cloroSur
11th TECHNICAL SEMINAR
WCC GST SAFETY WORKSHOP
TABLE TOP EXPO
November 14-16, 2018
Monterrey - Mexico

Practical experiences from projects with conversion from mercury to membrane electrolysis technology



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Monterrey, November 15th, 2018

Overview

Introducing Chemieanlagenbau Chemnitz GmbH

More than 50 years of experience

RusChlor

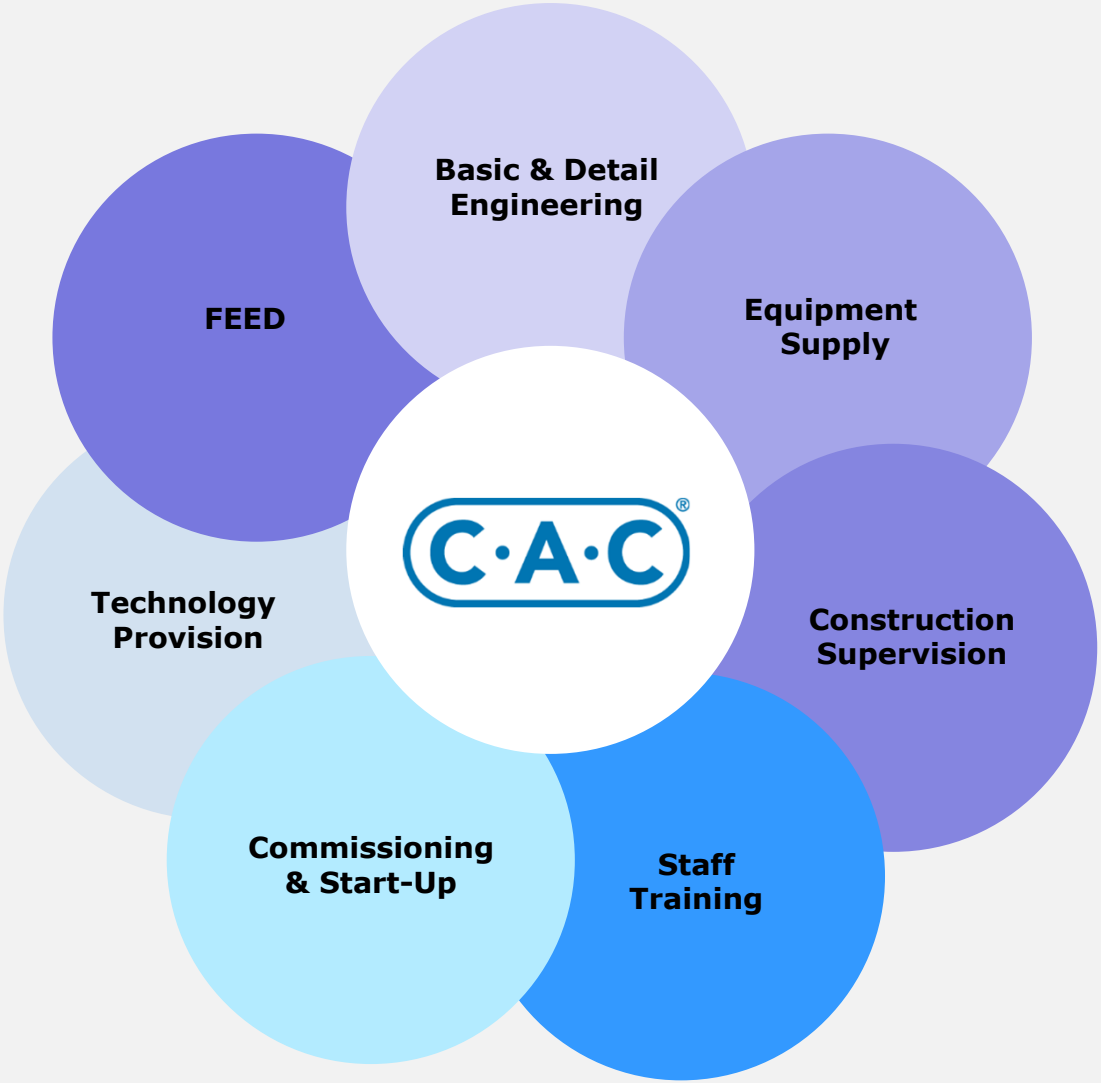
euro chlor 17.

cloroSur

1964	Plant engineering and contracting division within the factory "Germania"
1970	Directorate plant engineering in collective combine CLG
1990	Foundation of "Lurgi Anlagenbau Chemnitz GmbH" and integration in the Lurgi group
2004	Foundation of an independent plant engineering company in Chemnitz and foundation of "Chemieanlagenbau Chemnitz GmbH"
2005	Foundation of HUGO PETERSEN within the CAC group of companies
2006	Take-over of the majority stake of BiProTech Sp.z.o.o. in Kraków, Poland

Introducing Chemieanlagenbau Chemnitz GmbH

CAC offers all services for construction, reconstruction or expansion of your plant



Overview

Introducing Chemieanlagenbau Chemnitz GmbH

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Targeted Industries & Market Segments

Refinery & Crude Oil Processing

- Refinery Engineering
  - Atmospheric Distillation
  - Vacuum Distillation
  - Hydro-desulphurisation
  - Reforming / Zeoforming
  - Bitumen
  - Isomerisation
  - Demercaptanisation
- Lube Oil Refining

