

Technical report

Klabex Laboratory

Project title: Water borne epoxy-acrylic
hybrid enamel

Project number: K20-024

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Purpose

To formulate a one-component, glossy water-based epoxy-acrylic hybrid enamel easy-to-brush compatible with universal colourants based on Synthapox H-1040 resin.

Initial considerations

Synthapox H-1040 resin is recommended for use on concrete floors, due to its particle size (70-110 nm) and its adherence to common substrates.

It has good chemical resistance and the possibility of use both indoors and outdoors, due to the protection against sunlight offered by its partially acrylic nature.

With this project we want to explore the possibility of increasing the versatility of the resin by formulating a glossy enamel, which can be applied as a finish for floors, as well as for finishes on metal and finishes on primers of a different nature.

Conclusion

An easy-to-apply water-based epoxy-acrylic hybrid enamel was formulated with the following characteristics:

- Good adhesion on pavements;
- Good adhesion on metal;
- Good adhesion on primers, both water-based and solvent-based;
- Good compatibility with universal colourants.

The epoxy nature of the resin provides:

- Mechanical strength;
- Chemical resistance.

Discussion

Based on previous developments, different products were formulated aimed at achieving a high gloss enamel with good mechanical and chemical properties and compatible with

universal colourants.

Various dispersants were used and the influence of mixing various levelling agents and humectants were tested.

Mechanical properties

Abrasion resistance tests was carried out by Taber test and hardness test was carried out by Persoz pendulum.

Adhesion to metal and primers

The enamel was applied on carbon steel (SA015D), aluminium 5005 (AB015D) and galvanized steel (SG015), as well as on commercial primers of the following nature:

- Synthetic antioxidant primer S / R solvent based;
- 2-component solvent-based epoxy primer;
- Solvent-based phosphating primer;
- Water-based alkyd primer.

Chemical resistance

Chemical resistance tests were performed, evaluated as resistance to double rubs with methyl ethyl ketone.

Compatibility with Colourants

To evaluate the compatibility, the enamels formulated were mixed by weight with the following colourant composition, homogenizing with a high-speed mixer:

- | | |
|---|--------|
| - ColourFal Zero 700-030 TS Oxide yellow: | 7.89% |
| - ColourFal Zero 700-060 YS Oxide Red: | 76.12% |
| - ColourFal Zero 700-160 RS Blue HS: | 15.99% |

Results

1.- Abrasion, method with abrasive rubber wheels and rotating test specimen (Taber test), based on UNE-EN ISO 7784-2 standard.

For the Taber abrasion test, samples were applied on cardboard with a 200 micron extender, which were left to cure for 28 days at laboratory ambient conditions, CS10 abrasive wheels were used, weighing 1000 grams and lasting 500 cycles, at a speed of 60 rpm, using a "BGD 523 Abraser"

from Biuged Instruments and "Calibrase CS-10" abrasive wheels from Taber Industries.

Abrasión TABER		Initial weigh Cardboard 1	Final weigh Cardboard 1	Weigh lost 1	Initial weigh Cardboard 2	Final weigh Cardboard 2	Weigh lost 2	Weigh lost
Sample	Name	g	g	g	g	g	g	mg
K20-024 Synthapox H-1040	LD 3 H-1040	3,460	3,371	0,089	3,532	3,452	0,080	85

We consider adequate weight loss of less than 100 milligrams, using as a reference the weight loss required for "Pinturas acrílicas de emulsión para señalización de pistas de aterrizaje" INTA 16 44 15 B standard of June 2010, which establishes a maximum acceptable loss of 75 milligrams, under the same test conditions, being intended for performance in much more demanding use than those intended in this type of formulation.

2.- Hardness, pendulum damping test, Persoz pendulum method, based on UNE-EN ISO 1522 standard.

For the hardness test with the Persoz pendulum, samples were applied on glass panels with a 150 microns extender. After the pre-established hours from the application, the samples were tested by counting the oscillations in the pendulum, using a Biuged Instruments "BGD 509 Automatic-counting pendulum hardness tester" equipment.

PERSOZ hardness		24 hours	48 hours	72 hours	96 hours	7 days	14 days
Sample	Name	oscillations	oscillations	oscillations	oscillations	oscillations	oscillations
K20-024 Synthapox H-1040	LD 3 H-1040	94	117	120	132	153	160

Based on our experience, it can be concluded that the hardness is higher than a solvent-based synthetic enamel based on long oil alkyd resin applied under the same conditions.

