

Anodized Aluminium Sealing for Alkali Resistance



Exactly your chemis

The background of the slide is a close-up photograph of a white, anodised aluminium automotive part, possibly a steering wheel or a door handle, showing its curved shape and metallic texture.

*Anodised Aluminium is
commonly used as a
decorative exterior
automotive finish*

Sealing Process for Alkali
Resistance
Public

Clariant Produkte Schweiz AG
Aluminium Finishing

16.08.2006

Slide 2

The Problem



**Sealing Process for Alkali
Resistance**
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Slide 3

The Problem

- Automotive exteriors are exposed to aggressive chemicals used in automatic car washes
- These chemicals cause deterioration of the decorative finishes



The Problem

Surface Deterioration



**Sealing Process for Alkali
Resistance**
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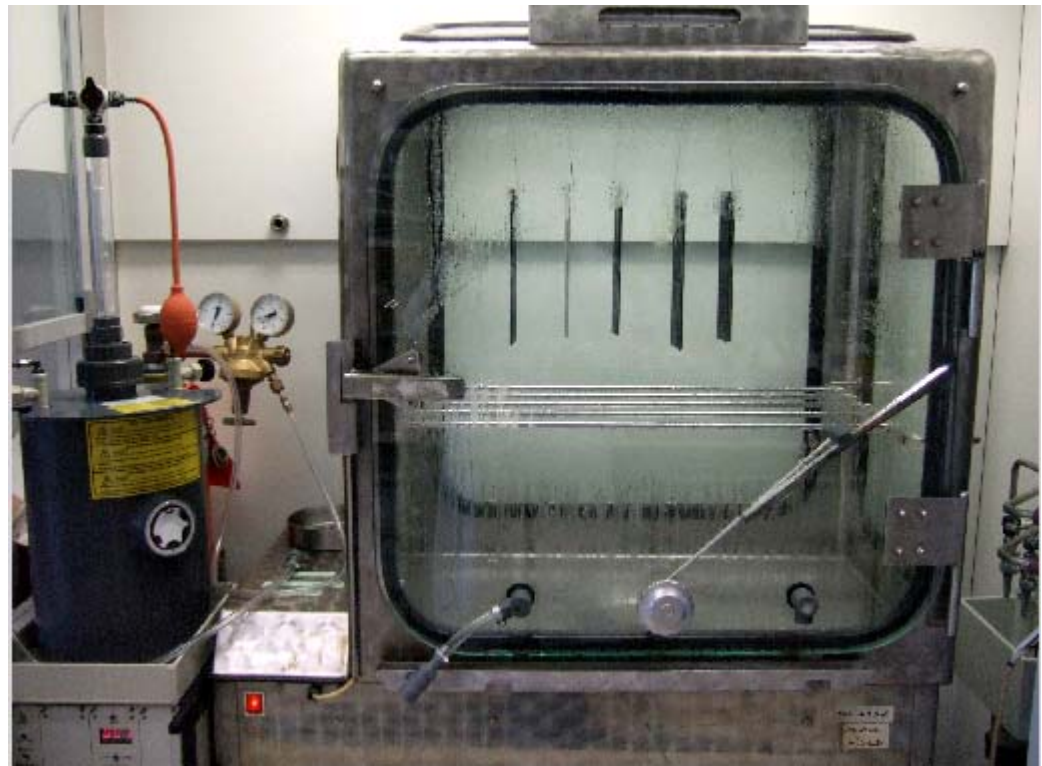
Slide 5

Volkswagen Test Procedure

- 10 min. pre-dip in:
 - 2g/l Na_3PO_4
 - 200mg/l CL^-
 - **pH 12.5** (NaOH and H_3PO_4)
 - room temperature
- Rinse & dry;
- Kesternich Test: according to DIN 50018; 2.0 S; 5 cycles

Kesternich Test

Corrosion in damp heat alternating atmosphere containing sulphur dioxide (SO₂)



