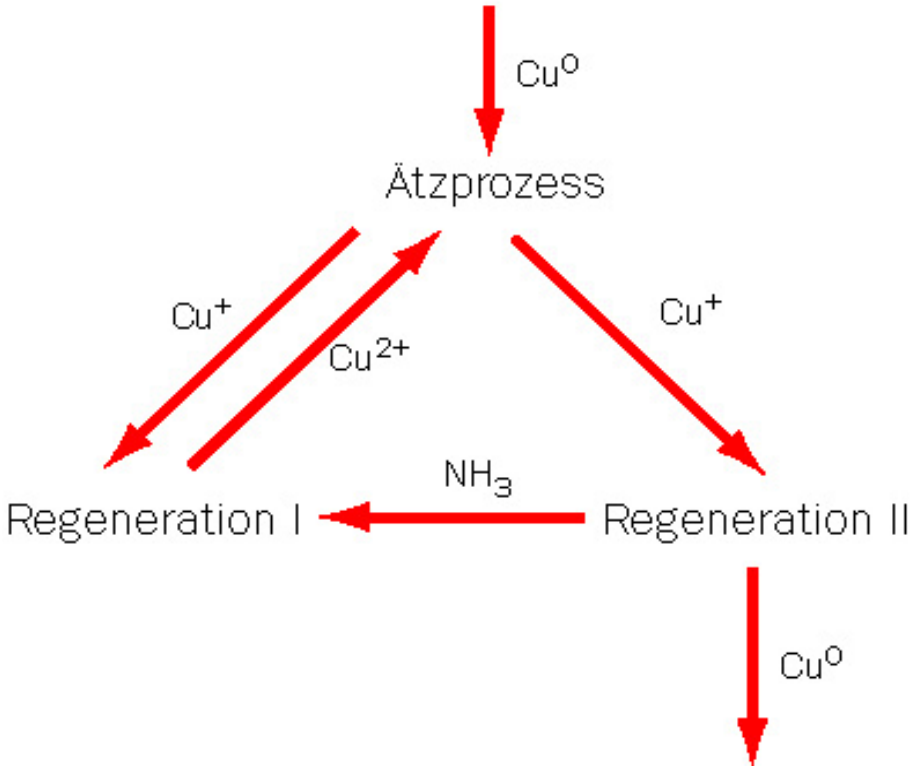
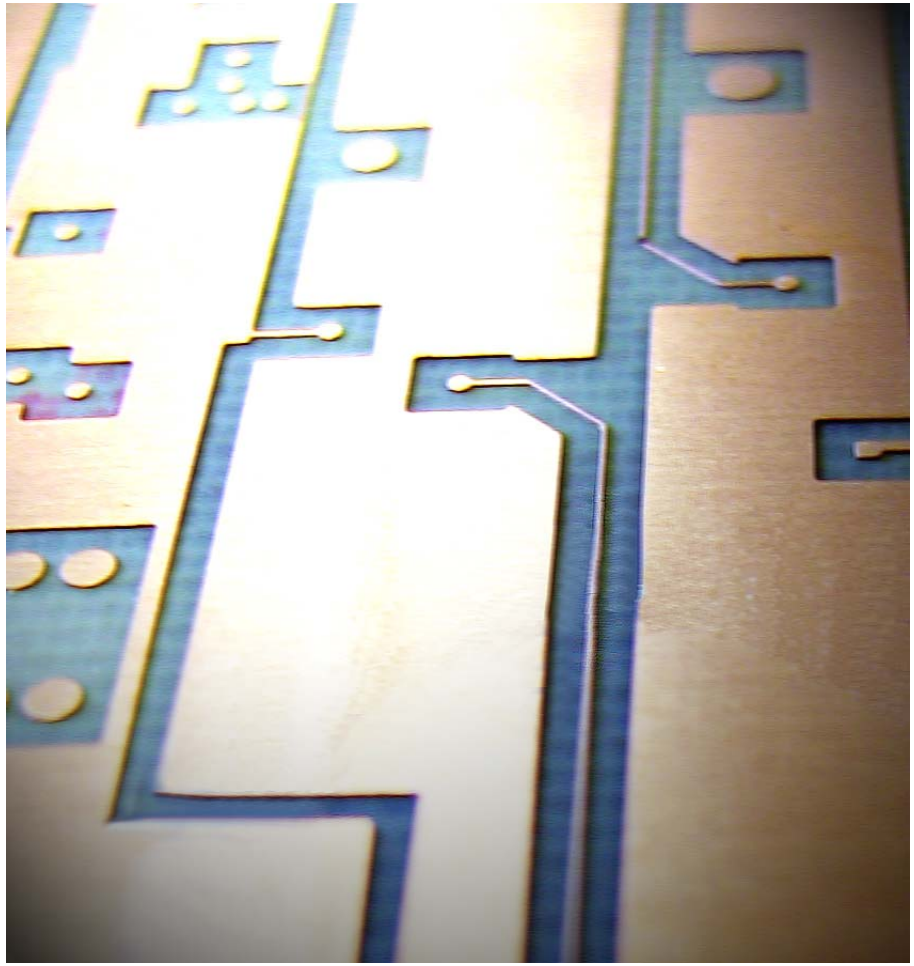
ELO-CHEM – Closed loop process



Highest quality with the ELO-CHEM process



Integrated etching and copper recovery process The successful step towards for quality, speed and precision

Integrated process means:

Considering the entire production sequence “etching” chemically as well as equipment related.

Focusing customer requirements by coordinating technical demands and rigid cost effectiveness.

ELO-CHEM-CSM process competence to achieve best quality and production reliability.

The process

Two physical different regeneration circulations of the etching solution:

Regeneration I:

Continous reactivation and reoxidation of the etching solution in the first closed loop process.

Regeneration II:

Recovery of the etched-in copper by electrolysis in the second closed loop process.

