HogMaZ

Hochleistungs**g**alvanisieren von **Ma**ssenteilen in einer **Z**entrifugenanlage
(High Performance Galvanising of Mass Articles in a Centrifuge)

- Disadvantages of Conventional Barrel Plating
- A New Technology Concept
  - Increase of Space/Time Efficiency
  - Minimisation of Electrical Resistance
  - Non-Cyanide Alkaline Zinc Plating and Catalytic Zinc Generator
  - ZincOperator
- Status – Next Steps

Disadvantages of Conventional Barrel Plating

- electroplating lines with high throughput are occupying large **surfaces**
- during the plating process in these lines, **widely spread emissions** are produced, requiring a special periphery in respect of waste air and water
- mass articles are **transported** with high efforts from production sites to plating shops (and back)

Conventional Barrel Plating	HogMaZ Concept
several parallel zinc plating stations result in a high demand on surface to reach an economical capacity	high space/time efficiency, low demand on surface
current density 0.5-1 A/dm^2; 15 µm in 60-160 min	current density 5-10 A/dm^2; 15 µm in 10 min
high drag-out, high amount of waste water	reduced drag-out due to spinning
open tanks: fumes, mist ...	plating in a closed system
high performance (50,000-200,000 m^3/h) exhaust required, high energy losses in cold seasons	emission-free, no exhaust system required

A New Technology Concept

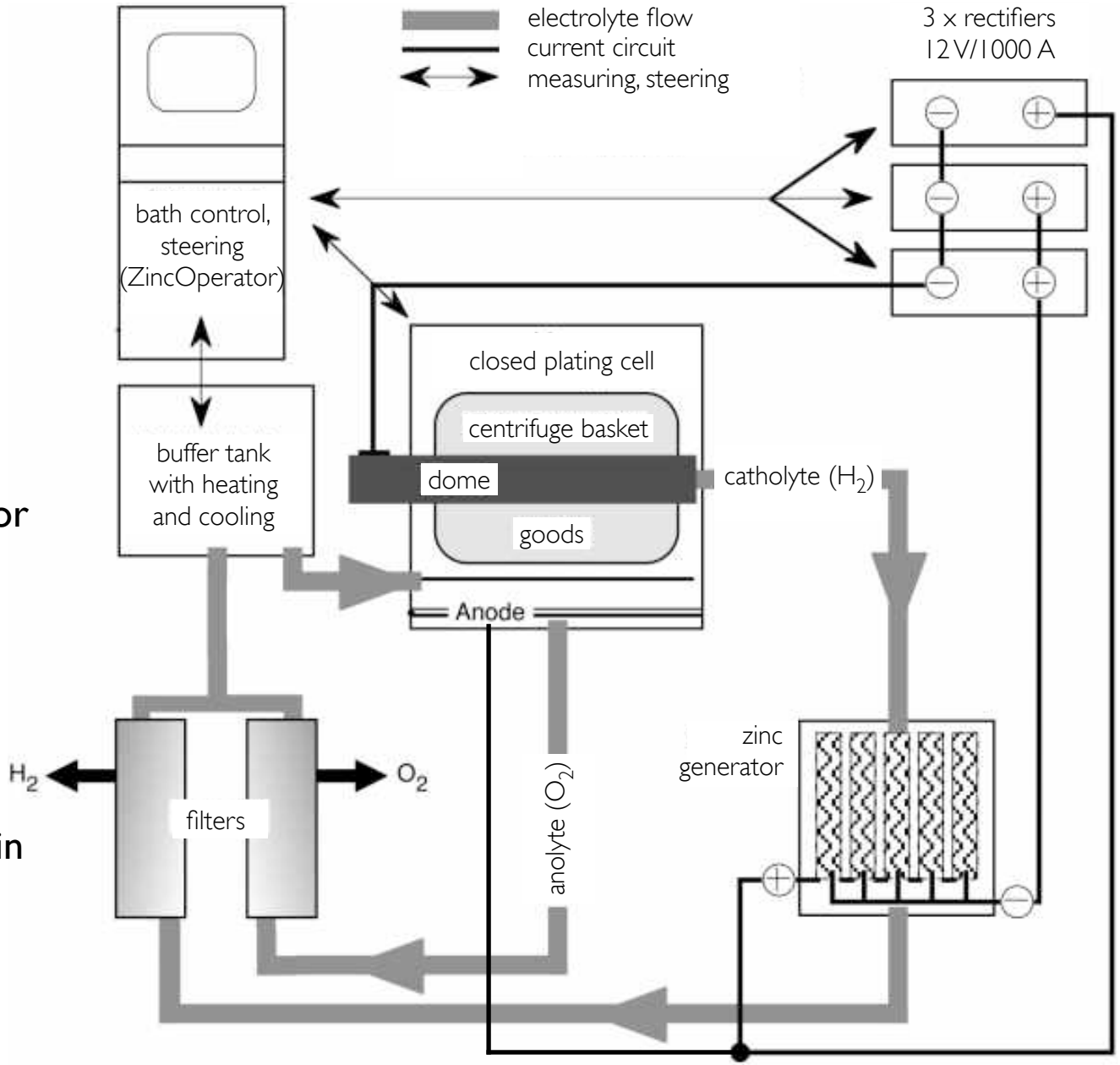
- Basic Ideas:
  1. the electrolyte comes to the goods
  2. a closed plating cell
  3. low drag-out by spinning

