SurTec® 704
Cyanide Free Alkaline Bright Zinc Process of the New Generation (Electrolyte based on Potassium)

Properties

- excellent metal distribution
  (only about 25 % of variance on a 1 A · 30 min Hull cell panel)
- a high brilliant zinc deposit, easy to passivate
- very ductile, without blistering
- perfectly suited for rack as well as for barrel or continuous applications
- easy plating even on parts with difficult shapes
- high burning limit, suited for high current densities
- simple waste water treatment
- excellently adapted for an external zinc generator
- IMDS-number: 213570

Application

The process SurTec 704 (Electrolyte based on Potassium) includes the following products:

- SurTec 704 I Carrier is the responsible for the very good metal distribution
- SurTec 704 II Brightener effectuates the desired brightness to the layer
- SurTec 704 R Conditioner avoids optical influences on the layer caused by water hardness or impurities inside sodium hydroxide
- SurTec 700 L LCD Booster is used as a secondary brightener as required and works at low current density
- SurTec 701 Purifier is used to precipitate the metal impurities
- SurTec 700 EK Potassium Zincate Electrolyte, 3x Concentrate provides zinc, potassium hydroxide and potassium carbonate for the bath make-up
  (as an alternative to the make-up with the separate salts)

make-up values:	zinc oxide	12.5 g/l	
	potassium hydroxide	170 g/l *	
	potassium carbonate	50 g/l	
	or using the electrolyte concentrate:		
	SurTec 700 EK	33 %vol	
	SurTec 704 I	10 ml/l	(5-15 ml/l)
	SurTec 704 II	1 ml/l	(0.5-2 ml/l)
	SurTec 704 R	10 ml/l	(5-15 ml/l)
	SurTec 700 L	as required	(0-1 ml/l)
	SurTec 701	only if necessary	(0-4 ml/l)

*This value is valid only for KOH 100 %; at lower contents of KOH (see specification of the raw material), the make-up value has to be calculated
(Example: KOH 86 % => 170/0,86 = 198 g/l)

analytical values:	zinc	10	g/l	(8-15 g/l)
	potassium hydroxide	170	g/l	(150-210 g/l)
	potassium carbonate	max. 180	g/l	

make-up: Steps for make-up:

1. Fill the tank to 1/3 with deionised water.
2. Add and dissolve potassium hydroxide in small portions while stirring the solution (attention: the solution becomes hot!).
3. Add zinc oxide and stir until the solution is clear.
4. Dissolve potassium carbonate.
5. Fill the tank with deionised water to its final volume.
   Alternatively fill the bath with 33 %vol SurTec 700 EK Potassium Zincate Electrolyte, 3x Concentrate (30 g/l Zn).
6. Add SurTec 704 I Carrier and SurTec 704 R Conditioner.
7. Work in for 8 h at low current density.
8. Finally add SurTec 704 II Brightener.
9. Metal impurities (lead, cadmium, copper) have to be precipitated by adding max. 4 ml/l SurTec 701 (previous test in the Hull cell!).

temperature:	20-40°C	
cathodic current density:	0.5-6 A/dm^2 (max. current density depends on zinc content and agitation)	
current efficiency:	55-80 %	
deposition rate:	0.2 µm/min at 1 A/dm^2	*barrel*
	0.4 µm/min at 2 A/dm^2	*rack*
tank material:	plastic tank or steel tank with plastic coating	
agitation:	cathode movement with 3-5 m/min	
filtration:	continuous filtration is necessary	
cooling:	necessary at high current load, depending on the electrolyte volume	
exhaust:	strongly recommended, especially when using inert anodes	

