

SurTec® 876

Trivalent Bright Chromium Electroplating Process

Properties

- the new chromium(III) chloride electrolyte offers a very high conductivity
- very high burning limit, high current densities can be applied
- good metal distribution, good current efficiency, even at lower current densities
- high layer thickness can be achieved
- the deposited chromium layer is very glossy, and its colour comes close to the colour of layers deposited from hexavalent chromium electrolytes
- the process tolerates breaks in the current flow (in contrary to hexavalent processes)
- graphite anodes shall be used
- metal impurities as copper, zinc, iron or nickel can be removed selectively with SurTec 876 IAT Ion Exchange Resin
- feed-back of rinsing water is possible
- easy waste water treatment by simply increasing the pH-value above pH 8

Application

The trivalent chromium electroplating process SurTec 876 is suited for rack and barrel applications. SurTec 876 can be prepared and maintained with the following products:

- SurTec 876 C Conductivity Salt contains the buffer substances and the conductivity salts in the preferred ratios
- SurTec 876 M Chromium Concentrate is the chromium source for make-up and maintenance
- SurTec 876 I is the Wetting Agent
- SurTec 876 II is the Catalyst
- SurTec 876 III is the Adjuster for the high current density

make-up values:	SurTec 876 M	120 ml/l	(100-140 ml/l)
	SurTec 876 C	260 g/l	(240-280 g/l)
	SurTec 876 I	1 ml/l	(1-5 ml/l)
	SurTec 876 II	60 ml/l	(50-75 ml/l)
	SurTec 876 III	1.5 ml/l	(1-3 ml/l)
analytical values:	chromium(III)	18 g/l	(16-20 g/l)
	boric acid	50 ml/l	(45-55 ml/l)
	SurTec 876 II	60 ml/l	(50-80 ml/l)

make-up: Steps for make-up:

1. Clean the plating tank and the system and rinse with 1-2 % hydrochloric acid for 6-8 hours. Dispose the rinsing solution and rinse again with tap water.
2. Clean the graphite anodes with 1-2 % hydrochloric acid and install them in the bath in a close distance to each other and to the tank wall.

3. Fill the tank to 2/3 of the final volume with deionised water, and heat it up to 60-65°C.
4. Dissolve SurTec 876 C Conductivity Salt portion by portion in the hot deionised water. Stir vigorously and keep on heating, because the dissolution of the salt consumes energy.
5. Add SurTec 876 M Chromium Solution while stirring well, and let the electrolyte cool down to 55°C.
6. Add slowly SurTec 876 II Catalyst. Stir very well during addition, in order to avoid high local concentrations causing high local pH-values.
7. Add SurTec 876 I Wetting Agent and SurTec 876 III Adjuster.
8. Leave the bath for 30 to max. 45 min at 55°C.
9. Complete the bath with deionised water, mix well, and let it cool down to 32°C. The continuous filtration can be started immediately after filling with water.
10. Dummy plate for 1 Ah per litre at 10 A/dm². Dummy plating can be done once the temperature dropped below 38°C, and during the bath is still cooling down.
11. Adjust the pH-value to pH 2.7, and verify the analytical values of the electrolyte to be in their respective ranges. Check the plating conditions of the electrolyte in the Hull cell, and finally start the production.