- $\Longrightarrow$ centrifuge technique

- with the HogMaZ concept both small production-integrated machines as well as large central lines with high capacity are possible

- the prototype of a HogMaZ zinc plating machine was developed and constructed

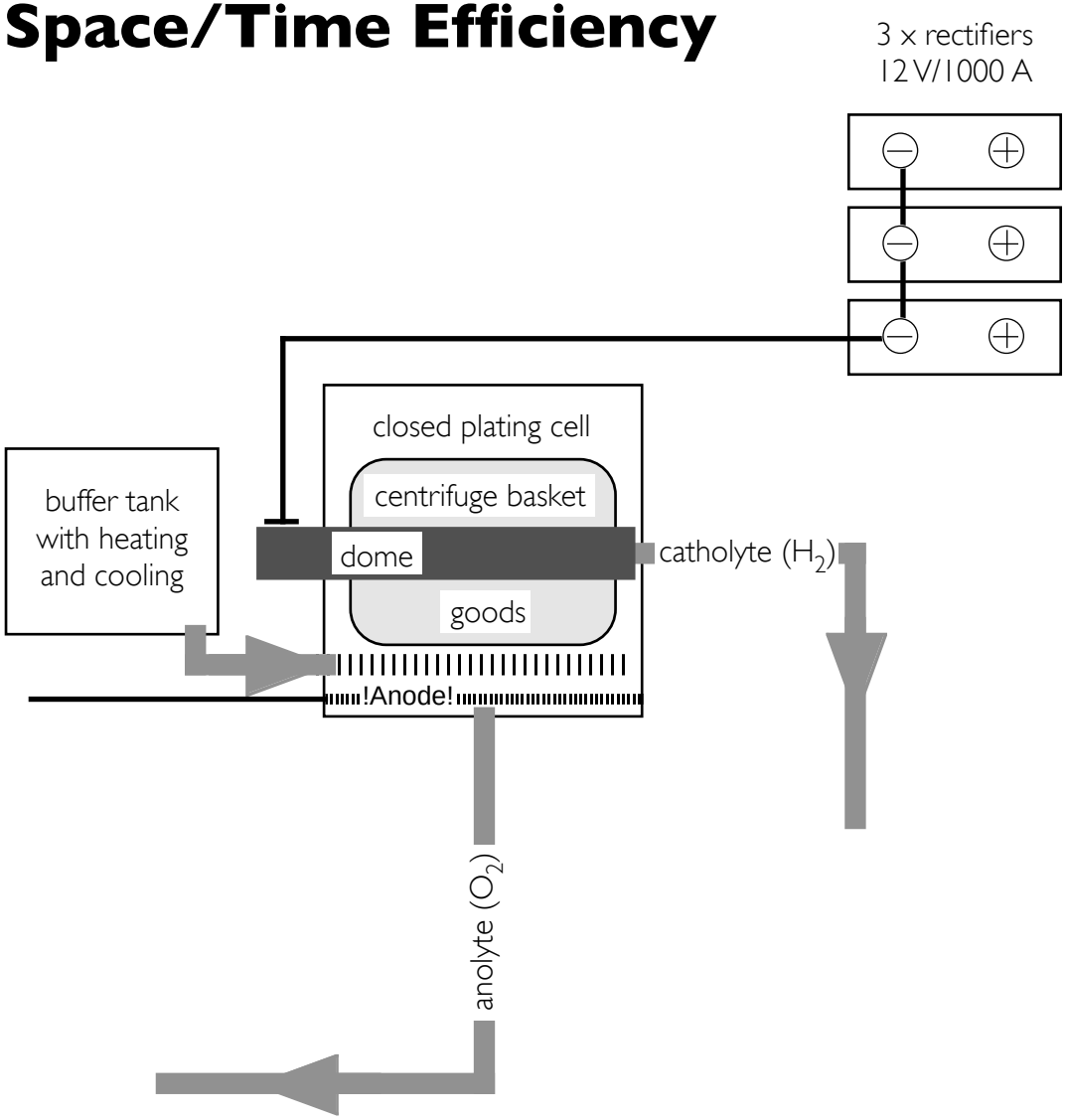
- closed cell with inert anodes
- separation of anolyte and catholyte
- turbulence, high convection
- the large contact area (dome) can transport high currents
- the catholyte is sucked off into the dome inside and then streams through the electrically adjustable zinc generator
- the anolyte is sucked off through the anode grids to the rear
- gases are separated in the filter units and used for heating
- both electrolyte streams are reunited in the buffer tank
- there the electrolyte is checked and adjusted by the ZincOperator