3.- Gloss, determination of gloss value at 20°, 60° and 85°, based on UNE-EN ISO 2813 standard.

Measurement of specular gloss on paint film applied on cardboard with an extender of 150 microns, using a "micro-TRI-gloss" equipment from CHN Spec.

Gloss		Angle		
Sample	Name	20	60	85
K20-024 Synthapox H-1040	LD 3 H-1040 White	47,5	76,5	94,9
K20-024 Synthapox H-1040	LD 3 H-1040 Tinted	47,0	75,1	94,2

The gloss obtained is similar to the usual ones in one-component water-based acrylic enamels.

4.- Adhesion, cross-cut test, based on UNE-EN ISO 2409 standard.

4.1.- Adhesion on metal: the film was cut, with a multiple blade of 1 millimetre of separation, on applications with an extender of 150 microns on metals in which it is desired to test the adhesion of the product, the test was carried out after 1, 7 and 14 days after application, with the specimens under normal laboratory conditions, using a "BGD 502/3 Cross hatch adhesion tester" equipment.

Adhesion on metal		Days		
Sample	Surface	1	7	14
K20-024 Synthapox H-1040	Steel	GT 3	GT 5	GT 2
K20-024 Synthapox H-1040	galvanized steel	GT 1	GT 2	GT 2
K20-024 Synthapox H-1040	Aluminium	GT 2	GT 2	GT 3

4.2.- Adhesion on primers: the film was cut, with a multiple blade of 1 millimetre of separation, on applications with an extender of 150 microns on the primers in which the adhesion of the product is to be tested. The primers were applied between 72 hours to 7 days prior to the enamel application. The test was carried out after 7 and 14 days after the enamel application, with the specimens under usual laboratory conditions, using a "BGD 502/3 Cross hatch adhesion tester" equipment from Biuged Instruments.

Adhesion on primers		Days	
Sample	Primer	7	14
K20-024 Synthapox H-1040	Imp antioxidante S/R	GT 0 ⁽¹⁾	GT 0 ⁽¹⁾
K20-024 Synthapox H-1040	Imp epoxi 2C	GT 0	GT 0
K20-024 Synthapox H-1040	Imp alcídica al agua	GT 1	GT 1
K20-024 Synthapox H-1040	Imp fosfatante	GT 0	GT 0

(1) Detachment of the primer from the substrate

5.- Chemical resistance, evaluation by resistance to double MEK rub.

Paint was applied on glass with a 150 micron applicator and allowed to dry for 4 weeks under usual laboratory conditions, once this period was elapsed, 50 double rubs were carried out with a cotton wool soaked in methyl ethyl ketone and it was evaluated the destruction of the film (the assessment was made based on experience, not having a product against which to compare to).

We consider that the chemical resistance of the developed formulation is among the highest of the water-based enamels available on the market.

6.- Compatibility with universal colourants, evaluation by measuring the colour difference between rubbed area versus unrubbed area.

For the compatibility test, 0.6 grams of the mixture of colourants, previously prepared, were added to 30 grams of the white enamel to be tested, they were mixed using a high speed mixer, with IDM "IGT SimplyMix" equipment, for 60 seconds and it was applied on cardboard with a 150 micron applicator, using an automatic applicator with absorbent base "BGD 218 Automatic film applicator" from Biuged Instruments, rubbing vigorously with the finger 4 minutes after application.

To evaluate the test, the colour difference between the rubbed area and the non-rubbed area was measured with a "Datacolor 400" spectrophotometer connected to a computer using the Largo Innova "Synergy M3" software, measuring at 24 hours of sample application.

Colour difference		ΔE Lab	ΔE CMC (1:1)	ΔE Lab 2000 (1:1:1)
Sample	Name			
K20-024 Synthapox H-1040	LD 3 H-1040	0,46	0,45	0,42

The colour difference obtained after the test is considered acceptable, being below 1 in the three calculation methods used, taking into account that the chosen dye mixture is difficult to stabilize.

Formulation

Klabex has developed and has the formulations used for this report.

For additional information, please contact us.

Klabex is able to reformulate this product according to the needs of each client, using the raw materials that the client deems appropriate, under the conditions listed in our confidentiality agreement.

The substitution of raw materials could lead to a change in the performance of the product.