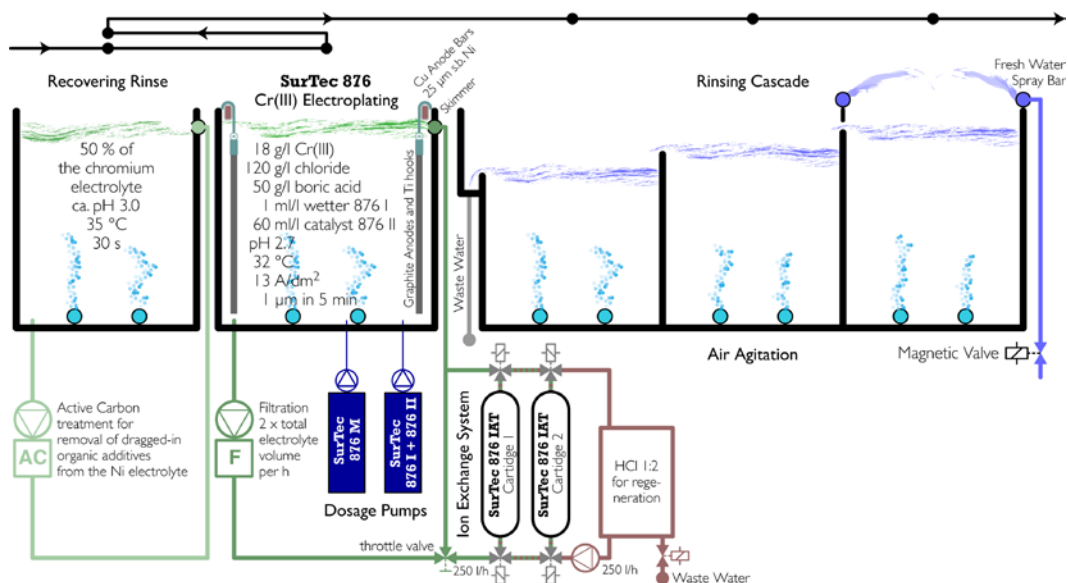
pH-value:	2.7	(2.5-2.9)
	adjust with hydrochloric acid or ammonia solution	
temperature:	32°C	(28-38°C)
cathodic current density:	13 A/dm ²	(8-19 A/dm ²)
	The throwing power can be increased by applying a 20 % higher covering current for 30 to 45 s.	
	The ripple of the rectifier has to be less than 5 %.	
plating speed:	0.15-0.25 µm/min at 13 A/dm ²	
anodes:	Graphite anodes are mandatory. In order to provide a good electrical contact, screw the graphite anodes firmly mounted into clamps made of titanium. The clamps are fitted onto latches or hooks for contacting the anode bar. The anode, including the clamp must be completely immersed into the electrolyte.	
	If the anodes are badly mounted or contacted, then chlorine gas may be evolved, and an extraordinary sludge formation at the anode surface might occur.	
	The anode bar is preferably made of semi-bright nickel-plated massive copper.	
	For better prevention of the electrolyte from contamination with copper or nickel, the anode bar can be coated with rack insulation (plastisol).	
anodic current density:	4 A/dm ²	(3-5.5 A/dm ²)
ratio anode : cathode:	2-2.5 : 1	
agitation:	finely dispersed air agitation (oil-free!)	

tank material:	steel with acid resistant coating (PVC, PP, PE...)
filtration:	continuous filtration mandatory, 1-5 times the total volume per hour, using chloride resistant filter cartridges with a pore size of 10 µm New cartridges shall be rinsed for 1 h with hot water before use.
heating:	necessary: a thermostatically regulated heating out of acid resistant material (e.g. titanium, porcelain, PTFE)
cooling:	necessary: made of acid resistant material
exhaust:	required for worker's protection
hints:	<p>After working, allow the electrolyte to rest for 60 min for further reactions at the anodes.</p> <p>Stop or minimize the air agitation if the electrolyte is not in use. If storage for more than two days is planned, adjust the pH to 2.4.</p> <p>While cooling down, the electrolyte may crystallize. Before starting to work again or if the tank has to be changed, ensure that any precipitates will be re-dissolved again. Start heating 24 h in advance before plating. Re-adjust the pH if necessary.</p> <p>Installation of an ion exchange unit is recommended. Heavy metal impurities may strongly impact the quality of the chromium deposition. The ion exchange resin SurTec 876 IAT (see separate product information bulletin) selectively removes Fe, Ni and other heavy metal impurities from the trivalent chromium electrolyte.</p> <p>To prevent an excess of iron in the bath, parts fallen into the electrolyte have to be removed on a regular basis.</p> <p>Drag-in of nickel electrolyte from previous plating steps should be minimized by the following measures:</p> <ul style="list-style-type: none"> ▪ good triple cascade rinsing after nickel plating with continuous fresh water addition ▪ air agitation in the rinsing tanks and/or double immersion of the parts into each rinsing bath ▪ recovering rinse before chromium plating at pH 3 (pH-correction with hydrochloric acid)

recommended process sequence (for steel parts):