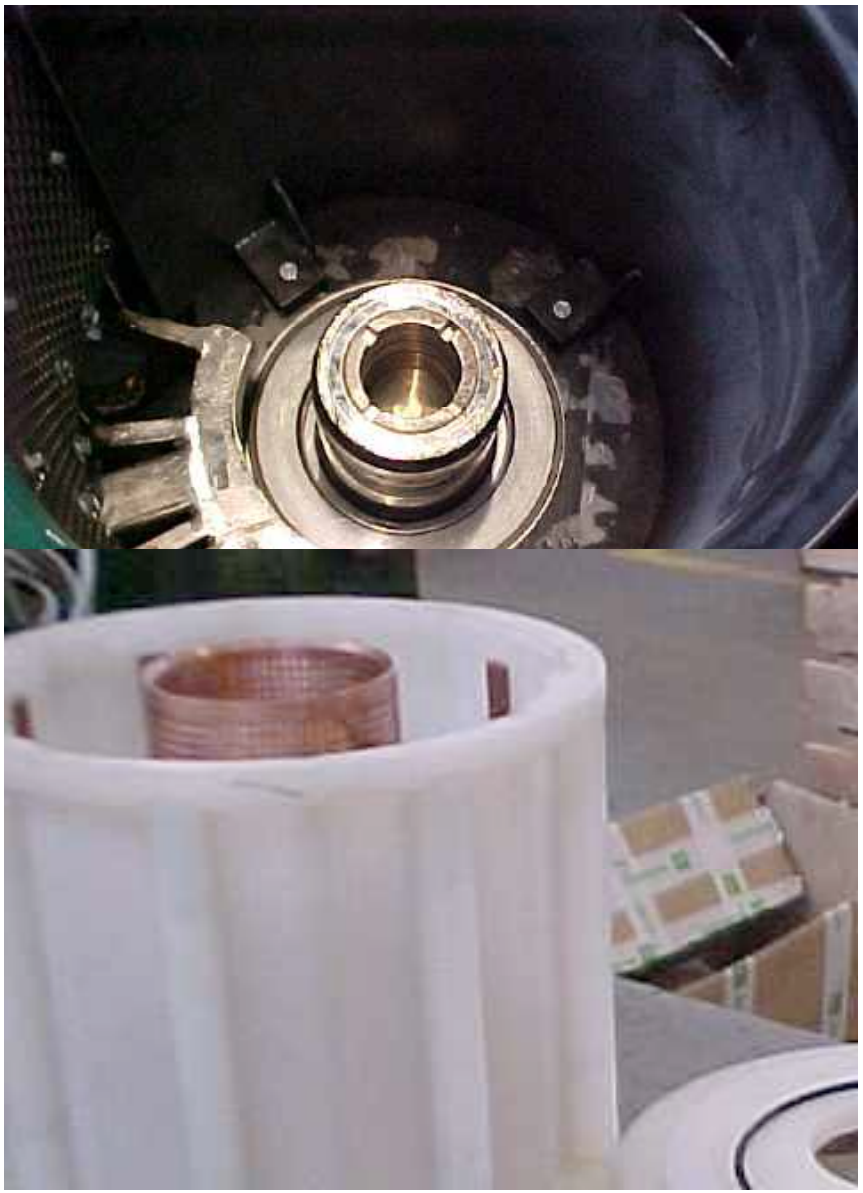


Increase of the Space/Time Efficiency

- in heterogeneous electrochemical processes, **mass transport** is the limiting factor
- in order to increase the space/time efficiency, every measure is sensible which is **accelerating** the mass transport:
  - rise of **concentration**
  - improvement of the **electrolyte exchange** to prevent zones of poor concentration
  - increase of the **working temperature** to lower the viscosity and to rise the coefficient of diffusion