Gas Engineering

- Natural Gas Underground Storage
- Gas Compressor Stations
- Gas Treatment
  - Pre-treatment
  - Purification
  - Gas Scrubbing
  - Separation of higher hydrocarbons
  - Gas Compression
  - Sulphur Recovery
  - Demercaptanisation

Petrochemicals

- Expandable Polystyrene
- Ammonia
- Urea
- Melamine
- Butadiene
- Maleic Anhydride
- Butanediol
- Nitric Acid

Inorganics

- Sulphuric Acid
- Cl-Alkali Electrolysis
- Chlorine Purification
- Ammonium Sulphate
- Poly-aluminium Chloride
- Ferric Chloride
- Calcium Chloride

Overview

Chlor-Alkali business

Track record of the chlor-alkali business

1964	1st Chlor-alkali electrolysis (mercury) built for BASF AG, Germany
1976	1st Chlorine plant (diaphragm) built for Sameit Alkali, Norway
1983	1st Chlorine plant (membrane) built for United Srichai Chemicals, Thailand
2004	Transfer of Lurgi's chlor-alkali business to Chemieanlagenbau Chemnitz GmbH
2010	Acquisition of Krebs Swiss chlor-alkali technology from GEA Messo, France

CAC is **Associate Member** of EuroChlor

Chlor-alkali business

BASIC & DETAIL ENGINEERING – C/A PLANTS					
No.	**CLIENT**	**LOCATION**	**PLANT CAPACITY (in thousand tons per year)**	**YEAR (start-up)**	**REMARKS**
1	OAO NAVOYAZOT	Navoi, Uzbekistan	23 Chlorine 26 Caustic Soda	2001	FS BE NEW PLANT
2	SAYANSKCHIMPLAST I.	Sayansk, Russia	150 Chlorine 168 Caustic Soda	2006	FS BE CONVERSION
3	MOSVODOKANAL	Moscow, Russia	10 Chlorine 11.3 Caustic Soda	2013	BE DE NEW PLANT
4	SAYANSKCHIMPLAST II.	Sayansk, Russia	180 Chlorine 202 Caustic Soda	2013	BE DE EXPANSION
5	SODA CHLORAT	Beresniki, Russia	26 Chlorine 40 Caustic Potash	2014	FS BE DE CONVERSION
6	JSC BELARUSKALI	Soligorsk, Belarus	16.5 Chlorine 25 Caustic Potash	2015	BE DE NEW PLANT

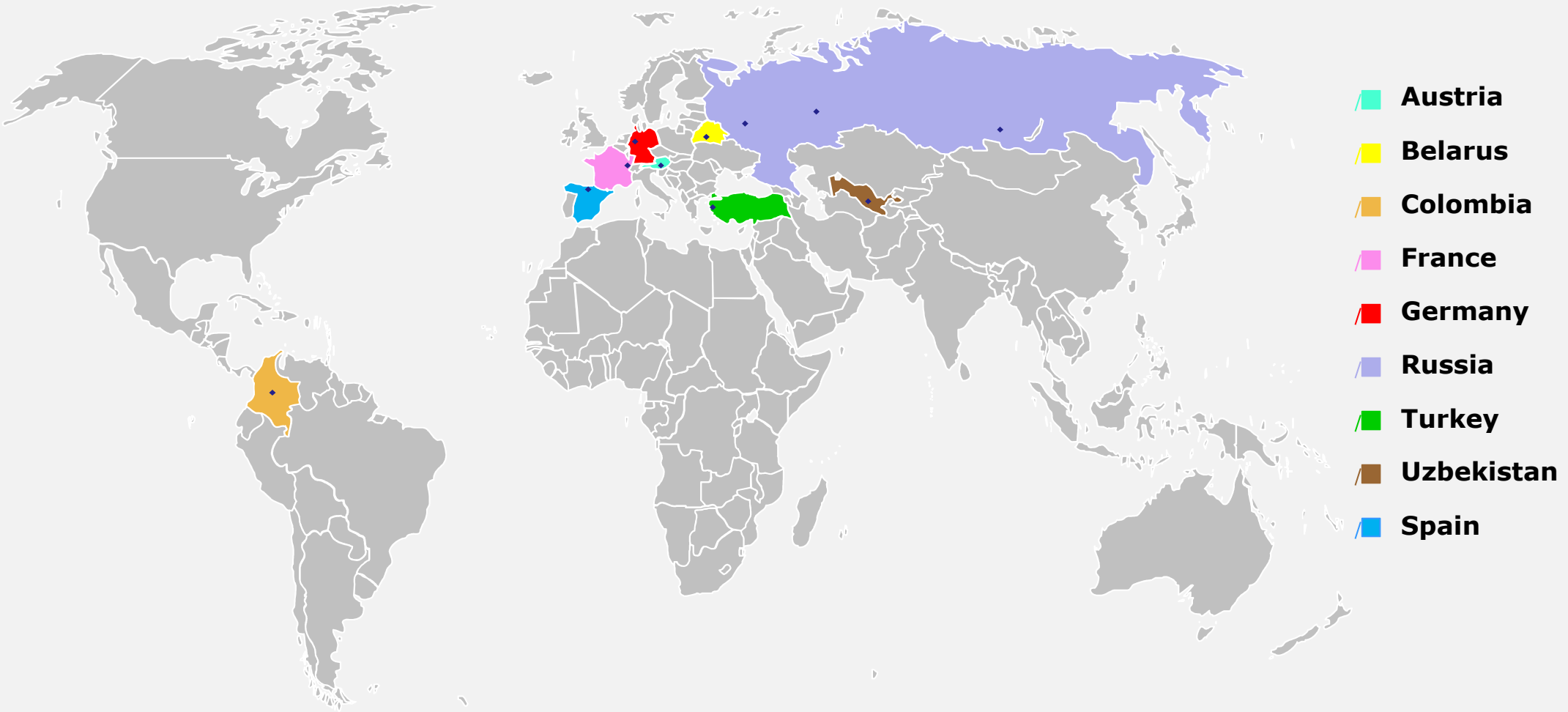
FS = Feasibility Study, BE = Basic Engineering, PDP = Process Design Package, DE = Detail Engineering