1. soak cleaning SurTec 190/091 + triple cascade rinsing
2. hydrochloric acid pickling SurTec 424 + triple cascade rinse
3. anodic electrolytical cleaning SurTec 190/091
+ triple cascade rinse
4. neutralisation SurTec 481
5. recovering rinse (r.r.), before and after step 6
6. semi bright nickel plating SurTec 854
+ r.r. + triple cascade rinse
7. recovering rinse, before and after step 8
8. bright nickel plating SurTec 855 + r.r. + triple cascade rinse
9. recovering rinse, pH 3, 35°C, 30 s, before and after step 10
10. chromium electroplating SurTec 876 + r.r. + triple cascade rinse
11. post dip 1: 5 ml/l H₂O₂ at 40°C for 30 s
12. [optional: post dip 2: 3 % SurTec 104, 15 s + fresh water rinse]
13. hot air drying at 80°C for 15 min

The rinsing methods have to be adapted to the plating line.



Technical Specification

(at 20°C)	Appearance	Density (g/ml)	pH-value (conc.)
SurTec 876 M	liquid, dark green-bluish	1.389 (1.35-1.43)	0.7 (< 2)
SurTec 876 C	powder, white	1.050 (0.99-1.11) kg/l	ca. 4.5 (at 1 %)
SurTec 876 I	liquid, yellowish	1.003 (0.99-1.02)	4.2 (3.5-5)
SurTec 876 II	liquid, colourless	1.363 (1.35-1.38)	7 (6-8)
SurTec 876 III	liquid, yellow-brown	1.071 (1.05-1.09)	1 (< 2)

Maintenance and Analysis

Analyse the chromium content regularly and adjust with SurTec 876 M Chromium Concentrate.

Analyse the boric acid concentration and correct it with SurTec 876 C Conductivity Salt.

Control and adjust the pH-value regularly.

Sample Preparation

Take the sample at a homogeneously mixed position and keep the temperature at 32 °C to prevent a crystallisation. If the sample is turbid, let the turbidity settle down and decant or filter the solution.

Chromium(III) – Analysis by Titration

reagents:	sodium hydroxide (10 %) H ₂ O ₂ (30 %) hydrochloric acid (conc.) potassium iodide 0.1 N sodium thiosulfate solution (= 1 mol/l) starch solution (1 %)
procedure:	<ol style="list-style-type: none">1. Pipette 10 ml bath sample into a 100 ml volumetric flask.2. Complete to 100 ml with deionised water and mix well.3. Pipette 10 ml of this diluted sample into a 250 ml Erlenmeyer flask.4. Add 50 ml deionised water.5. Adjust the pH-value to about pH 10 with 10 % sodium hydroxide solution.6. Add 1 ml H₂O₂ (in order to oxidize all chromium(III) to chromium(VI)).7. Heat the solution to boiling (the solution should become clear and its colour should change to yellow).8. While stirring well, continue boiling until the excess of H₂O₂ has been completely decomposed or evaporated. Boil continuously until the solution is reduced to a bare minimum and becomes viscous (be careful to remove the flask timely from the heater, before the solution begins to run dry and starts sputtering).9. Dilute with approx. 100 ml deionised water.10. Add 10 ml conc. hydrochloric acid (the colour of the solution changes from yellow to orange).11. Add und dissolve 1 g potassium iodide.12. Immediately titrate with 0.1 N sodium thiosulfate solution until its colour turns to weakly yellow.13. Add some drops starch solution.14. Quickly continue the titration until the blue colour disappears.
calculation:	consumption in ml · 1.7332 = g/l Cr(III)
correction:	6.67 ml/l of SurTec 876 M Chromium Solution equals 1 g/l Cr(III)