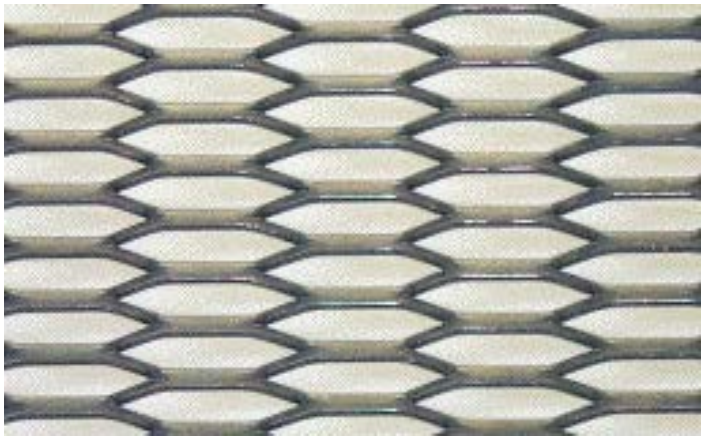
Anodes

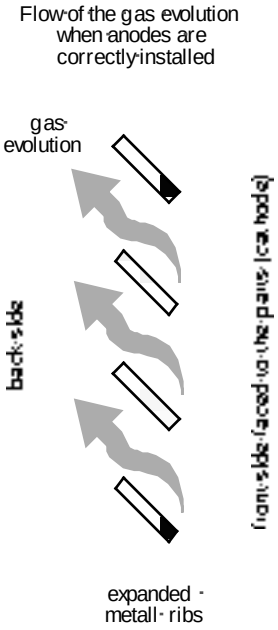
SurTec recommends the use of inert anodes in combination with an external zinc generator. Despite this recommendation, SurTec 704 can of course be operated with soluble zinc anodes. However, SurTec strongly warns against mixed operation of inert and soluble anodes.

Operation with inert anodes and external zinc generator

Anodes: made of expanded metal (30 mm x 8 mm piccolo mesh, rib width 6 mm, material thickness 2 mm), of mild steel (e.g. ST 37), plated with 15 µm semi bright nickel. The expanded metal should be installed with the ribs horizontally oriented for driving the gas evolution to the backside.

Before plating the expanded metal with semi bright nickel, it should be vertically stiffened with flat irons leading to the anode hooks. For optimal current distribution, the anodes should be placed at both sides of the cathode along the full width of the plating tank, with an anodic current density up to 20 A/dm^2.





Zinc generator: with baskets (optimal: 62.5 mm x 62.5 mm x 1000 mm of 1.5 mm perforated mild sheet DD 11 GK according to DIN 10111/10051; perforation Rv 3-5 DIN 24041), plated with the SurTec Catalyst. Fill the baskets with zinc clippings (approx. 10 mm Ø, lead content < 0.002 %). Control the zinc concentration in the electrolyte adjusting the exchange rate between plating cell and zinc generator. For an online calculation of the necessary number of catalytic baskets and for determination of the size of the zinc generation tank, please consult:

http://Berechnung.SurTec.com/Zinkgenerator.html

Operation with soluble anodes

Anodes: soluble zinc anode pieces, clippings, drops or balls in titanium baskets as usual in the trade, or zinc anode panels at titanium hooks (the lead content of the zinc anodes must be generally < 0.002 %): up to a current density of about 3 A/dm^2, the anodic current efficiency is at 100 %. Above 3 A/dm^2 the anode gets covered with a semi-conductive zinc oxide parting layer, the anode becomes black, the cell voltage increases abruptly by 3 to 4 V, and the anodic current efficiency drops down to 2-5 % in favour of 95-98 % O_2 evolution. However, it is not impossible, but it is hard to control the zinc content of the electrolyte by adjusting the anode surface. Anodes must be removed and placed back frequently. Consequently, the current in the plating cell is of course very unevenly distributed.

Technical Specification

(at 20°C)	Appearance	Density (g/ml)	pH-value (conc.)
SurTec 704 I	liquid, colourless-yellowish, clear	1.017 (1.01-1.03)	9.0 (8-10)
SurTec 704 II	liquid, yellowish, clear	1.001 (1.00-1.02)	6.3
SurTec 704 R	liquid, colourless, clear - slightly turbid	1.400 (1.38-1.44)	12.0
SurTec 700 L	liquid, yellowish, clear	1.052 (1.01-1.09)	12-14
SurTec 701	liquid, colourless, clear	1.014 (1.00-1.03)	8.1
SurTec 700 EK	liquid, colourless, clear	1.485 (1.46-1.51)	> 11.0

Maintenance and Analysis

Analyse the concentration of zinc and potassium hydroxide regularly. Dose potassium hydroxide corresponding to the analysis, and keep constant the zinc content by regulation of the anode surface or by use of an external zinc generator.

Add SurTec 700 L LCD Booster as required, usually 0-0.2 l per 10 kAh. Avoid strong overdosages because they would reduce the current efficiency and had to be worked out.

Sample Preparation

Take a sample at a homogeneously mixed position. Let it cool down to room temperature. If the sample is turbid, let the turbidity settle down and decant or filter the solution.