BASIC & DETAIL ENGINEERING – C/A PLANTS					
No.	**CLIENT**	**LOCATION**	**PLANT CAPACITY (in thousand tons per year)**	**YEAR (start-up)**	**REMARKS**
7	TESSENDERLO GROUP	Loos, France	54.0 Chlorine 61.0 Caustic Soda or 40.7 Chlorine 64.5 Caustic Potash	2012	PDP CONVERSION
8	DONAUCHEMIE	Brueckl, Austria	31.6 Chlorine 35.7 Caustic Soda	2015	BE DE EXPANSION
9	POTASSE ET PRODUITS CHIMIQUES SAS	Thann, France	43.2 Chlorine 68.4 Caustic Potash	2015	BE DE CONVERSION
10	BRINSA S.A.	Zipaquirá, Colombia	27 Chlorine 30 Caustic Soda	2016	BE DE CONVERSION
11	JV AKZO / EVONIK	Ibbenbueren, Germany	82 Chlorine 130 Caustic Potash	2017	BE CONVERSION
12	PETKIM PETROKIMYA HOLDING A.Ş.	Aliağa, Izmir, Turkey	103 Chlorine 113 Caustic Soda	2019	BE, DE CONV. MON/BIP
13	Altamira-Electroquimica del Cantabrio, S.A. (BONDALTI GROUP)	Torrelavega, Spain	68 Chlorine 76 Caustic Soda	2019	CONVERSION

FS = Feasibility Study, BE = Basic Engineering, PDP = Process Design Package, DE = Detail Engineering

Chlor-alkali business

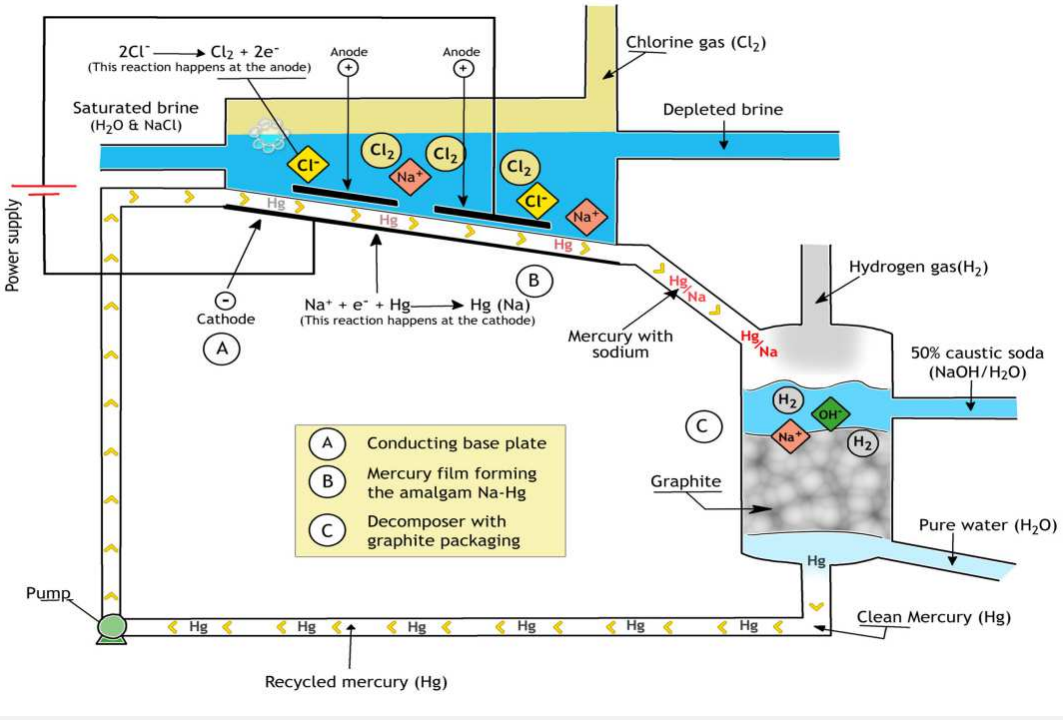
> 600,000 t/a of chlorine are produced in our reference plants