Sealing Process for Alkali
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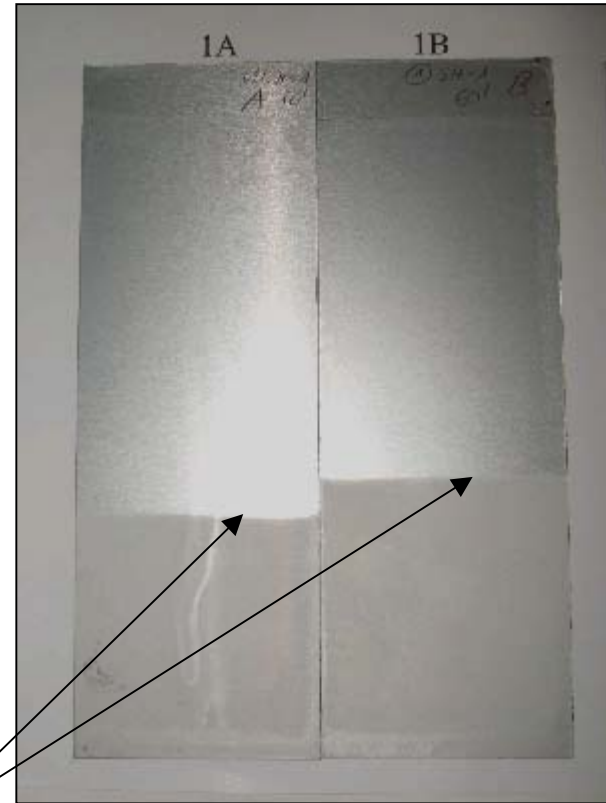
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Slide 7

Specification

- No visual change of the surface after cleaning with commercial polish
- No visual dip border



Pre-dip demarcation

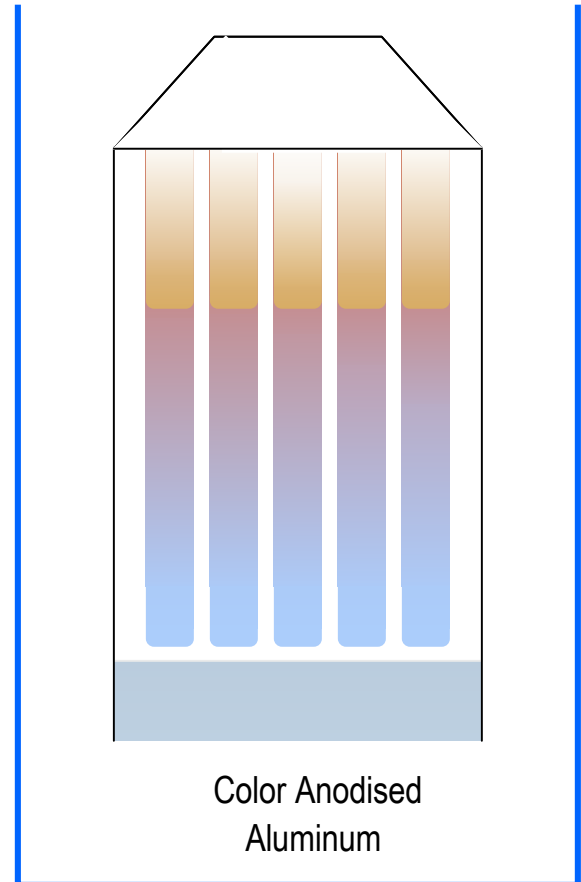
Sealing

Provides corrosion protection, color retention, stain & electrical resistance to anodised aluminum

What is Sealing?