  - increase of the **relative speed** between electrode surface and electrolyte in order to decrease the diffusion layer thickness and thus the mass transport into the reaction zone at the surface
  - optimisation of electrode shape and position for a uniform **current distribution**
- all these general principles are valid for electroplating, as continuous lines are showing impressively (e.g. tube plating at 400 A/dm^2)

Increase of the Space/Time Efficiency





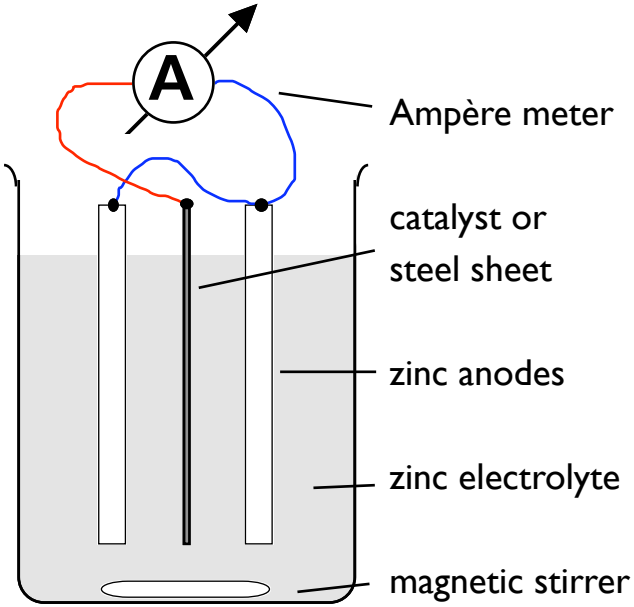
Minimisation of the Electrical Resistance