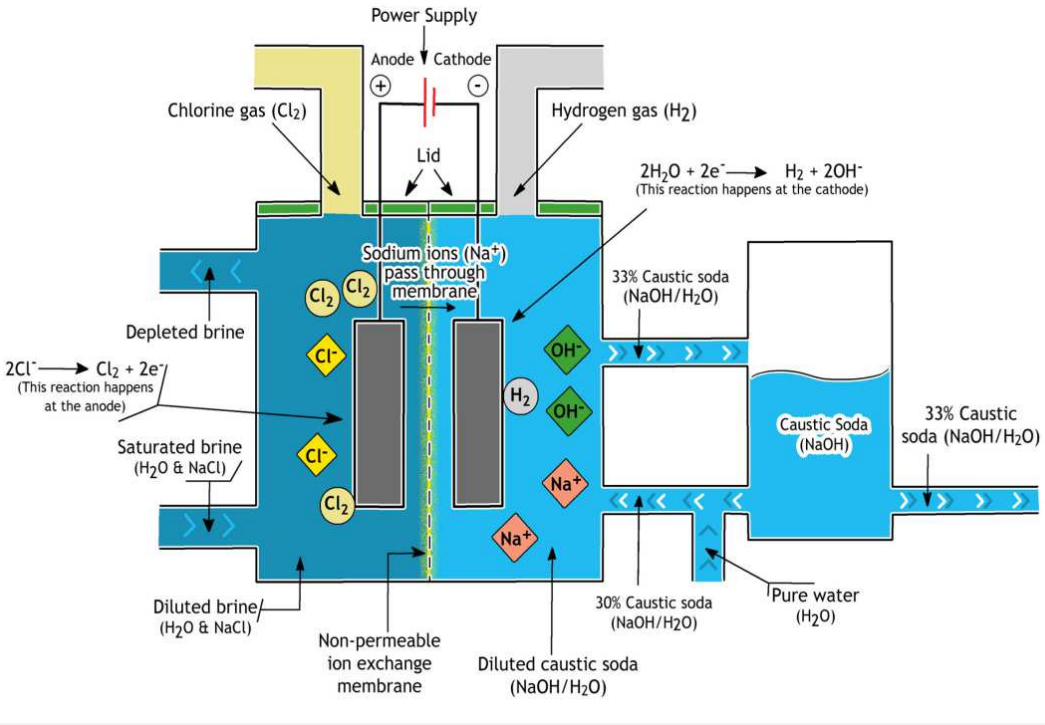
Overview

Electrolyser technologies

Mercury electrolyser



Membrane electrolyser



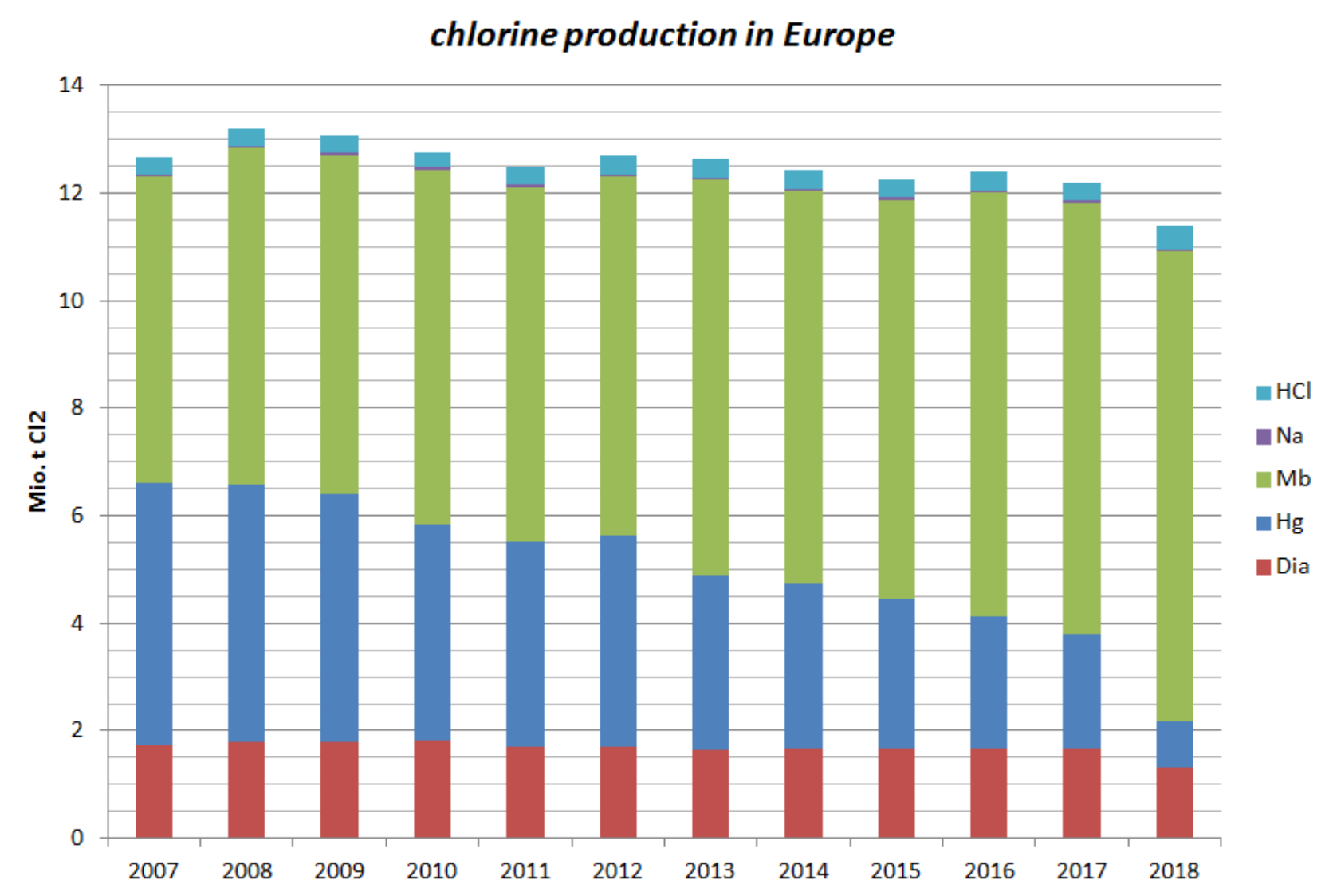
source: EuroChlor

Advantages of membrane vs. mercury process

- **Environmental impact & improvements**
  - Complete reduction of the mercury emissions to the air
  - Exclusion of contamination of mercury to the soil
  - No waste water and waste disposal contaminated with mercury

- **Significant reduction of electrical power consumption – up to 30% less!**

- **Essential savings of operational costs** due to:
  - No further mercury treatment & disposal required
  - Up to 50% less operational staff required
  - Less maintenance costs



data source: EuroChlor

Overview

Re-usable equipment

✓ Salt dissolver, tanks, heat exchangers

✓ Gas treatment sections (coolers, drying towers, blowers, compressors...)

✓ Filters and columns: usually too big, but no problem (more retention time)

X Pumps: not recommended – especially brine pumps are usually too big

X Transformer/rectifier: not recommended – different requirements for current & voltage

- Physical and static conditions of the equipment & piping have to be checked carefully
- Cleaning of filters, tanks, pumps etc. has to be done properly with water or with diluted hypo solution
- Check for elementary mercury at low points
- Change precoating agent from perlite/harborlite to cellulose (avoid Al & SiO_2 contamination)
- Install additional ion exchanger column with special Hg resin (to protect Ca+Mg resin)

Overview

Location / placement