Boric Acid – Analysis by Titration

reagents:	0.1 N NaOH solution EDTA sodium salt mannitol NaOH solution (15 %)
procedure:	<ol style="list-style-type: none">1. Pipette 2 ml bath sample into a 250 ml Erlenmeyer beaker.2. Dilute with approx. 50 ml deionised water.3. Add 2-4 g EDTA salt.4. Adjust the pH-value to pH 7.9 with 15 % NaOH solution.5. Add so much mannitol to the clear solution, until the pH is not changing more than 0.1 points (approx. 10 g).6. Titrate with 0.1 N NaOH solution to pH 7.9 again.
calculation:	consumption in ml · 3.09 = g/l boric acid
correction:	5.2 g/l SurTec 876 C Conductivity Salt equals 1 g/l boric acid

SurTec 876 II – Analysis by Titration

reagents: sodium carbonate solution (5 %)
potassium iodide solution (10 %)
sulfuric acid (50 %)
0.1 N sodium thiosulfate solution
0.15 N potassium permanganate solution
starch solution (1 %)

procedure:

1. Filter a sample of the plating solution through a fine-grained filter paper, and afterwards do NOT wash the filter.
2. Pipette 0.5 ml of the filtrated solution into a 250 ml Erlenmeyer **flask A**.
3. Prepare a second 250 ml Erlenmeyer **flask B** for the blank analysis.
4. With a graduated pipette, add 5 ml of 5 % sodium carbonate solution to each of the **flasks A** and **B**.
5. Shake **flask A** slightly until the initially heavy gas evolution and foaming has calmed down.
6. Place both flasks into a boiling water bath and heat for 30 min, or until all the ammonia is evaporated (no more smell in **flask A**). Every 10 min, rinse the inner walls of the flasks with small amounts of deionised water.
7. Finally remove the flasks from the boiling water, and rinse the inner walls once again.
8. After cooling down, pipette 10 ml of 0.15 N potassium permanganate solution into each of the flasks and mix very well, so that any precipitate can react.
9. Place the flasks into the boiling water bath again for 5 min, and finally rinse the inner walls with max. 5 ml deionised water.

Proceed with the following steps with **flask A** first and subsequently repeat the steps with **flask B**:

10. Add 5 ml of 50 % sulfuric acid and mixing well.
11. Add 5 ml of 10 % potassium iodide solution.
12. Immediately titrate with 0.1 N sodium thiosulfate solution until the colour turns into light yellow.
13. Add some drops of the starch solution.
14. Quickly continue the titration until the dark blue colour disappears and a clear light bluish colour is left.

calculation: **A** = consumption of 0.1 N sodium thiosulfate in ml for the sample
B = consumption of 0.1 N sodium thiosulfate in ml for the blank
(B - A) · 12 = ml/l SurTec 876 II Catalyst

Chloride – Analysis by Titration

reagents:	sodium chromate solution (10 %) 0.1 M silver nitrate solution
procedure:	1. Pipette 10 ml bath sample into a 100 ml volumetric flask 2. Complete to 100 ml using deionised water and mix very well. 3. Pipette 10 ml of this dilution into a 250 ml Erlenmeyer flask. 4. Add 50 ml/l of deionised water. 5. Add 10 ml of the 10 % sodium chromate solution. 6. Titrate with 0.1 M silver nitrate solution until the solution turns permanently yellow.
calculation:	consumption in ml · 3.5453 = g/l chloride
correction:	2.2 g/l SurTec 876 C Conductivity Salt equals 1 g/l chloride

Hull Cell Test

Before chromium plating, freshly plate the Hull cell panels in a bright nickel electrolyte (e.g. SurTec 855) and rinse with tap water that has been adjusted with hydrochloric acid to pH 3-4.

Perform all tests in a standard 250 ml Hull cell at 3 A for 3 min, using a graphite anode. Rinse the panel with tap water and dry it with compressed or with hot air.

Bath Impurities

Iron

For best layer appearance, the electrolyte needs an iron content of 30-70 ppm in the solution. It improves the throwing power and minimizes effects of low zinc contamination. Greater amounts of iron (caused by parts fallen into the bath or too long currentless stands inside the bath) will disturb the deposition. The chromium layer becomes dark (fluffy stains at medium current density areas), the throwing power will be reduced and inner stress occurs in the deposited layer.