Zinc (Zn) – Analysis by Titration

reagents: 0.1 mol/l EDTA solution (Titriplex III)
buffer solution (100 g/l NaOH and 240 ml/l 98 % acetic acid in deionised water)
indicator: xylenol orange tetra sodium salt (1 % in KNO_3)

procedure:
1. Pipette 5 ml bath sample into a 250 ml Erlenmeyer flask.
2. Dilute with approx. 100 ml deionised water.
3. Add 30 ml buffer solution.
4. Add a spatula tip of indicator.
5. Titrate with 0.1 mol/l EDTA solution from red to yellow.

calculation: consumption in ml · 1.3078 = g/l zinc

Potassium Hydroxide (KOH) – Analysis by Titration

reagents: 1 N sulfuric acid
indicator: Tropaeolin O (0.1 % solution)

procedure:
1. Pipette 5 ml bath sample into a 250 ml Erlenmeyer flask.
2. Dilute with approx. 100 ml deionised water.
3. Add 5 drops of indicator.
4. Titrate with 1 N sulfuric acid from orange-brown to yellow.

calculation: consumption in ml · 11.221 = g/l potassium hydroxide

hint: For the dosage of KOH, the quality (concentration) of the material has to be considered (see also „make-up values“).

Potassium Hydroxide (KOH) – Analysis by Titration

reagents: 0.1 N hydrochloric acid
barium chloride solution (15 % $BaCl_2 \cdot 2\ H_2O$; neutral)
indicator: phenolphthalein (1 % in ethanol)

procedure:
1. Pipette 0.5 ml bath sample into a 250 ml Erlenmeyer flask.
2. Dilute to approx. 100 ml with deionised water.
3. Add 50 ml barium chloride solution and wait for 10 minutes.
4. Add some drops of indicator.
5. Titrate while stirring with 0.1 N hydrochloric acid until a stable discolouration.

calculation: consumption in ml · 11.22 = g/l potassium hydroxide

hints:
- The barium chloride solution must be neutral; if necessary adjust with 0.1 N NaOH or HCl to the point of change of phenolphthalein.
- Add no bigger amounts of acid in one step and stir well.

Potassium Carbonate (K_2CO_3) – Analysis by Titration

reagents:	barium nitrate solution (5 %) 1 N hydrochloric acid 1 N sodium hydroxide solution indicator: methyl orange solution (0.04 %)
procedure:	1. Pipette 10 ml bath sample into a 250 ml Erlenmeyer flask. 2. Add 50 ml deionised water and boil the solution. 3. Add 75 ml barium nitrate solution. 4. After settle down of the precipitate, filtrate with a fine-grained filter paper and wash with hot deionised water. 5. Put the filter into a 250 ml Erlenmeyer flask. 6. Add 100 ml deionised water. 7. Add 20 ml 1 N hydrochloric acid. 8. Boil the solution shortly. 9. After cooling down, add 3 drops of indicator. 10. Titrate excessive hydrochloric acid with 1 N sodium hydroxide solution from red to orange-yellow.
calculation:	(20 - consumption in ml) · 6.91 = g/l potassium carbonate

Ingredients

- polymeric amines
- organic nitrogen compounds

Conversion of an Electrolyte to SurTec 704

For a complete conversion test, at least 3 litres original electrolyte are necessary.

First Indication Test:

1. Plate a hull cell panel in a freshly prepared SurTec 704 electrolyte according the instructions of the chapter ”Trouble Shooting“.
2. Plate an ”original“ panel in the customer’s electrolyte without any additions. If the original panel is already bright, you can only try the overdosage effect, if it is less bright than panel 1, you can already get an indication on the receptivity of the old system for SurTec 704.
3. Add 5 ml/l SurTec 704 I and 0.5 ml/l SurTec 704 II to the 250 ml Hull cell 2 and plate again.

If there is a positive effect (panel 3 is the same as or better than panel 2), a conversion is possible without an immediate problem.

Mid Term Compatibility:

1. Fill 1.8 litre original bath into a 2 l beaker, hang in a small Hull cell soluble zinc anode and a pre-treated jiggle cell panel (or, if not available, a 15 cm long and about 4 cm wide steel sheet) as a cathode, put it onto a magnetic stirrer and stir slowly, connect anode and cathode to the rectifier and plate with 1 A for 8 h.
2. Filtrate 250 ml of this treated electrolyte into a Hull cell and plate a Hull cell panel according the instructions of the chapter ”Trouble Shooting“.
3. Add 0.5 ml/l SurTec 704 I and 0.05 ml/l SurTec 704 II to the Hull cell and repeat the test.
4. Repeat (3) until a good result is achieved.

Long Term Compatibility:

1. Prepare 1 litre of a fresh SurTec 704 electrolyte with the desired concentrations of zinc and KOH and add 10 ml/l SurTec 704 I, 1 ml/l SurTec 704 II and 10 ml/l SurTec 704 R.
2. If the first indication test (see above) had shown a lack of brightness in the original bath, then add 0.5 ml/l SurTec 704 II to the untreated strange electrolyte.
3. Prepare 5 dilutions with a total volume of 250 ml each of the original electrolyte (if necessary + SurTec 704 II) with the SurTec 704 electrolyte mentioned above.

   a) 225 ml original bath + 25 ml SurTec 704 electrolyte
   b) 175 ml original bath + 75 ml SurTec 704 electrolyte
   c) 125 ml original bath + 125 ml SurTec 704 electrolyte
   d) 75 ml original bath + 175 ml SurTec 704 electrolyte
   e) 25 ml original bath + 225 ml SurTec 704 electrolyte

and plate a Hull cell panel in each electrolyte mixture.