- New equipment can be installed:
  - Greenfield, next to old plant
  - In old building → re-use cell room after decontamination
- Decontamination (EuroChlor TSEM 05/311, TSEM 11/378, TSEM 11/389):
  - Mercury is everywhere → concrete structure & ground need to be removed or not touched at all
  - Sand should not be brought back in place → to be removed & decontaminated
- Space requirements:
  - Membrane electrolysers require higher cell room
  - Space required underneath membrane electrolysers

Overview

Selected conversion projects

OAO Sajanskchimplast

Location: Sayansk, Russia

Plant: Chlor-Alkali Electrolysis

Capacity: 169,000 t/a Caustic Soda
150,000 t/a Chlorine

Electrolyser Technology: Asahi Kasei Corporation, Japan

AsahiKASEI

Services:

- Project Management
- Basic and Detail Engineering
- Design specification for civil works, steel structure, HVAC
- Deliveries
- Construction Supervision Assistance
- Supporting of start-up phase
- Training of personnel

Special conditions:

- First Chlor-Alkali Membrane Electrolysis in Russia
- Consideration of the Russian Regulation on Chlorine
- Financed through ECA-covered loan by Euler-Hermes Credit Insurance

Project Completion: 2006

Selected conversion projects

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Potasse et Produits Chimiques SAS

Location: Thann, France

Plant: Chlor-Alkali Electrolysis / Bromine Recovery Unit

Capacity: 68,400 t/a Caustic Potash
43,200 t/a Chlorine
4,000 t/a Bromine

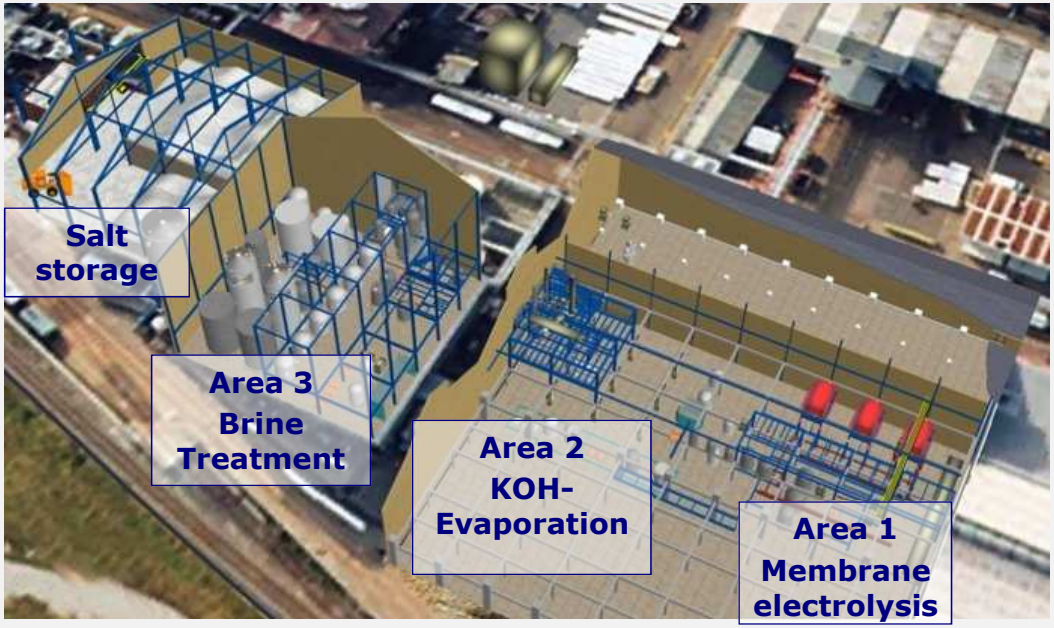
Electrolyser Technology:
Chlorine Engineers Corporation, Japan