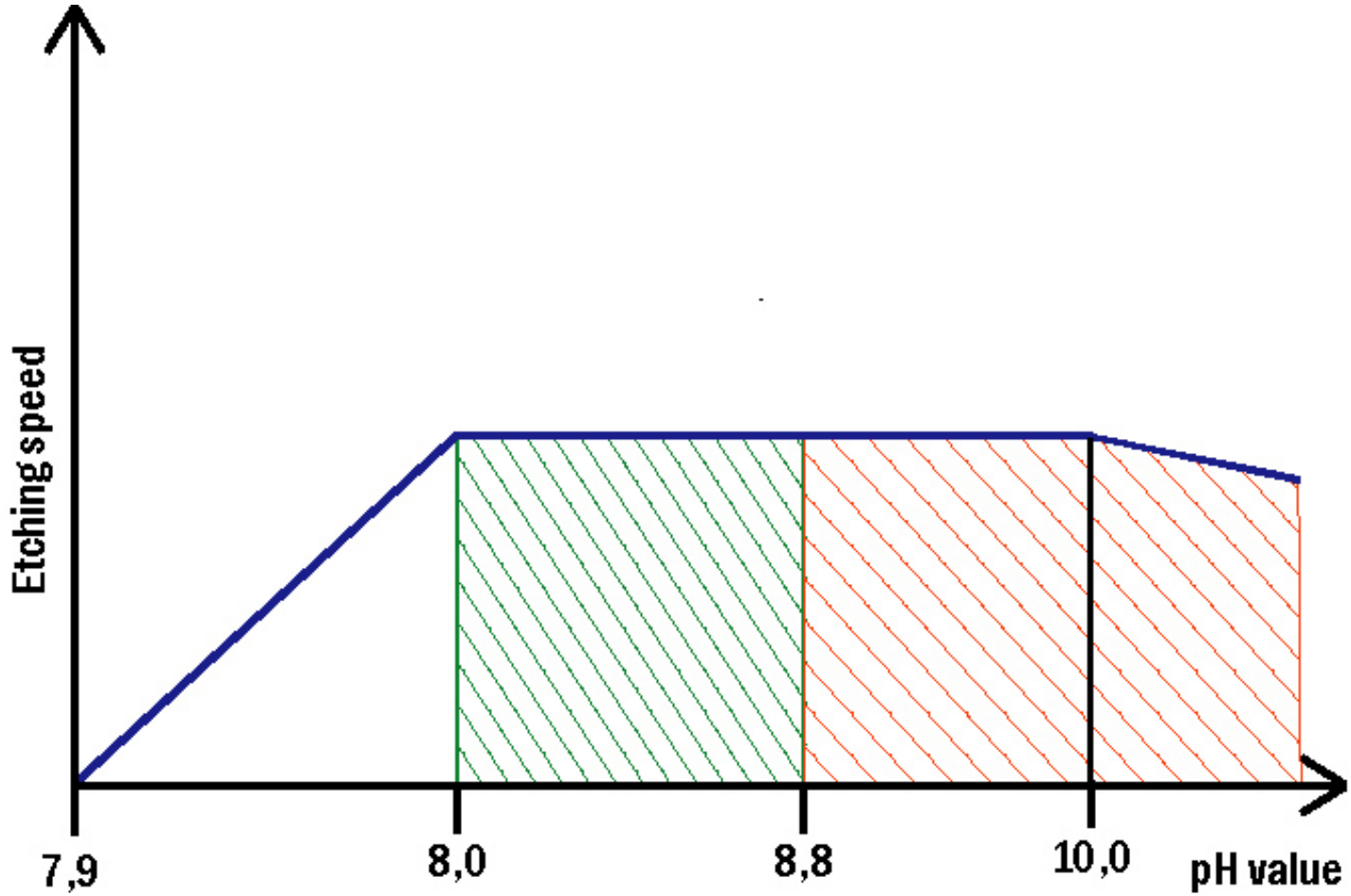
– Reoxidation and stabilization of the etching solution

Atmospheric oxygen is required for the oxidation process. The air is mixed into the etching agent with the help of the injector pump.

The installation is designed so that the extracted air is first conducted to the electrolytic cell where it entrains the gases created by electrolysis (oxygen, O2, and ammonia, NH3) and conveys them together with extracted air and gases from the etching module and from intermediate/storage tanks to the injector pump.

To etch copper with the etching agent there must always be a sufficient supply of bivalent copper ions. Regeneration I must always be switched on with the ELO-CHEM-CSM process during etching.

Recycling of gases in closed loop for pH stability at very low level



– Recycling of the etched-in copper

The etching agent used by ELO-CHEM is basically equivalent to the other popular ammoniac etching agents. In contrast to these, how-ever, copper chloride is replaced with copper sulphate. On one hand, this resulted in a slower etching process but, on the other, it permits direct electrolysis of the etching agent without creating chlorine gas. The slower rate is compensated by the accelerator EloFast 40.

Copper harvesting from the inox plates without any problems, automatizable (option).

Income by fine copper selling (min. 96,7% purity).

Controlled by two density measurements of copper content of the etching agent.

Process running independent from the etching line.

Fine copper with only one recovery step

– Chemical background

Etching:

[Cu (NH3) 4] SO4 + Cu ----> 2 [Cu (NH3) 2] 2 SO4

simplified: 1 (Cu(NH3)4) 2+ + 1 Cu 0 ------> 2 (Cu(NH3)2) 1+

Reoxidation:

2[Cu (NH3)2]2 SO4 + 2(NH4)2 SO4 + O2 + 4 NH3 ----> 4 [Cu (NH3)4] SO4 + 2 H2O

simplified: 4 (Cu(NH3)2)1+ - 4 e- ------> 4 (Cu(NH3)4)2+

– Combination of the regeneration steps

The interplay of regeneration I and II is controlled by two density measurements of the etching agent. Both density measurements are performed in parallel. As soon as the copper content of the etching machine falls below the required density value 1 (80g Cu / l), regeneration II switches off automatically.

During the etching process Cu+ ions are formed from Cu ^{2}+ ions. These have to be transformed back to Cu ^{2}+ ions. This transformation is referred to as oxidation. This process requires oxygen.