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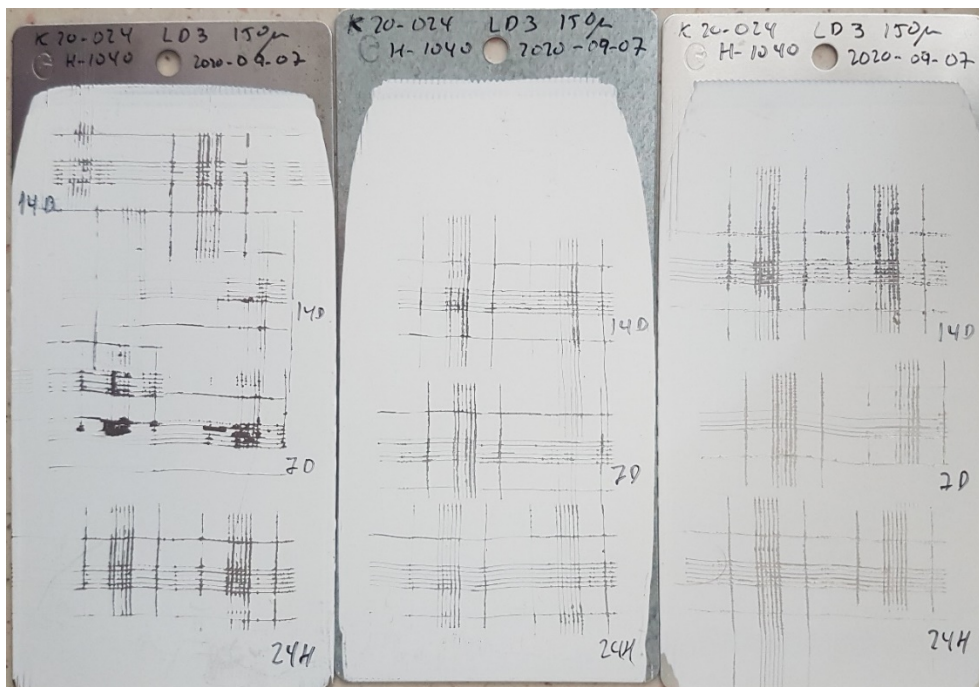
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Photographic Annex