The anodised part (color or clear) is immersed in a seal bath

Over time and under the right conditions, a chemical change occurs within the pores which causes them to close



Factors That Affect Any Seal

- Coating properties
 - Thickness
 - Porosity
- Process parameters
 - Chemical content
 - pH
 - Temperature
 - Time
- Contaminant level
 - Phosphates
 - Silicates

Objective & Method

- Produce clear & color anodised decorative coatings that pass the VW test
- Screen conventional 1 & 2-step seal methods via application test

Nickel Seals Tested

- Hot Nickel Acetate Seal
 - Typical conditions for use:
 - 95° to 100°
 - 2 to 3 min/ μm
- Mid-Temperature Nickel Acetate Seal (US Formulation "C")
 - Typical conditions for use:
 - 75° to 90°
 - 1 to 2 min/ μm
- Cold Nickel Fluoride Seal
 - Typical conditions for use:
 - 25° to 35°
 - ½ to 1 min/ μm

Nickel-Free Seals Tested

■ Hot Water Seal (with additive)

- Typical conditions for use:
 - 95° to 100°
 - 3 min/ μm

■ Mid-Temperature Tenside Seals

- Swiss formulation "A"
- US Formulation "B"
- Typical conditions for use:
 - 80° to 90°
 - 1 to 2 min/ μm

2-Step Seal Combinations Tested

■ Cold Seal followed by:

- Hot water seal
- Mid-temperature nickel free seal (Swiss formulation “A”)
- Hot nickel acetate seal

■ Hot nickel acetate followed by:

- Hot water seal
- Mid-temperature nickel free seal (Swiss formulation “A”)
- Mid-temperature nickel free seal (US formulation “B”)

Test 1

First series of seal screening tests

- Aluminium sheet AlMg1
- Clear anodised **23-27µm**
- Full Volkswagon test
- Pre-dip **pH set at 12.5** (original value)

Test 1

1-Step Seals

■ Seal time: 60min (approx. 3 min/ μm)

Seal type	Product* concentration	Temperature °C	pH	Result
Hot water	2ml/l	98	6	Red
Mid-temperature A	2ml/l	88	6	Red
Mid-temperature B	20ml/l	88	6	Orange
Hot nickel	20ml/l	98	5.7	Green

* products listed in appendix

Test 1

2-Step Seals

- Pre-seal:
 - 20ml/l **Hot nickel**;
 - 70°C; pH 5.7; 5min
- Second seal: 40min;

Second seal	Product* concentration	Temperature °C	pH	Result
Hot water	2ml/l	98	6	
Mid-temperature A	2ml/l	80	6	
Mid-temperature A	2ml/l	88	6	
Mid-temperature B	20ml/l	80	6	

Test 1

2-Step Seals (continued)

- Pre-seal:
 - 5g/l **Cold seal**;
 - 20min; 29°C; 5.7pH
- Second seal: 40min

Second seal	Product* concentration	Temperature °C	pH	Result
Hot water	2ml/l	98	6	Green
Mid-temperature A	2ml/l	80	6	Green
Hot nickel	20ml/l	80	5.7	Orange

Summary of Test 1

- Hot nickel alone or in combination with mid-temperature nickel-free seals can pass the original VW test using thick clear coatings
- Cold seal in combination with hot water or mid-temperature nickel free seals can also be used under these conditions.
- Many results are good however:
 - VW test was modified: pre-dip at pH 13.5 instead of 12.5
 - Thinner coatings were of interest to the automotive OEM

Test 2

Second series of seal screening tests

- Aluminium sheet AlMg1
- Clear anodised **5-7 μ m (thinner)**
- Abbreviated test:
 - Pre-dip only in pH 12.5 & **13.5**

Test 2

1-Step Seals

■ Seal time: 15min (approx. 3 min/ μm)

Seal type	Product* concentration	Temperature $^{\circ}\text{C}$	pH	Result 12.5	Result 13.5
Mid-temperature C	20ml/l	90	6.0	Red	Red
Hot nickel	20ml/l	98	5.5	Green	Red

* products listed in appendix

Test 2

2-Step Seals

■ Pre-seal:

- 5g/l **Cold seal**;
- 4min; 29°C; 5.7pH

■ Second seal: 15min

Seal type	Product* concentration	Temperature °C	pH	Result 12.5	Result 13.5
Hot water	2ml/l	98	6.0		
Mid-temperature A	2ml/l	80	6.0		
Mid-temperature C	20ml/l	90	6.0		
Hot nickel	20ml/l	98	5.5		
Mid-temperature B	20ml/l	90	6.0		