If a density of over 80 g Cu/l is measured in the etching agent at density measurement I, the electrolysis starts to operate.
A second density measurement checks the level of copper in the electrolytic cell. If it falls below a required value 2 of 30 g Cu/l, an electrovalve valve opens and allows liquid with a high copper content (>80 g Cu /l) to flow in. If flows in from the bottom of the cell so that a liquid with a low copper content is displaced to the top and flows over the overflow back to the etching machine.

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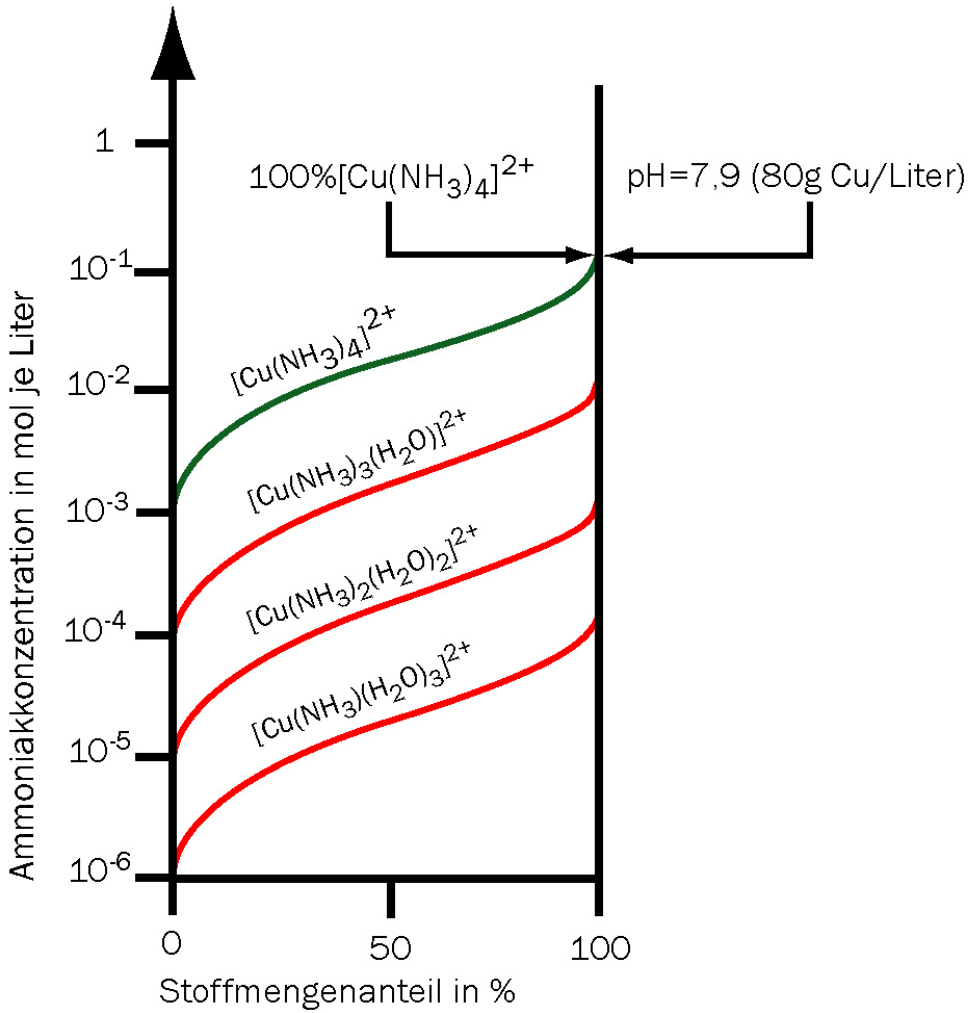
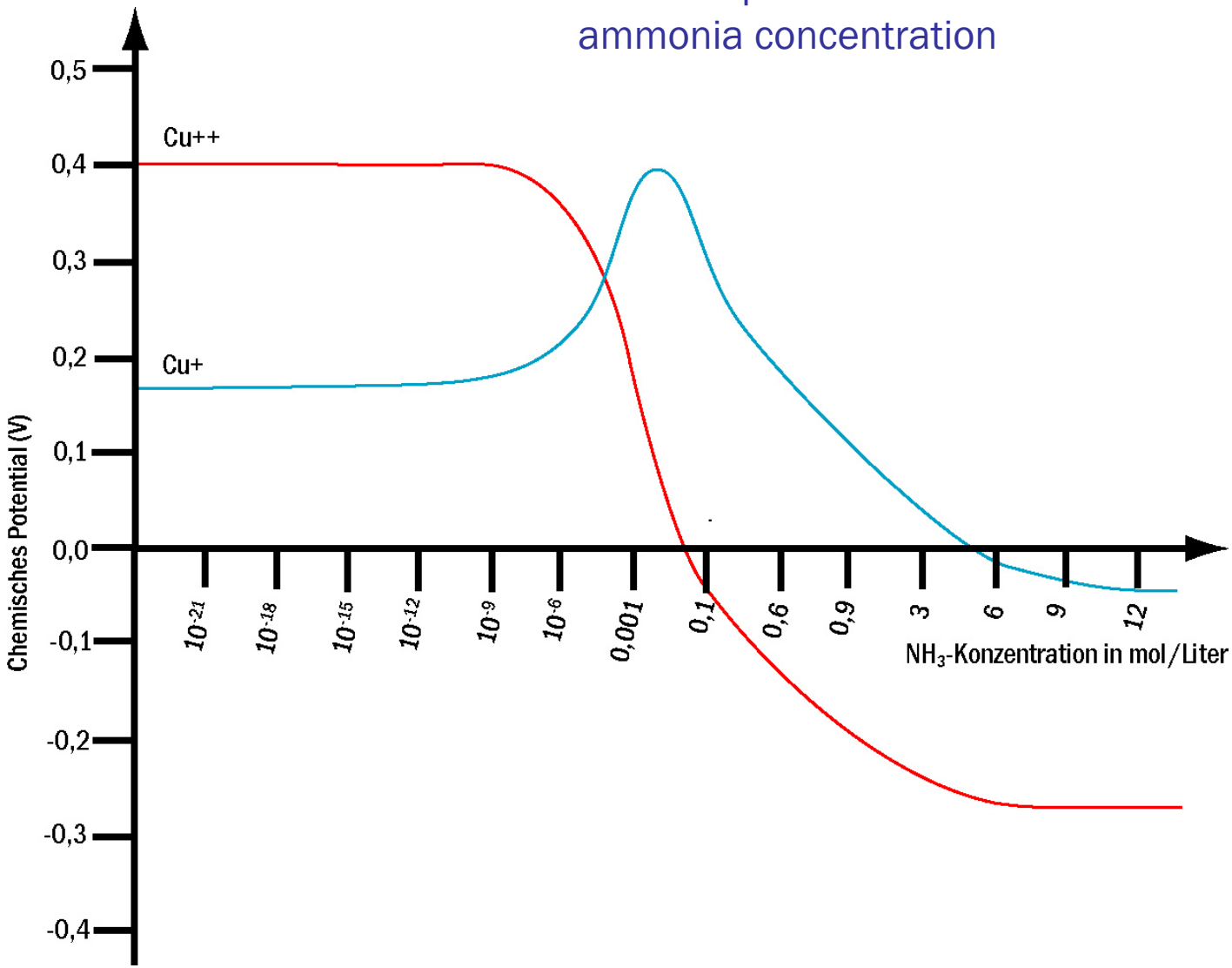
Process stability by optimized quantity of the desired copper tetraammin complex