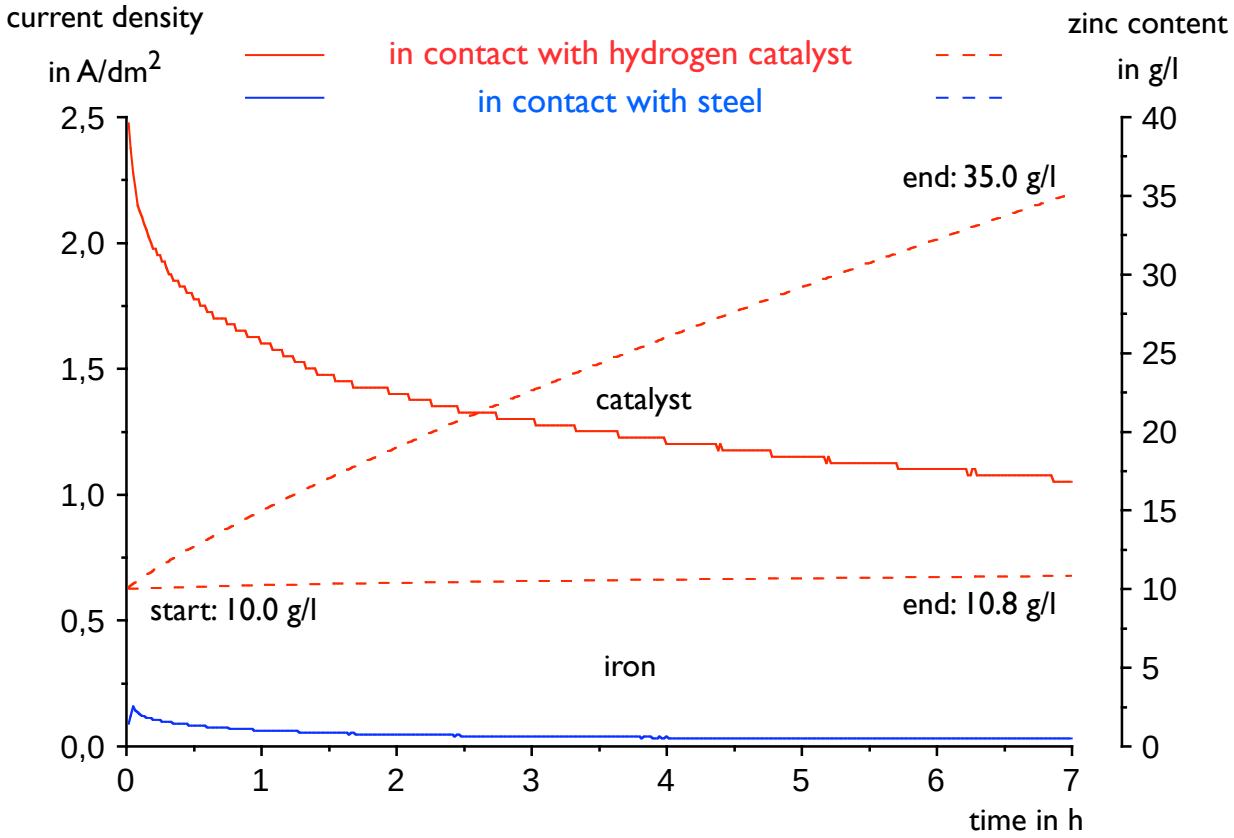
- in order to be able to work with high current densities, everything must be done in favour of a low electrical resistance:
  - correct choice of the **conductivity salt** (e.g. potassium instead of sodium)
  - concentration rise to the **conductivity maximum**
  - **temperature increase** for the further rise of the electrolytic conductivity
  - increase of the **electrode surface**
  - decrease of the **anode/cathode distance**
  - effective **removal** of the gases from the electrode surface and from the electrolyte in front of it
  - optimisation of the **barrel perforation**
  - optimisation of the **electrical contacts** of goods, anodes and current supply

Non-Cyanide Alkaline Zinc Plating

- a non-cyanide alkaline electrolyte was selected to test the prototype
- simple electrolyte system, typical process for mass articles, suited for a high load, automatic steering available, inert anodes possible
- because inert anodes are necessary, the metal cation must be delivered by an utmost effective zinc generator
- investigations in the project:
  - optimisation of the potassium zincate based electrolyte
  - adaptation of the additive system