An excess of iron can only be removed with the special ion exchange SurTec 876 IAT (request to SurTec Germany).

Heavy Metals

Impurities of heavy metals cause dark depositions in the low current density, and the throwing power will be reduced. They can be removed with the ion exchange SurTec 876 IAT as well as iron. They also can be worked out at low current density, but it needs a lot of time and this is not economical.

To reach a chromium layer with the same appearance as plated in a hexavalent electrolyte, the following metal concentrations must not be exceeded:

<u>metal impurity</u>	<u>concentration</u>
iron	80 ppm
nickel	25 ppm
copper	5 ppm
zinc	5 ppm
lead	1 ppm
chromium(VI)	1 ppm
aluminium	no limit known

The electrolyte does not tolerate Cr(VI) and lead. Both metals should be strongly avoided.

Lead causes spots in the deposit starting with white patches, haze in the low current density spreading around to the back side of the panel, part together with reduced coverage or even non-plated areas or adhesion problems in the hcd at higher concentrations. It can only be removed by selective working-out at 1.5-2 A/dm².

Hexavalent chromium reduces the deposition rate drastically. Small additions of hydrogen peroxide (0.2-0.5 ml/l) reduce Cr(VI) to Cr(III). But some additives might also be destroyed by this treatment.

Organic Impurities

Organic impurities are seldom. They will lead to reduced brightness and ductility of the deposited layer. Higher amounts of undesired organic can lead to burnings. An active carbon treatment will remove the organic impurities. Afterwards, the Wetting Agent has to be re-added, and the bath has to be adjusted in a Hull cell test.

Consumption and Stock Keeping

The components of SurTec 876 are consumed electrolytically and by the way of drag-out.

Electrolytic Consumption: (per 10,000 Ah)

SurTec 876 M	Chromium Concentrate	6.5 l
SurTec 876 I	Wetting Agent	0.3 l
SurTec 876 II	Catalyst	0.5 l

Drag-Out Consumption:

Please note, SurTec recommends employing a recovering rinse for better activation of the nickel layer and for reducing the drag-out by 50 % (see process sequence). For exact determination of the drag-out see [SurTec Technical Letter 11](#).

The following values can be taken as estimated average consumption:

drag-out in ml/m ² :	<i>recovering rinse</i>	
	NO	YES
<i>barrel:</i>	200	100
<i>rack:</i>	50	25

10,000 Ah electroplates 450 m² with 0.3 µm chromium. With that the drag-out consumption of the components of SurTec 876 can very roughly be expressed in units of 10,000 Ah consumption:

	<i>drag-out = 25 ml/m²</i>	<i>total (incl. el. consumption)</i>
SurTec 876 M	1.4 l	7.9 l
SurTec 876 C	3.0 kg	3.0 kg
SurTec 876 I	–	0.3 l
SurTec 876 II	0.7 l	1.2 l
	<i>drag-out = 100 ml/m²</i>	<i>total (incl. el. consumption)</i>
SurTec 876 M	5.6 l	12.1 l
SurTec 876 C	12.0 kg	12.0 kg
SurTec 876 I	–	0.3 l
SurTec 876 II	2.8 l	3.3 l
SurTec 876 III	only if necessary and after recommendation of the lab	

Additions to the bath should be done all 2-4 Ah/l electrolyte, to minimize the variations of the concentration and to give the substances time to react at working temperature.

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

SurTec 876 M	Chromium Solution	210 kg
SurTec 876 C	Conductive Salt	60 kg
SurTec 876 I	Wetting Agent	25 kg
SurTec 876 II	Catalyst	100 kg
SurTec 876 III	Adjuster	25 kg
SurTec 876 IAT	Ion Exchange Resin	60-100 l

Ingredients

SurTec 876 C

- boric acid

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:

<u>product</u>	<u>hazard designation</u>	<u>water hazard class</u>
SurTec 876 M	C - Corrosive	WHC 2
SurTec 876 C	T - Toxic	WHC 2
SurTec 876 I	Xn - Harmful	WHC 1
SurTec 876 II	-	WHC 1
SurTec 876 III	Xi - Irritant	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>