Chemical potential of Cu^{+} and Cu^{++} and ammonia concentration



– Process basics

Etching

Etching speed:	ca. 40 µm/min with accelerator EloFast 60 ca. 20 µm/min without accelerator
Process precision:	ca. ± 1 µm/min with accelerator
Etching factor:	> 3
Solution temp.:	50 °C bis 55 °C

Elektrolyse

Copper recovery:	average 3 kg Cu/h (per recovery module)
Amps (inox plates):	ca. 12 A/dm^2
Current:	16 x 2,4 V to maximal 16 x 2,4 V (bipolare Schaltung)

– Basics/consumption

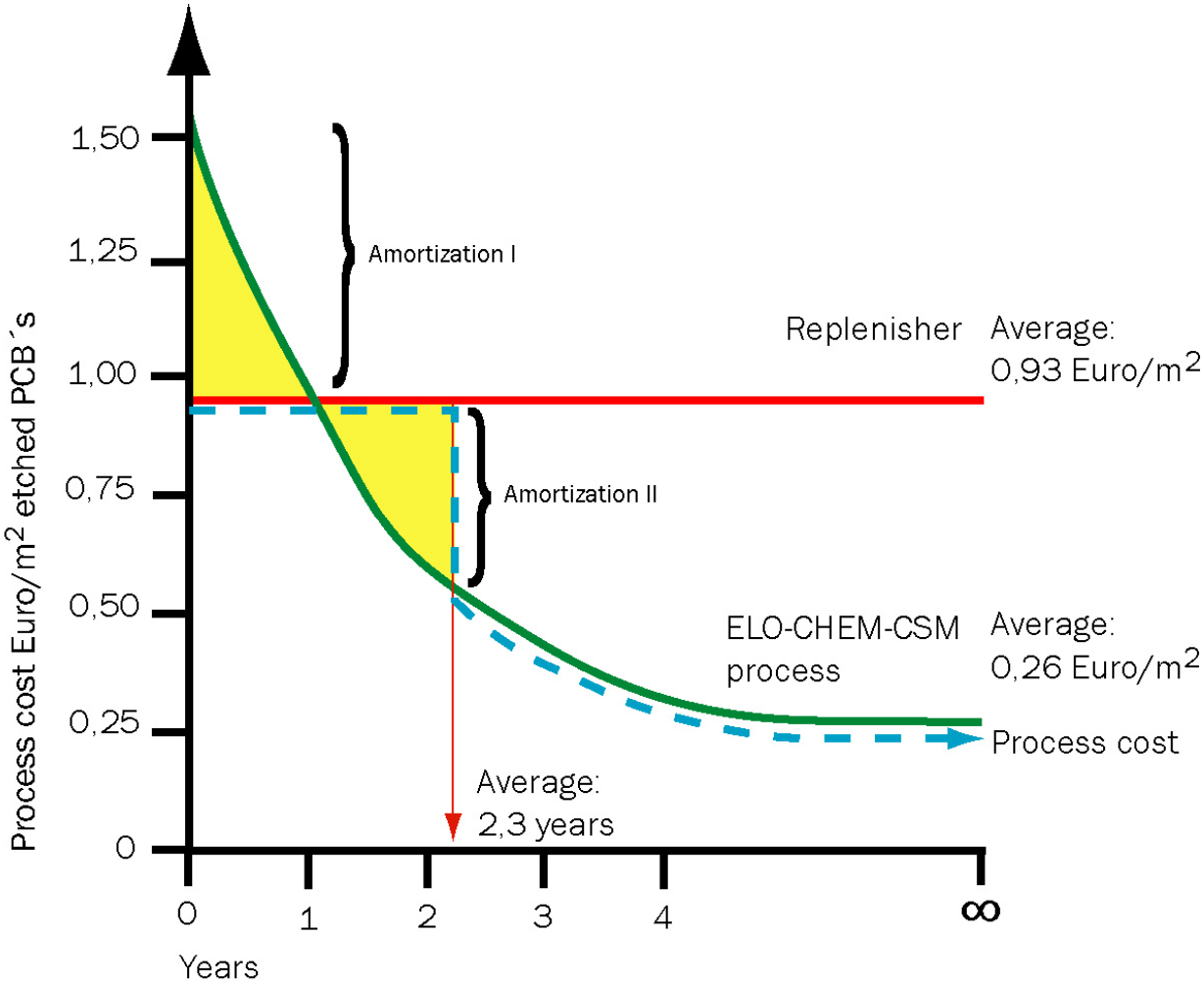
Basics:

Power cons.:	15 kW	
Empty weight:	ca. 700 kg (incl. electrical cabinet:)	
Needed space:	Regeneration module:	1450 x 950 mm²
	Control cabinet:	800 x 500 mm²

Process consumption

Solution temp.:	50° to 55°C
Ammonia gas:	< 150 g/ kg Cu
Elo-fast 40:	approx. 100 g/kg Cu
Ammonia sulf./phosph.:	< 30 g/kg Cu
Voltage:	16 x 2,4 to 3 V
Power:	approx. 3 kWh/kg Cu (plating)

Very short amortization – approx. 2 years or less
Basis: copper sale approx. 0,85 Euro/kg



Chemical optimization of the process by EloFast 40

EloFast 40 is an accelerator additive that increases the etching speed of the process.

Use as additve to CTS Recycling-Etch.

Etching speed 40 µm/min.

High process stability.

Etching factor >3.

Precise process control by exactly defined accelerator dosing quantity dependent on recovered copper.

Optimized resist protection by new chemical components specially für single sided or inner layer PCB`s.

Usage:

Only in connection with the Recycling process.

Process and equipment design

One recycling module recovers 3 copper/h.

Independent running of the process possible by buffering of etching solution.

Copper recycling in 24/7 mode.

Recovering breaks only while copper harvesting.

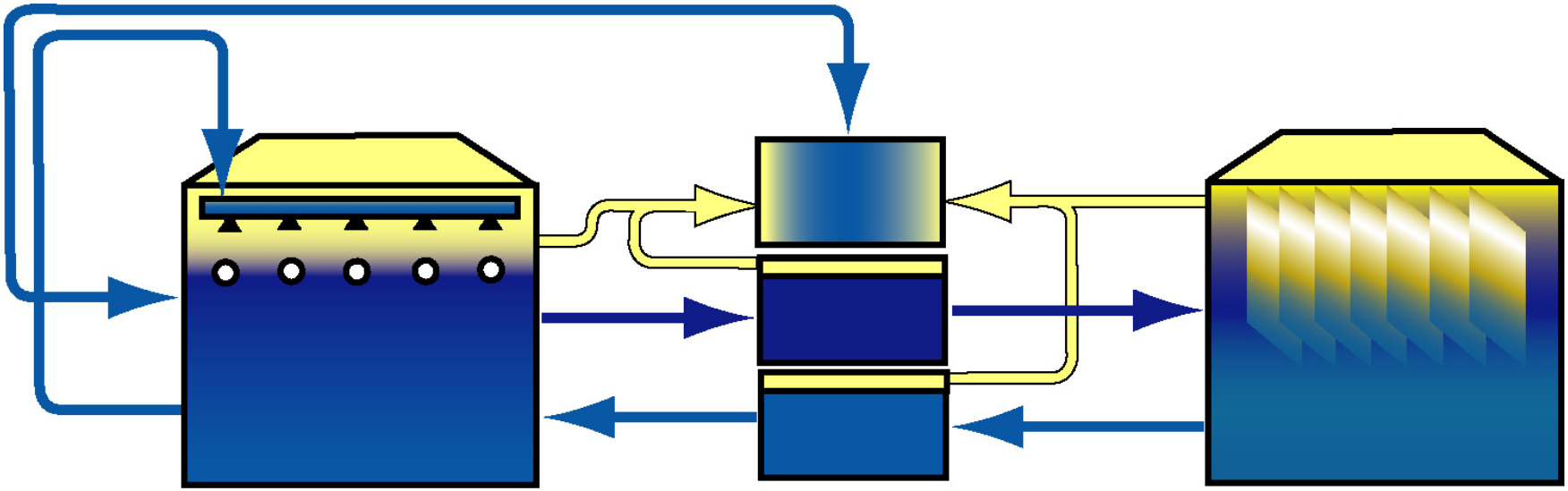
Operation on-line (beneath the etching line) or off-line (bigger distance to the etching line).

Various buffer systems with different performances and contents to meet exactly the customer requirements.

Needed basic data for process quotations

- . Kg copper etched per hour or needed replenisher solution or etched sqm per hour/day/year
- . Daily working time
- Type of etching line
- Special customer requirements