Catalytic Coated Zinc Generator



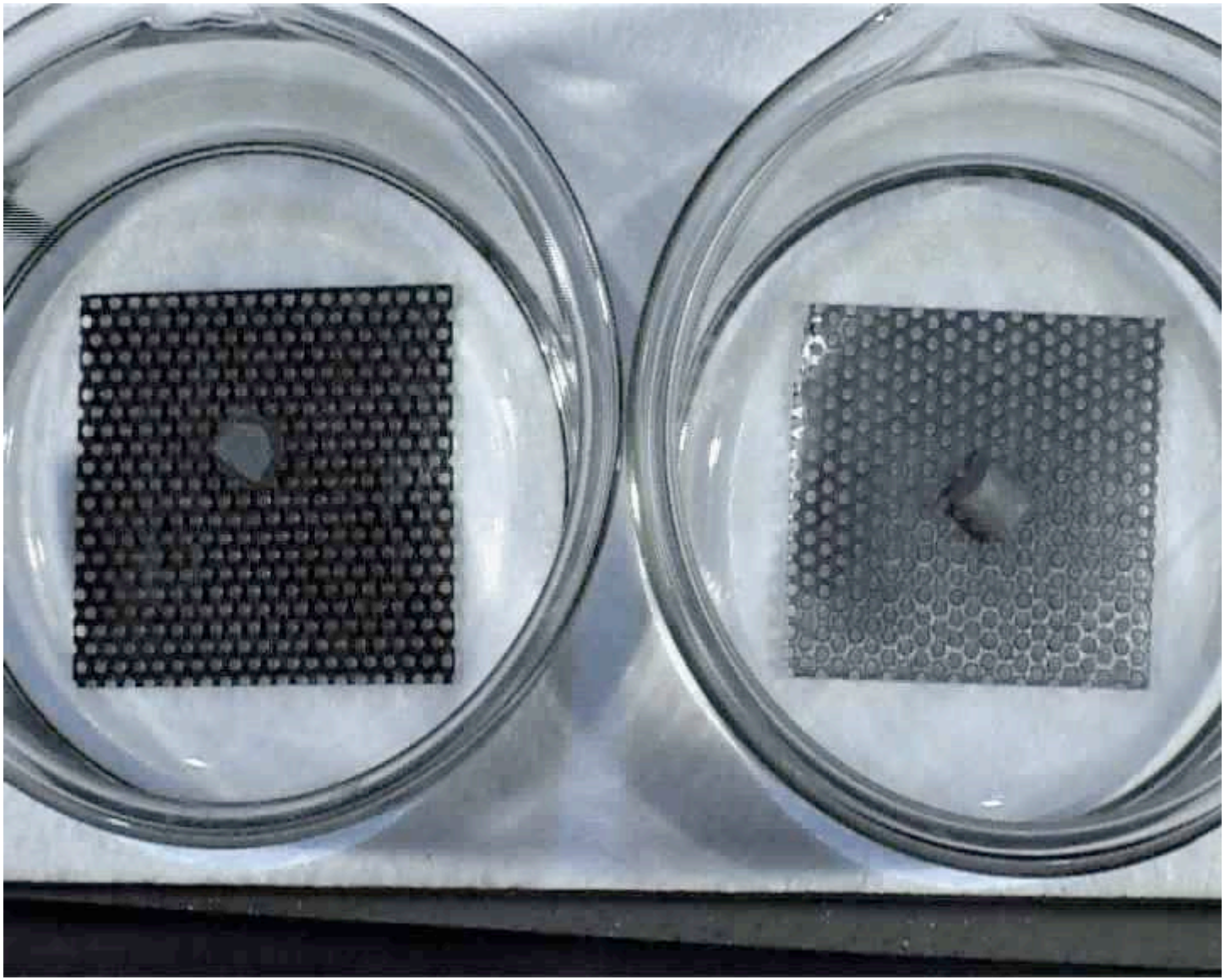


in contact with the SurTec catalyst, zinc dissolves in the average at 1.5 A/dm² (catalyst surface), the dissolution rate is more than 10x greater than with steel

Catalytic Coated Zinc Generator

left:
strong zinc dissolution
in contact with the
SurTec hydrogen catalyst

right:
hardly any zinc dissolution
in contact with iron



- because of the relatively small electrolyte volume, the closed plating cell and the fast changes, an automatic steering of the electrolyte is necessary
- the ZincOperator controls all chemical components:
  - the **zinc** content by steering the electrically adjustable catalytic zinc generator
  - the **alkalinity** by measuring the conductivity, dosage of liquid potassium hydroxide solution
  - the **organic additives** by evaluation of the current/voltage curve (direct control of the deposition conditions, no analysis of any concentration)
- the ZincOperator is documenting all steps

- the HogMaZ process is based on a project partnership of the following companies:
  - SurTec Deutschland GmbH
  - WMV-Apparatebau GmbH & Co.KG
    (common development and patent ownership)
    - Richard Tscherwitschke GmbH (barrel)
    - Ole Hansen (engineering)
- the official project is accomplished – HogMaZ was presented on Hannover Fair 2004

