a coating to resist regular exposure to repeating impact of small particles. (Panels from UST 1405 steel according DIN 1623, 80 µm dry film thickness).

1. Panels from UST 1405 according DIN 1623, 80 µm dry film thickness:
   up to 8.500 shot particles: rating A
   up to 9.000 shot particles: rating D
   this means approx. 110 shot particles / 1 µm film thickness
2. At 240 µm d.f.t. on Sa 2½ blasted and St 2 respectively St 3 prepared panels no loss of adhesion or chipping after being exposed to 10.000 shot particles.

9. Chemical resistance according DIN 53168-B

Chemical	Solution	Duration	Temperature/Remark
Salt water	5 %	240 hrs.	25º C.
Cooling fluid	0.5 %	720 hrs.	20º C. (pH value 8-9)
VARIDOS KK	2.5 %	720 hrs.	20º C. (pH value 10-11)
Anti-freeze Glythermin NF	50 %	720 hrs.	20º C.
Transformer oil	100 %	720 hrs.	20º C plus 4 x 60º C.
Diesel oil / Fuel oil	100 %	720 hrs.	20º C.
Transmission oil	100 %	720 hrs	20º C. plus 2 x 80º C.
Hydraulic oil	100 %	720 hrs.	20º C. plus 4 x 80º C.
Universal lubricating grease	100 %	720 hrs.	20º C. plus 4 x 60º C.
Mineral oil mix: A20 / NP II	100 %	120 hrs.	20º C.

In all cases there is no visible alternation of the coating film, both in immersion and on the interface (no loss of gloss, no blistering, no softening, no loss of adhesion).

10. General resistance – Tables

Examination according DIN 53168-B during at 20º C. 480 hrs.

"Household" chemicals	Very good
Salt solutions	Good / very good
Inorganic weak acids	Acceptable
Inorganic strong acids	Limited
Weak alkaline solutions	Good / acceptable
Strong alkaline solutions	Acceptable / limited
Lead free petrol	Good (short term only)
Concentrated alcohol	Not
Sea water	Very good
Transformer oil / Hydraulic oil	Good
Transmission oil / Diesel oil	Very good
Biological diesel oil	Good (short term only)
Condensation (high humidity)	Very good
Bird droppings (pigeons)	Good
Wood pulp	Very good
Molasses	Very good
Sulphuric acid 40 % solution	Not
Potassium Hydroxide 25 % solution	Not

11. Temperature resistance (dry heat)

- Repeatedly changing from + 70º C. to –20º C., did not affect the coating.
- Repeatedly heating up to 150º C., did not affect the coating.
- Heating from 200 up to 300º C. caused, dependable on colour, slight tot stronger colour changes (no colour change could be noted for brown-red) – subsequent loss of adhesion was not observed, the warm/hot coating film is weaker/softer.

12. Drying times according DIN 53150

… in order to establish the speed of drying of a coating film (60-80 µm).

T1 = 15 min.	T2 = 75 min.	T3 = 150 min.	T4 = < 24 hrs.

* Explanation: T 1 = tack free, T 2 = dry to touch, T 3 = dry to handle, T 4 = fully cured

13. Sag resistance

… to establish from which (wet) film thickness the coating starts to show sagging. Free of sagging applied on a vertical glass panel:

Colour	RAL no.	Dry film thickness	Wet film thickness
Brown/red	3009	up to 120 µm	240 µm
Blue	5010	up to 120 µm	240 µm
Grey	7032	up to 130 µm	260 µm
White	9010	up to 150 µm	300 µm
Red	3000	up to 150 µm	300 µm
Dark aluminium	9007	up to 220 µm	>400 µm

Remark: do not recommend this film thickness to be applied in one coat.

14. Pendel-surface hardness test acc. DIN 53157 (friction of surface)

… to establish the mechanical surface friction of coatings.

ca. 75 µm		ca. 100 µm	
7 days 23º C.	Aged at 60º C	7 days 23º C.	Aged at 60º C
73 sec.	93 sec.	40 sec.	54 sec.

15. Degree of gloss according DIN 67530 (Surface gloss)

Grey	80 µm	20º = 5 %	60º = 33 %	85º = 49 %
RAL 7032	100 µm	20º = 7 %	60º = 39 %	85º = 61 %

Classification according NCS:	semi-flat to egg shell	11 - 59
Depends on colour:	e.g. yellow, orange, red = 11 – 29,	white = 39 - 59

16. Flammability behaviour according DIN 4102-1

Meets the requirements of Building Class B2