Process principle I – equipment set-up and flow of solution and gases



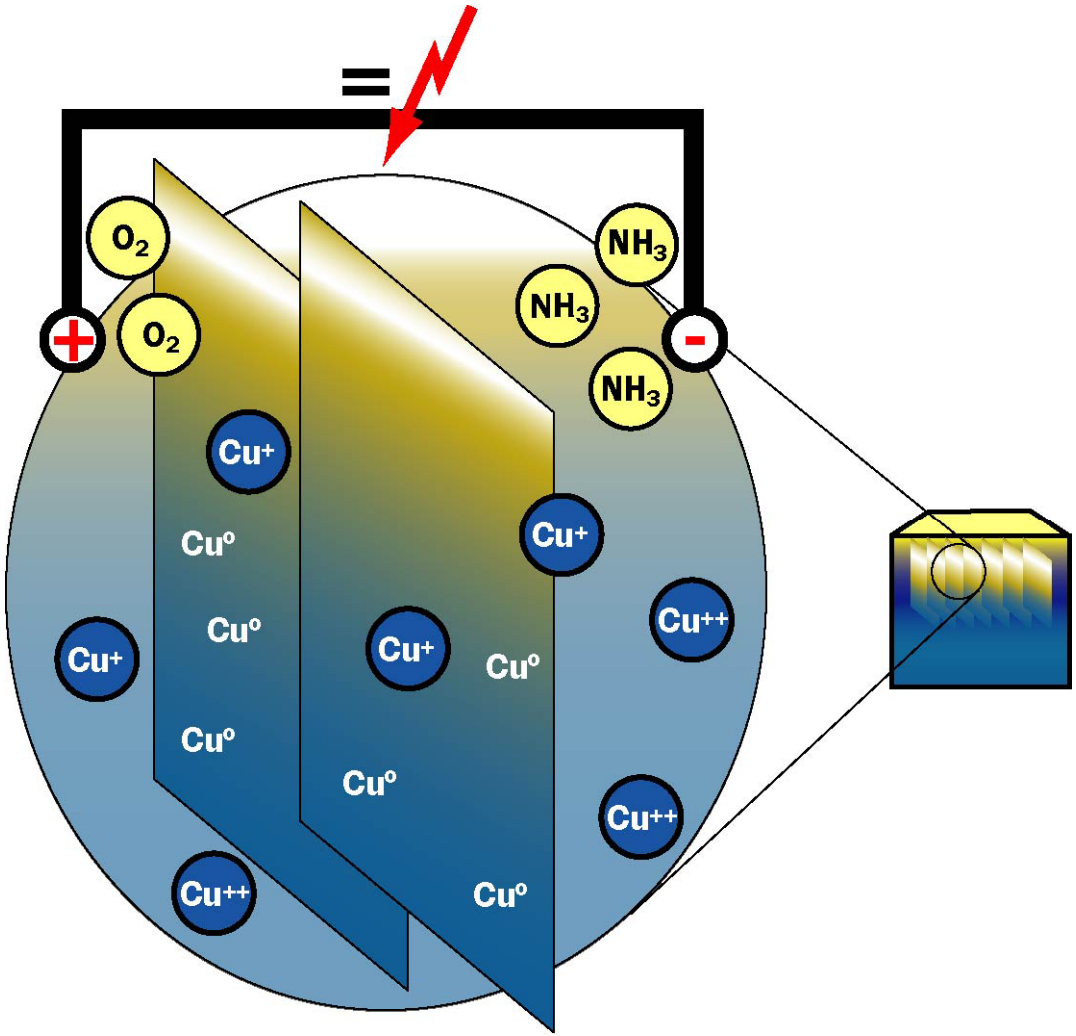
Ätzmodul

Puffer-/Lagerbehälter/

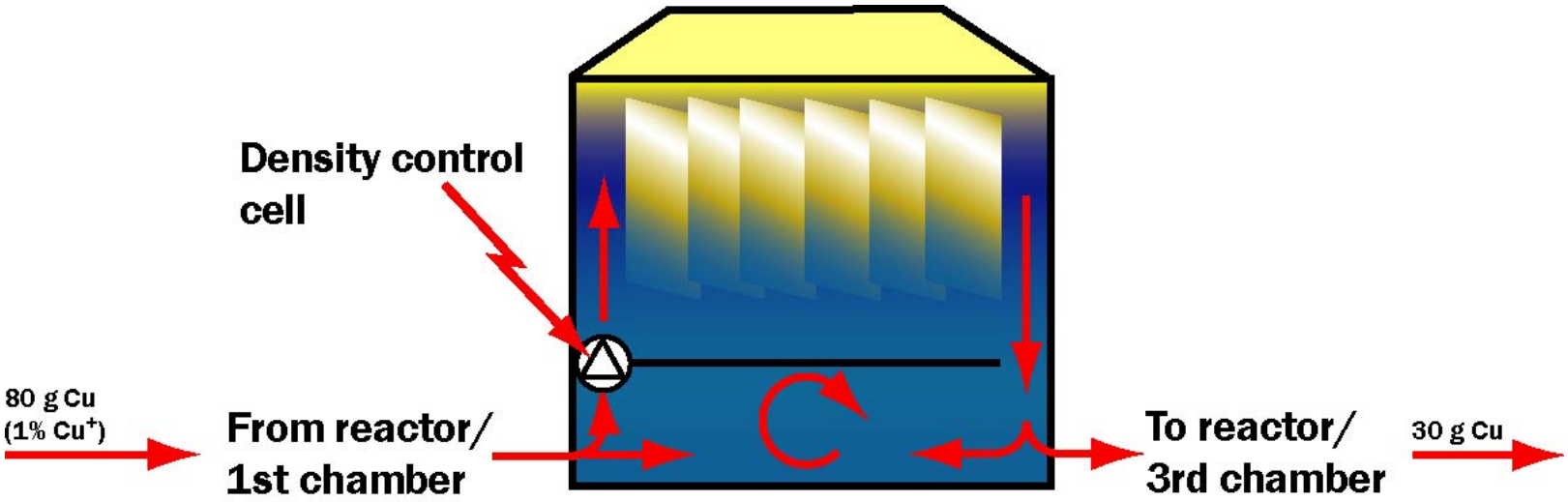
Regenerationsmodul

(Zelle)