There should not be any negative effect in any dilution. If e.g. the panel plated in bath c) had an unexpected appearance, e.g. uncorrectable spottiness, possible problems must be expected after about 5 weeks of conversion (barrel application) resp. 15-20 weeks (rack application).

If every dilution can be adjusted to a good panel, no problems are expected by the conversion itself.

Consumption and Stock Keeping

The total consumption consists of the drag-out and the electrolytic consumption. For the dosage both have to be considered:

		due to drag-out* [per kg KOH]	electrolytic [per 10 kAh]
SurTec 704 I	Carrier	60 ml	0.5-1.5 l
SurTec 704 II	Brightener	6 ml	0.5-1.5 l
SurTec 704 R	Conditioner	60 ml	

*valid only for the given make-up values

SurTec 700 L LCD Booster (consumption per 10 kAh): ca. 0-0.2 l, as required

In order to prevent delays in the production process, per 1,000 l bath the following amounts should be kept in stock:

SurTec 704 I	Carrier	100 kg
SurTec 704 II	Brightener	25 kg
SurTec 704 R	Conditioner	90 kg
SurTec 700 L	LCD Booster	25 kg
SurTec 701	Purifier	25 kg

Product Safety and Ecology

The safety instructions and the instructions for environmental protection have to be followed in order to avoid hazards for people and environment. The Material Safety Data Sheets (according to European legislation) contain explicit details for this.

The following hazard designations and classifications into water hazard classes (WHC) have to be taken into account:

product	*hazard designation*	*water hazard class*
SurTec 704 I	-	WHC 3
SurTec 704 II	-	WHC 0
SurTec 704 R	X - Irritant	WHC 1
SurTec 700 L	C - Corrosive	WHC 1
SurTec 701	Xn - Harmful	WHC 1
SurTec 700 EK	C - Corrosive N - Dangerous for the environment	WHC 1

Warranty

We are responsible for our products in the context of the valid legal regulations. The warranty exclusively accesses for the delivered state of a product. Warranties and claims for damages after the subsequent treatment of our products do not exist. For details please consider our general terms and conditions.

Further Information and Contact

In our forum, you can discuss topics of the surface technology:
http://forum.SurTec.com/

If you have any questions concerning the process, please contact your local technical department: http://SurTec.com/International.html

30 June 2011/DK, AB

Trouble Shooting

Before consulting the following list, it should be verified that temperature, current density and analytical values stay within the above limit ranges.

Than prepare for better evaluation Hull cell tests with a 250 ml Hull cell at 1 A · 15 min on thoroughly pre-treated (pickled and anodal cleaned) steel panels. Rinse the plated Hull cell panel in 0.5 %vol nitric acid for 15 s, rinse again with tap water and dry with hot air.

problem	possible cause	remedy
bright uniform layer within the whole current density range	electrolyte is o.k.	none
bad throwing power	concentration of SurTec 704 I Carrier is too low	add SurTec 704 I in steps of 2-5 ml/l; confirm each step by Hull cell tests before addition to the bath
low but uniform brightness within the whole current density range	concentration of SurTec 704 II Brightener is too low	add SurTec 704 II in steps of 0.25 ml/l; confirm each step by Hull cell tests before addition to the bath
dull irregular regions in the zinc deposit	a) bad pretreatment	improve the pretreatment (note: pretreatment of Hull cell panels is also very important for good test deposits)
	b) water hardness is too high	for water conditioning, add SurTec 704 R to the electrolyte in steps of 5 ml/l; confirm each step by Hull cell tests before addition to the bath
small dendrites (whisker), distributed in all current density regions	overdosage of SurTec 704 II Brightener	work out
bad current efficiency, no deposits in low current density area	a) overdosage of SurTec 704 I Carrier or SurTec 700 L LCD Booster	work out
	b) impurities of chromium (VI)	add reduction agent sodium dithionite according to Hull cell tests
discoloured passivation layers	a) passivation bath is wrongly adjusted	check passivation bath and activation
	b) metal impurities in the zinc electrolyte	close the source of the impurities; dummy plate at low current densities
dull grey deposits in the low current density area	lead impurities (>1 ppm)	a) add SurTec 701 Purifier in steps of 1 ml/l, leave 15 min for reaction; confirm each step by Hull cell tests before addition to the bath
		b) treat the electrolyte with 1 g/l zinc dust