Contract: EPC

Services:

- Project Management
- Basic Engineering
- Detail Engineering
- Procurement & Supplies
- Construction & Construction Management
- Training of personnel & Start-up

Project Completion: 2016



Selected conversion projects

Evonik Industries AG & Akzo Nobel Industrial Chemicals GmbH

Location: Ibbenbueren, Uffeln, Germany

Plant: Chlor-Alkali Electrolysis

Capacity: 130,000 t/a Caustic Potash
82,000 t/a Chlorine

Electrolyser Technology: Asahi Kasei Corporation, Japan

AsahiKASEI

Services:

- Project Management
- Basic Engineering
- Detail Engineering & Procurement
- Construction Management
- Commissioning support & Training

Project Completion: 2017

Akzo Nobel – Location at Ibbenbueren/Germany

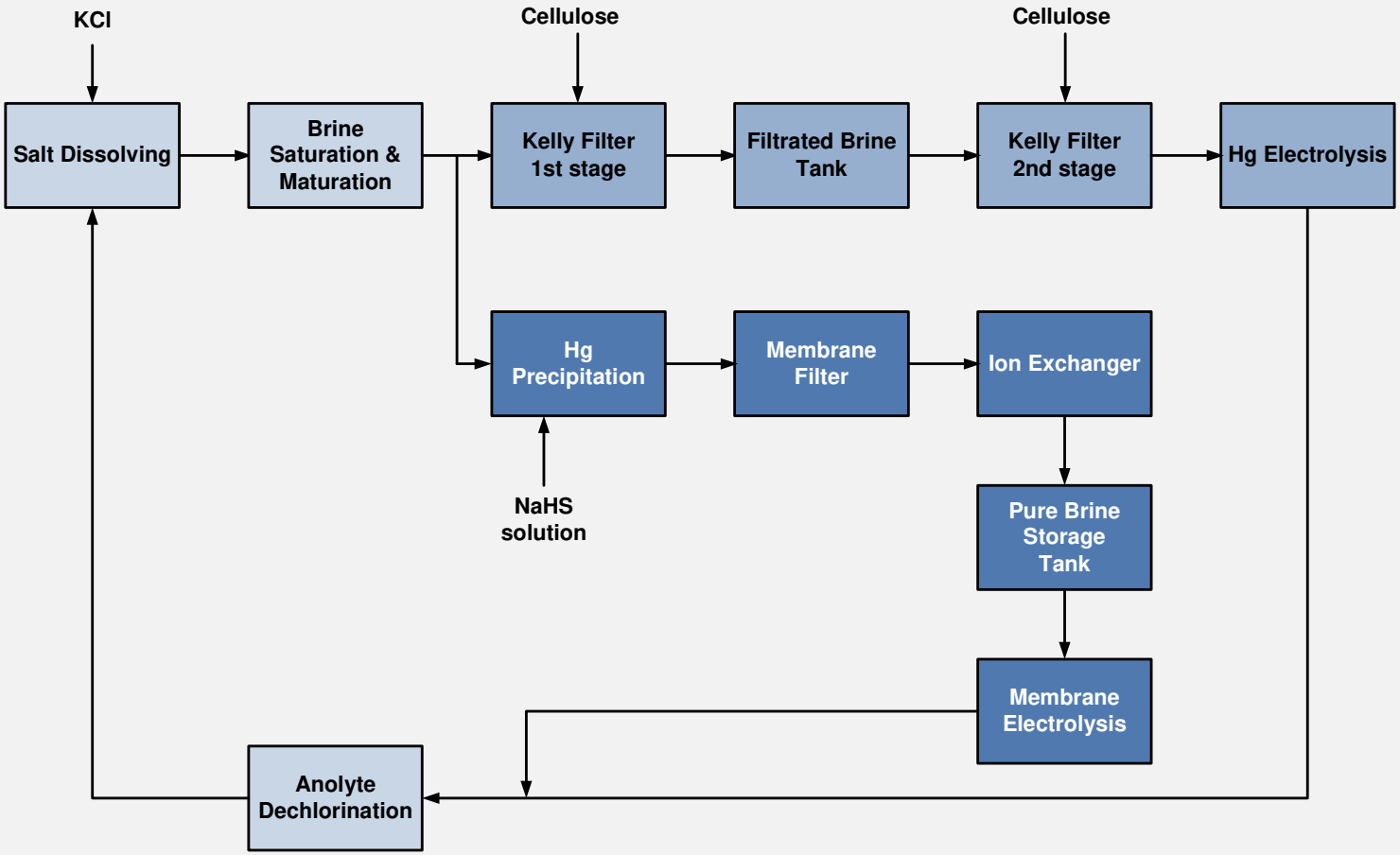
Overview

Parallel operation of Hg & Mb electrolysis

- Advantage: minimise downtime by establishing
  - one combined brine loop for treatment of brine to/from Hg electrolysis as well as membrane electrolysis and
  - proper tie-in points for common product handling