Process principle IV - Electrolysis



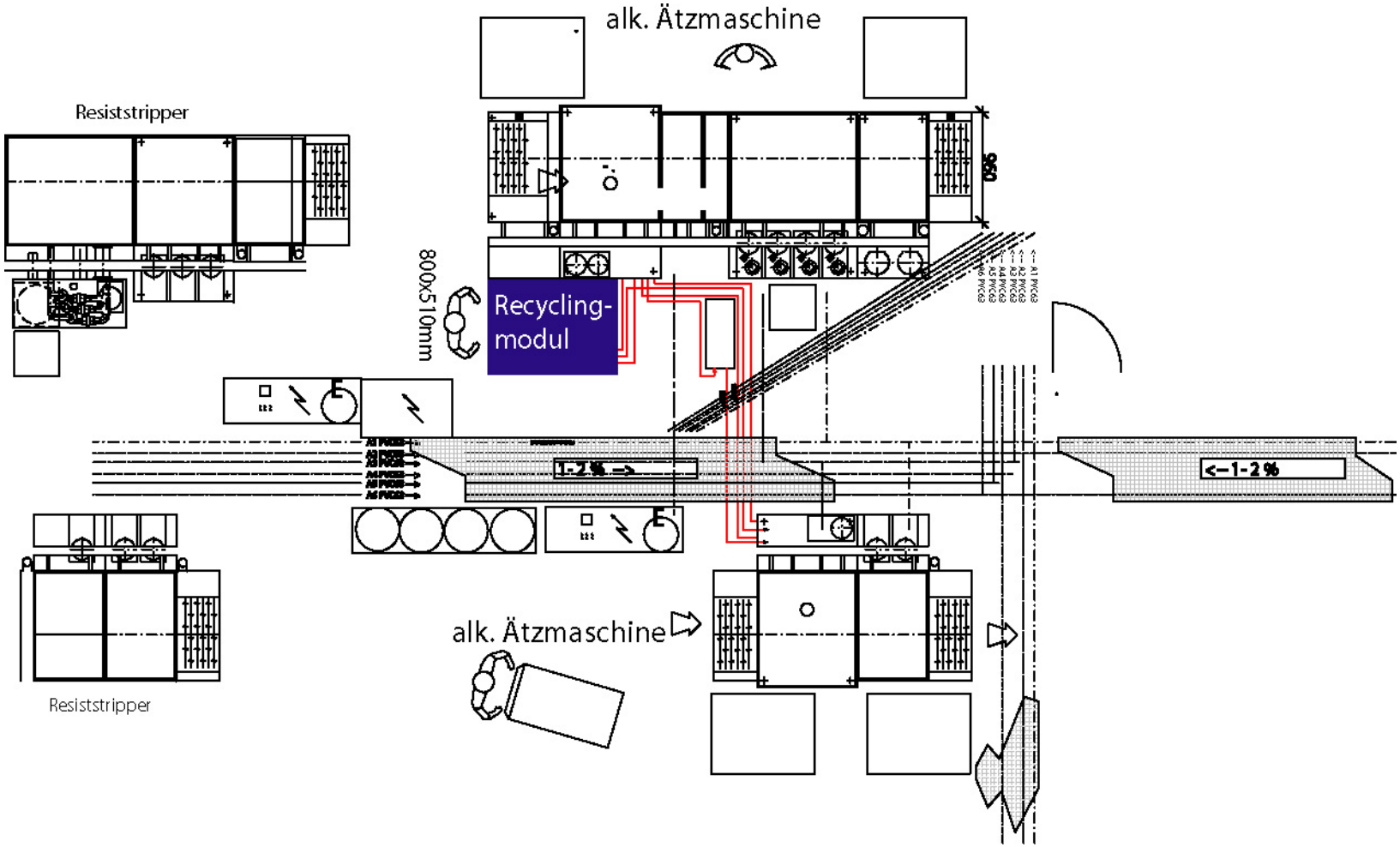
Function mode of the recycling module



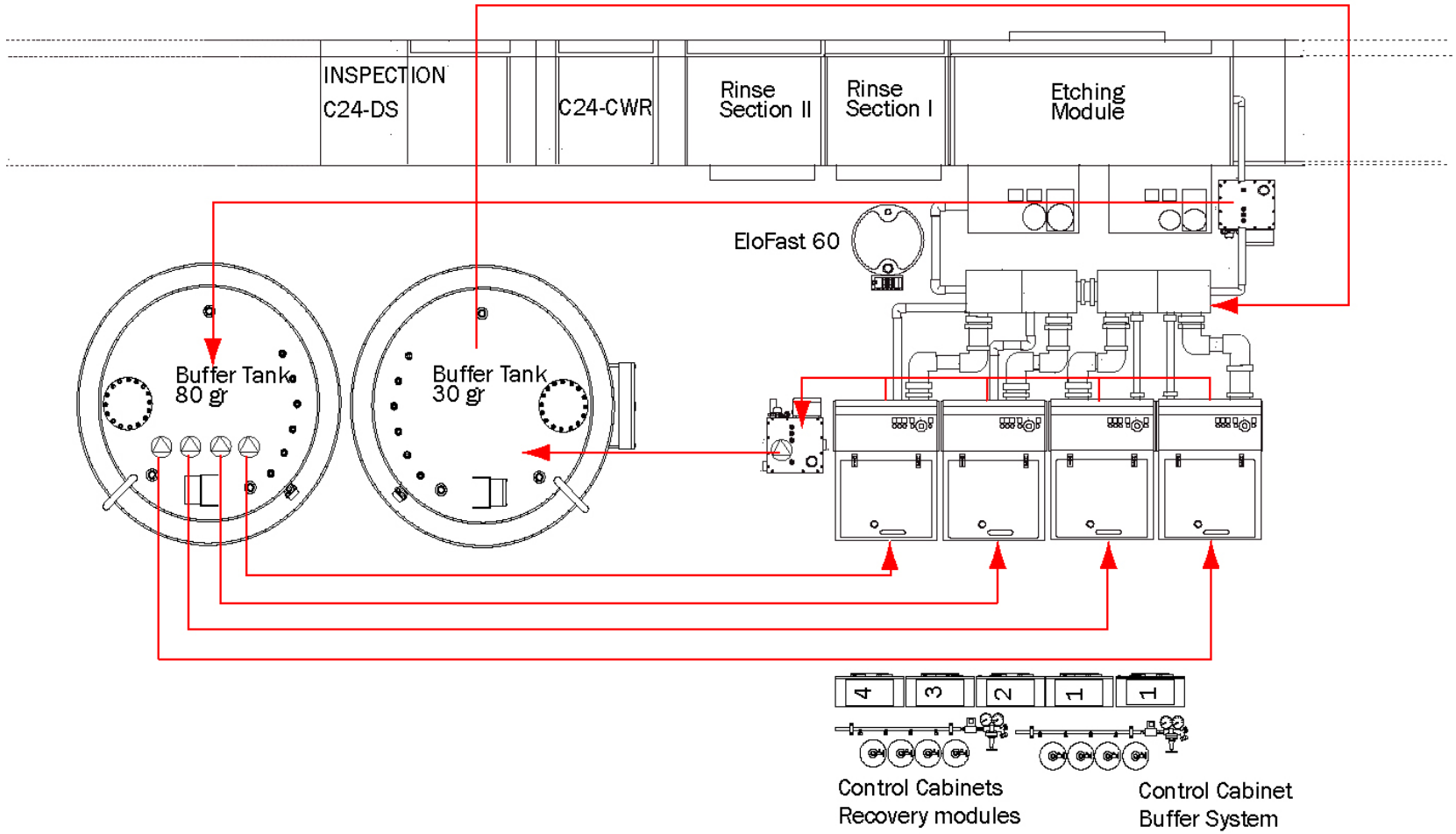
Process equipment beneath the etching line