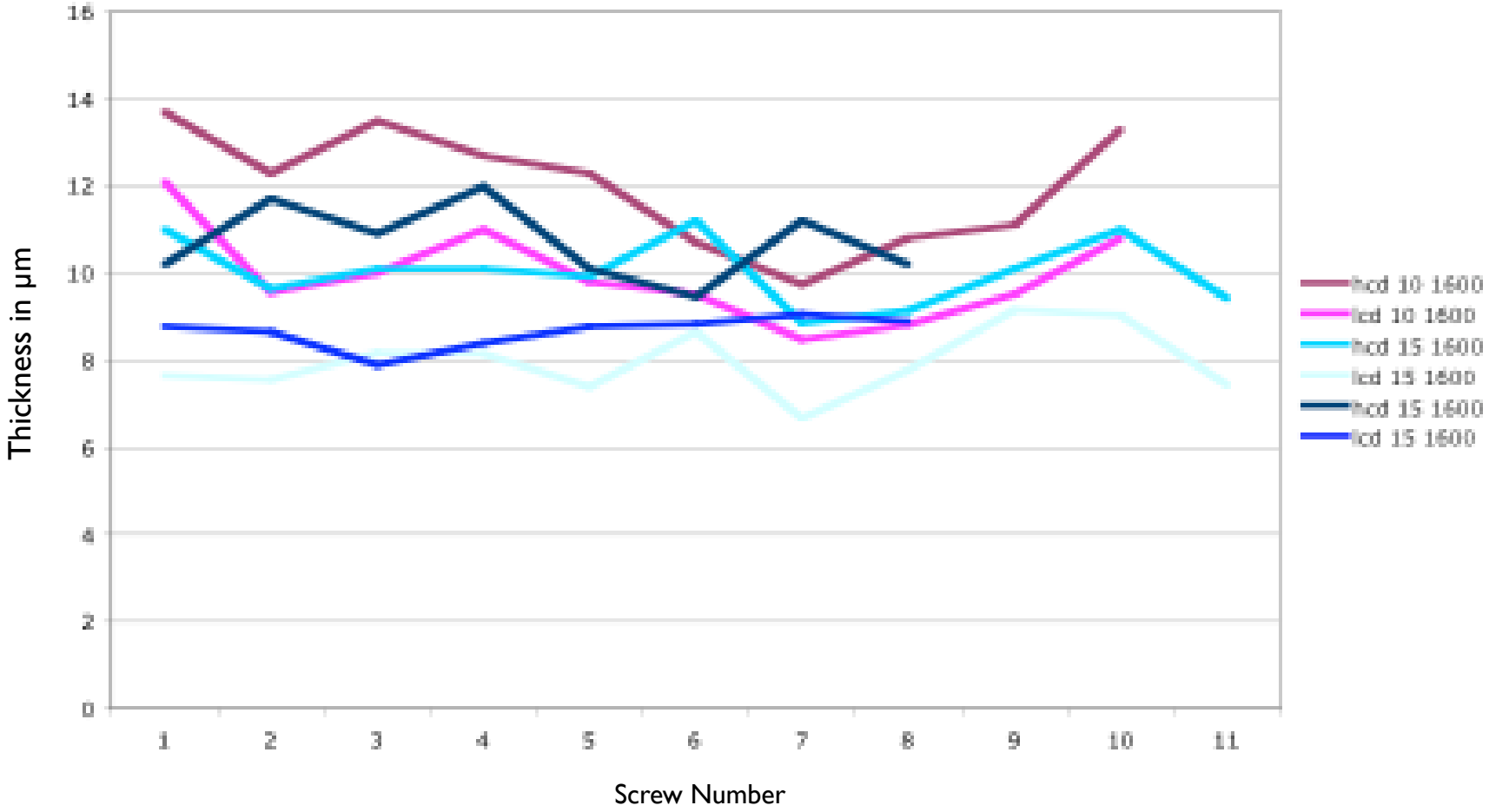
Status Summer 2004

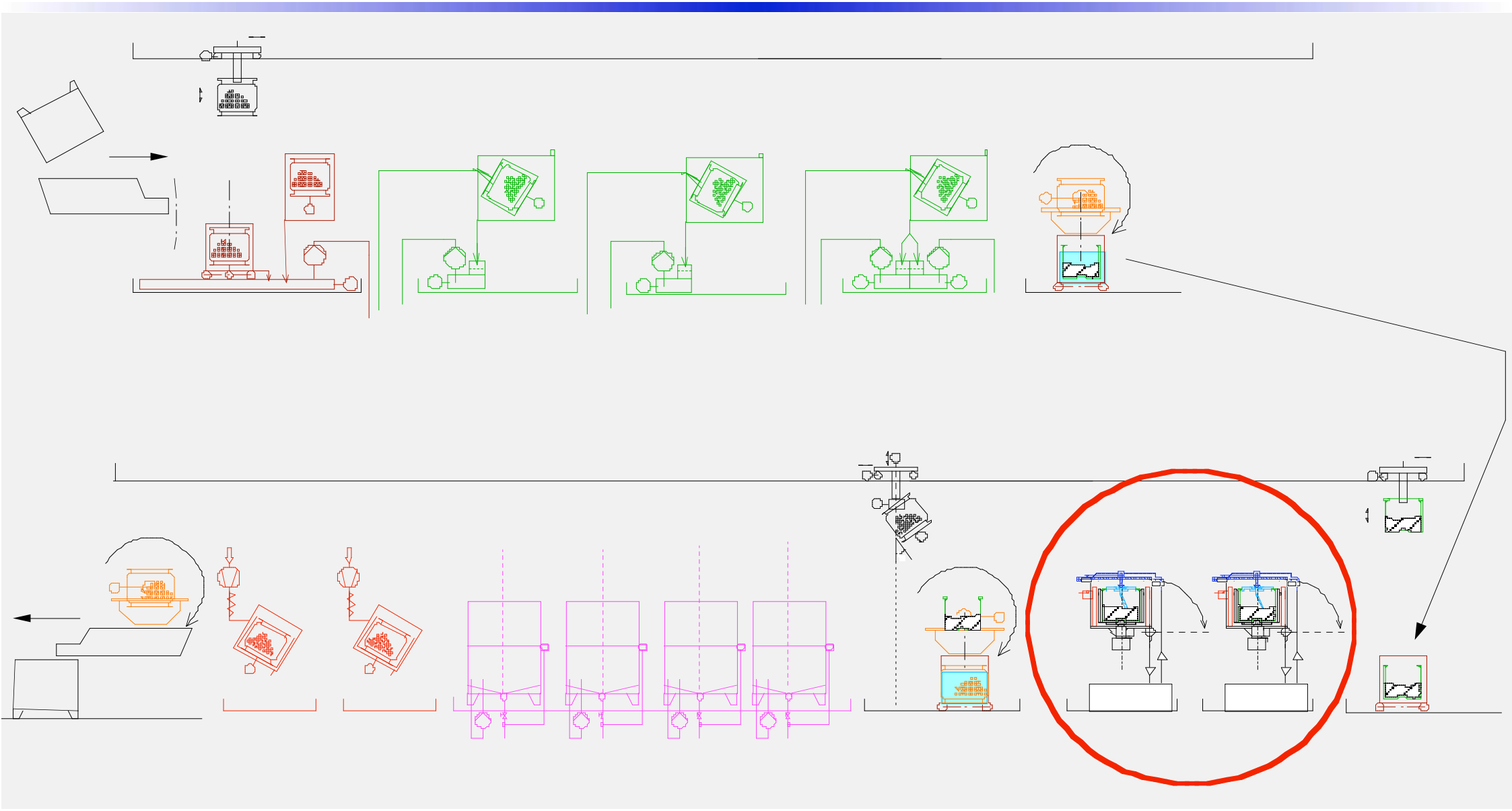
- the prototype is designed for the non-cyanide alkaline zinc plating with a lot size of 15 kg and current densities up to 10 A/dm^2
- during the trials, mainly M 8 x 60 screws with inner hexagon were plated
- the technical targets of HogMaZ were closely achieved (deposition rates of 10-12 µm in 10 min)
- in one cell of prototype size, an output of 60-90 kg per hour is possible (incl. load/unload)
- after Hannover Exhibition, the prototype was reworked by WMV according to technical observations during the first test phase in Zwingenberg

Status Summer 2004

- 12 kg screws zinc plated with 7 A/dm^2 at 60 °C in the HogMaZ-Prototype
- 10 µm in 10 min, chromited with SurTec 680

Metal distribution





introduction of HogMaZ into a centrifuge line with pre- and post treatment

- re-installation of the prototype in Zwingenberg
- further trials in the prototype:
  - maximum deposition rate in the prototype (do we get the 15 µm in 10 min now?)
  - shorter pretreatment (ultrasonic, possible omission of pickling and/or electrocleaning?)
  - does HogMaZ have reduced hydrogen impact on hardened parts?
- in parallel, lay-out of a customer project (size about 2x of the prototype), including pre- and posttreatment AND a special frame design for rack parts (heavy drilled parts with sharp edges)
- in parallel, lay-out of a customer project (2-4 cells of ~2x prototype size), including pre- and posttreatment, with a special cell design for specific parts (very long fasteners, currently extremely difficult to plate); output = 300-600 kg/h
- in parallel, design and construction of a 3-4x size pilot line until summer 2005 (outside of a real customer project); formation of a joint engineering group (linked to the international R&D Centre)