Adhesion to metal

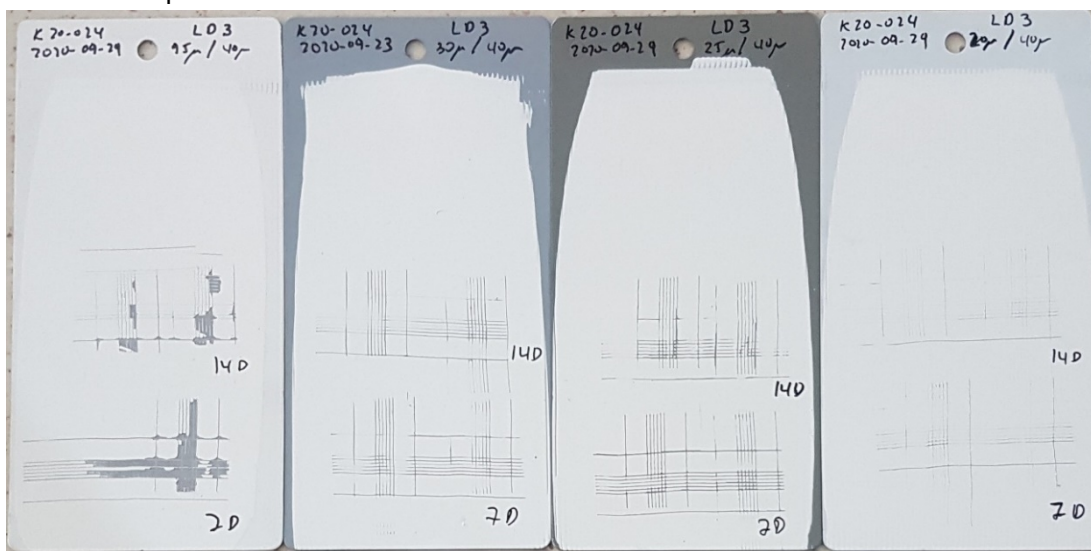


Steel

Galvanized Steel

Aluminium

Adhesion on primers



Synthetic *

Epoxy 2c

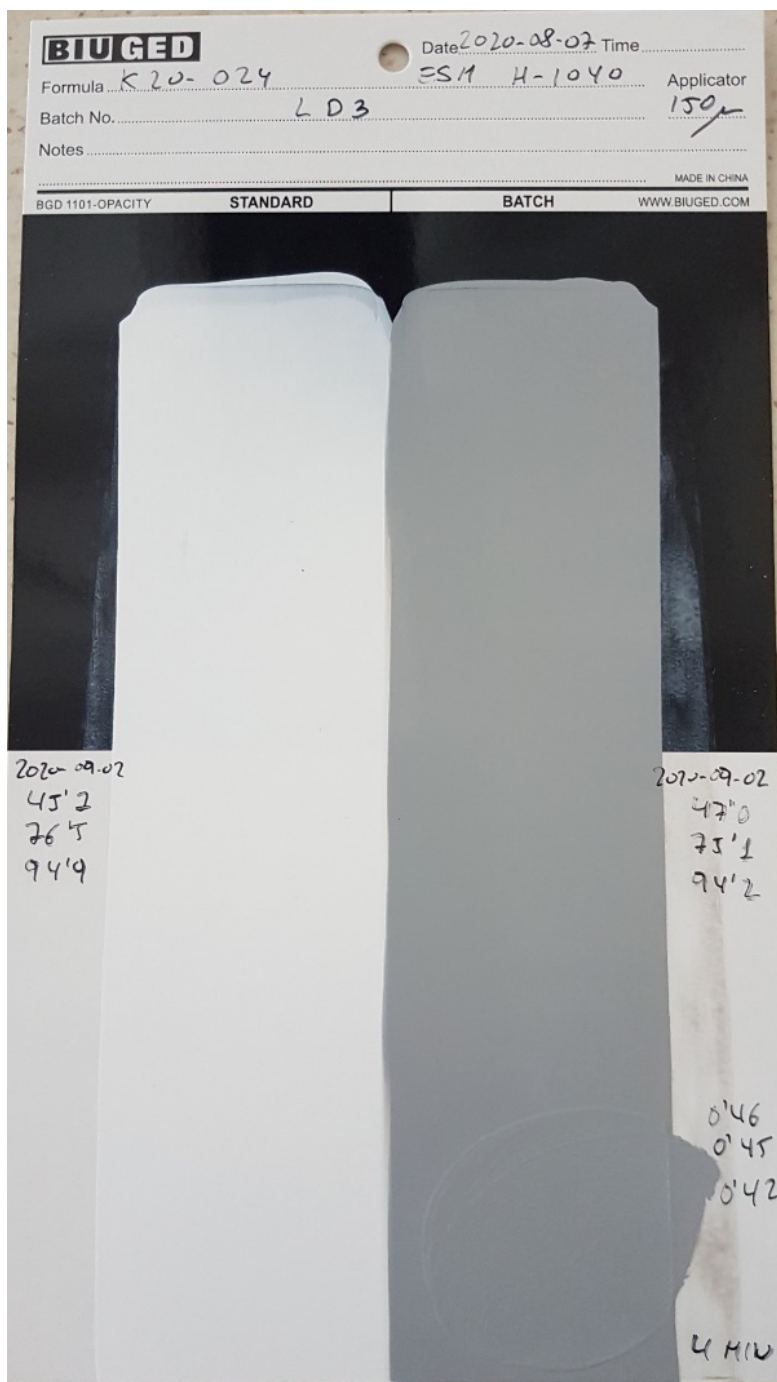
Alkyd water

Phosphatant

* Detachment of the primer



Chemical resistance: 50 double MEK rubs



Gloss and universal colourants compatibility

The information given and recommendations made herein are based on our research and are believed to be accurate, but no guarantee of accuracy is made. In every case we urge and recommend that purchasers before using any product in full scale production make their own tests to determine to their own satisfaction whether the product is of acceptable quality and is suitable for their particular purposes under their own operating conditions. The products discussed herein are sold without any warranty as to merchantability or fitness for a particular purpose or any other warranty, express or implied. No representative of ours has any authority to waive or charge the foregoing provisions but, subject to such provisions, our engineers are available to assist purchasers in adapting our products to their needs and to the circumstances prevailing in their business. Nothing contained herein shall be construed to imply the non-existence of any relevant patents or constitute a permission, inducement, or recommendation to practice any invention covered by any patent, without authority from the owner of the patent.