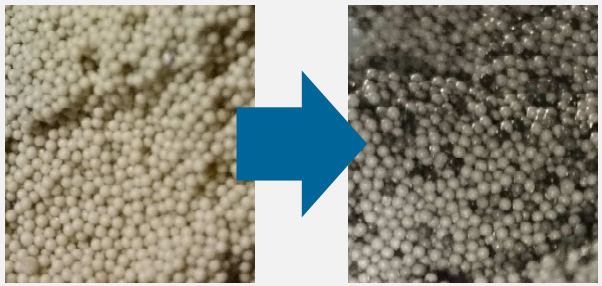
- Disadvantages:
  - requires more time for planning and establishing of tie-in points
  - possibly creates unwanted interferences from one system to the other (e.g. back pressure, interlocks, Hg contamination...)
  - requires additional step(s) for removal of mercury (precipitation and/or ion exchanger)

Parallel operation: practical example



strainer of filtrated brine pump: covered by HgS

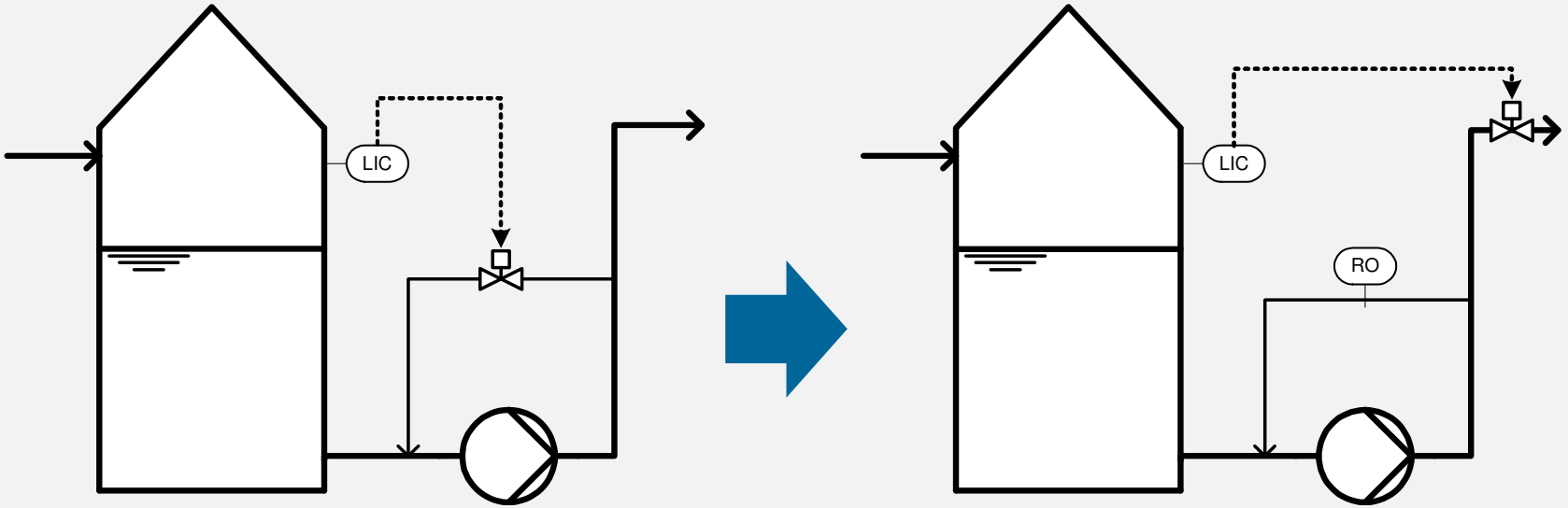
ion exchanger resin for Hg (TP214): covered and partially blocked by HgS