Summary of Test 2

- Pre-dip in a pH 13.5 solution is very severe
- The best results use a cold pre-seal followed by hot nickel

Test 3

Focus on the 2-Step seal (cold/hot nickel)

- Aluminium sheet AlMg1
- Clear anodised 5-7µm
- Pre-seal:
 - 5g/l **Cold seal**;
 - 28°C; 5.7pH
- Second seal:
 - 20 ml/l **Hot Nickel**,
 - 98°C; 5.5 pH
- Abbreviated test:
 - Pre-dip only in pH 13.5

Test 3

2-Step Seal (cold/hot nickel)

Cold Seal min.	Hot Seal min.	Result 13.5
4	15	Red
4	30	Green
4	40	Green
6	15	Green
6	30	Green
6	40	Green
8	15	Green
8	30	Green
8	40	Green

- For thin clear coatings
 - Many combinations pass (not process sensitive)
 - As little a 6-8 min plus 15 min produce a quality seal

Test 4

Focus on the 2-Step seal (cold/hot nickel)

- Aluminium sheet AlMg1 & MgSi profile
- Clear & color anodised 5-7 μ m & 12-14 μ m
- Pre-seal:
 - 5g/l Cold seal;
 - 28°C; 5.7pH
- Second seal:
 - 20 ml/l Hot Nickel,
 - 98°C; 5.5 pH
- **Full VW test:**
 - Pre-dip in pH 13.5

Test 4

2-Step Seal (cold/hot)

Clear anodised coatings on AlMg1

Cold Seal min.	Hot Seal min.	Coating μm	Result 13.5
8	30	5-7	
8	40	5-7	
10	30	12-14	
10	40	12-14	
15	30	12-14	
15	40	12-14	

- This seal combination can pass the severe VW test for both thin & thick clear anodised coatings on aluminum sheet

Test 4

2-Step Seal (cold/hot)

Overdyed coatings on AlMg1

Cold Seal min.	Hot Seal min.	Coating μm	Result 13.5
8	30	5-7	
8	40	5-7	
10	30	12-14	
10	40	12-14	
15	30	12-14	
15	40	12-14	

- This seal combination can pass the severe VW test for both thin & thick color anodised coatings on aluminum sheet

Test 4

2-step Seal (cold/hot)

Profiles

Cold Seal min.	Hot Seal min.	Color	Coating μm	Result 13.5
6	30	Clear	5-7	Red
6	40	Clear	5-7	Red
8	30	Clear	5-7	Green
8	40	Clear	5-7	Green
10	30	Overdye	12-14	Red
10	40	Overdye	12-14	Red
10	60	Overdye	12-14	Green
15	30	Overdye	12-14	Red
15	40	Overdye	12-14	Green
15	60	Overdye	12-14	Green

- This seal combination can pass the severe VW test for both thin & thick:
 - color anodise coatings on aluminum profile
 - color anodise coatings on aluminum sheet

Recommendations

- The preferred method of sealing anodised aluminum for maximum alkali resistance is to use a 2-step process consisting of a cold nickel fluoride followed by a hot nickel acetate.
- For thinner coatings a pre-seal of 8 -10 minutes followed by a minimum 30 minutes of hot seal should be used.
- For thicker coatings a pre-seal of 10-15 minutes followed by a minimum 30-40 minutes of hot seal should be used.
- Longer seal times are better however time limitations and cracking are a concern.

Appendix

- Hot nickel: Anodal Sealing Salt ASL liq
- Cold nickel fluoride: Anodal CS-2 pdr
- Hot water additive: Anodal SH-1 liq
- Mid-temperature nickel “C” (US formulation): Anodal MS-1 liq
- Mid-temperature nickel free “A” (Swiss formulation): Anodal SH-2 liq
- Mid-temperature nickel free “B” (US formulation): Anodal ES-1 liq