Buffer tanks, ammonia suppply and control cabinet for recycling modules and buffer system

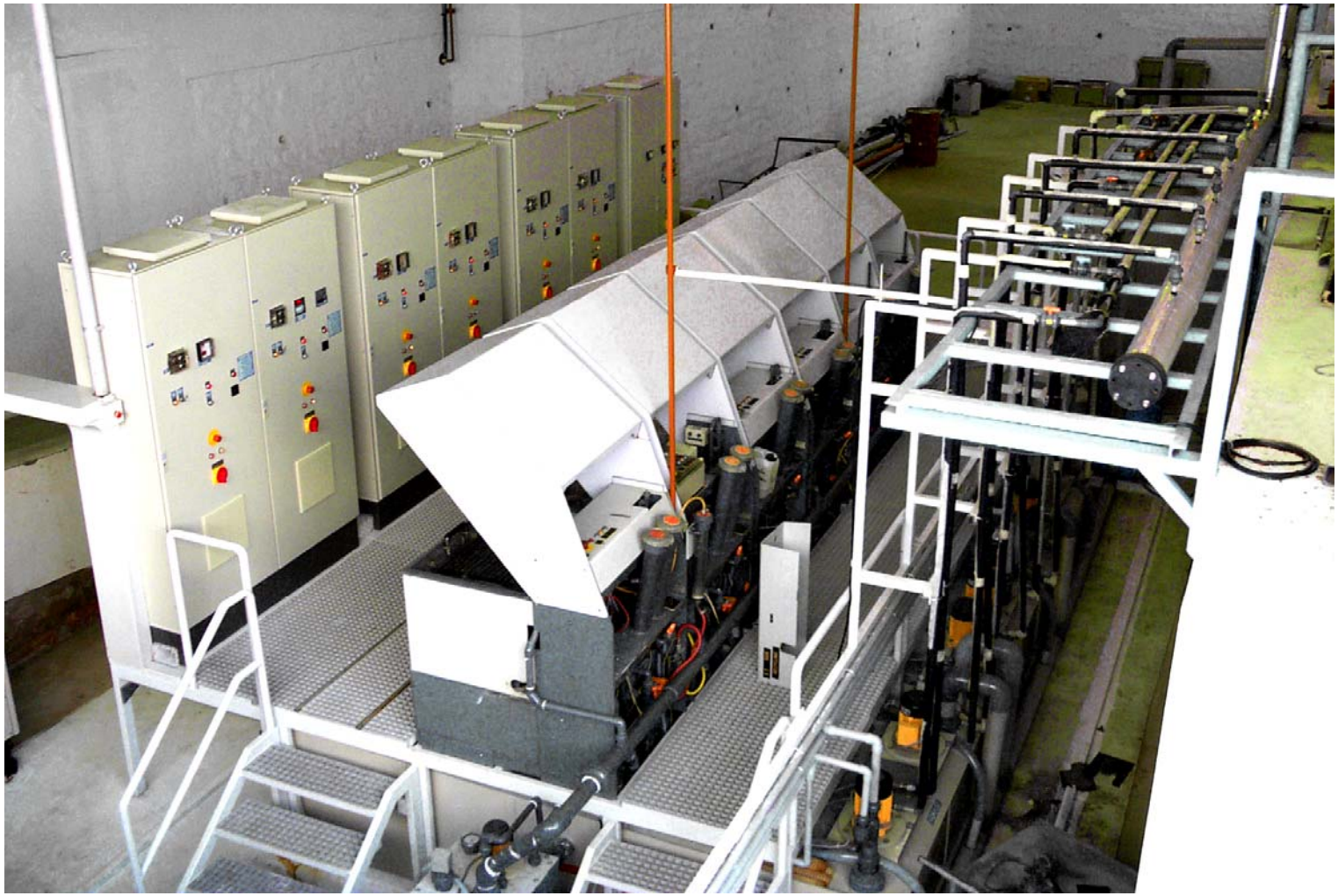
Little needed space – set up for one cell connected with two etching lines



High capacity equipment – four-cell-process connected with one etching line



Bigger plant set-up – capacity > 80 tons copper/year



Set-up of process and storage tanks under the cells

Performance

Controlled high speed etching at 40 microns per minute.

Multipurpose process for all types of boards.

Precise equipment and process design to cut service and maintenance procedures drastically.

Minimizing of return of investment period up to less than 2 years, included all maintenance and material expenses.

Flexible hire purchase or process lease modalities to meet the customers economic demands,
f.e. copper recovery based payment.

Prozess-Sicherheit

Etch factor of >3 granted.

Homogenous combination of wet process chemicals for etching and stripping, completed by first-rate equipment cleaners. All chemicals are developed upon customer requirements.

Customized system design and economic consideration depending on the amount of copper etched per hour and the daily etching time.

Complete environmental management through a closed loop process that already today corresponds to future laws and regulations.

Service system:

For chemicals within 72 hours all over the world maintaining the customers production process.

For spare parts and technical assistance within 24 hours all over the world, supporting the customer in technical and chemical situations.

Quick communication about system and process improvements.

Das Servicesystem

- Chemicals within 72 hours worldwide
- Production stability
- Spare parts and technical service within 24 hours worldwide
- Support in allen technischen und chemischen Situationen
- fast information exchange at system and process improvements

At the world market

- United competence for equipment set up, industry automatization and etching-recycling closed loop processes.

- Etching in closed loop process.

- Without expensive chemicals treatment

- Equipment quality worldwide ackonwledged