Overview

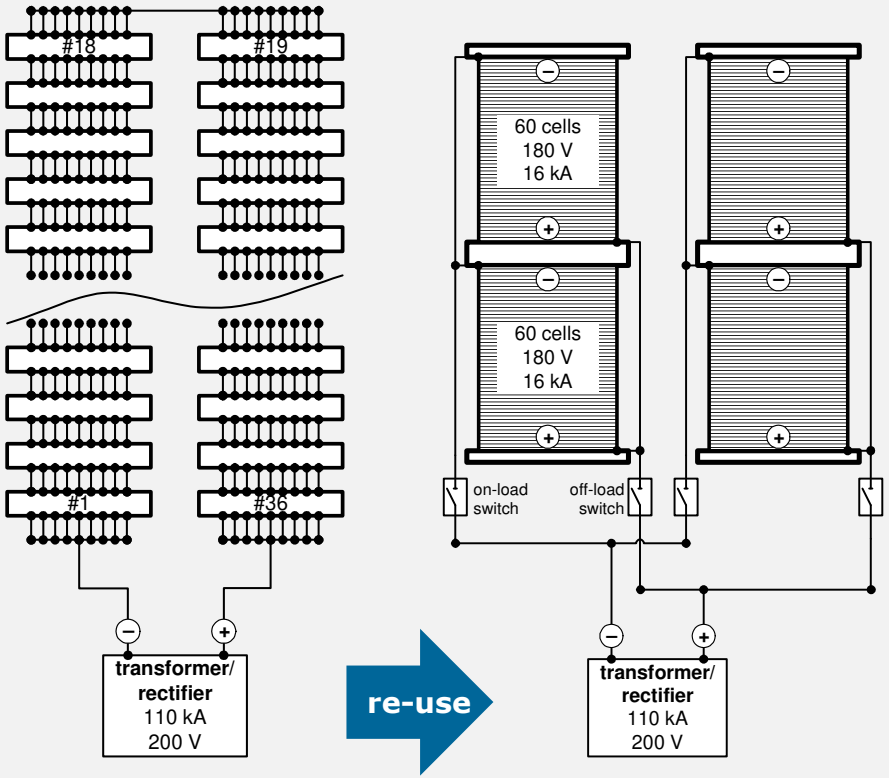
Re-use of equipment: brine pumps

- brine flow in Hg plant is **2.5-fold** than in Mb plant
- pumps could be equipped with variable frequency drive (VFD) or
- control philosophy has to be adjusted → otherwise such big pumps would operate not at their optimum point or beyond their performance curve



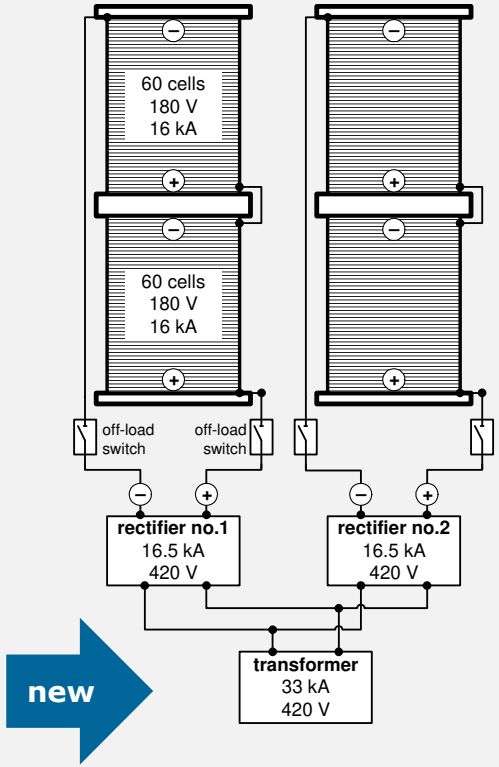
Re-use of equipment: transformer/rectifier

- Traditionally Hg electrolysis requires relatively high current and low voltage
- Area of membrane cells is smaller and current density is smaller than in Hg cells
  → more cells are connected in series – resulting in higher overall voltages
- Example: Hg cell room with 36 cells (10 m²) → converted to 4x60 Mb cells



➢double power feed

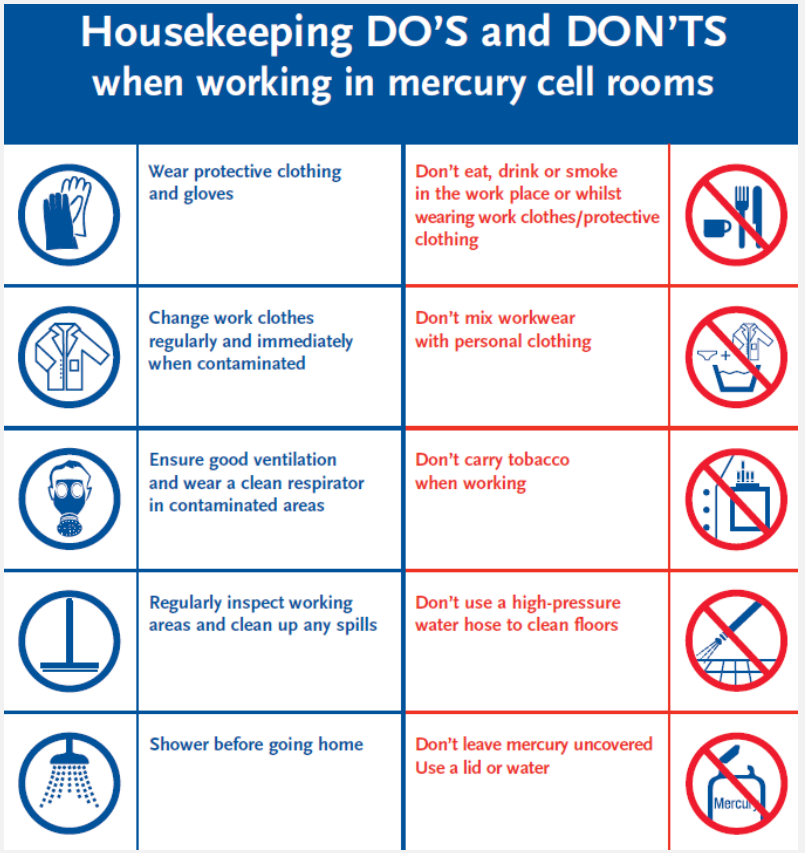
➢disadvantage: electrolysers are connected in parallel
→ less flexibility



Overview

Separation of contaminated area & construction area

- Personal safety → high risks of operating personnel as well as personnel of construction company due to
  - Mercury emissions
  - Chlorine emissions
- Protective equipment, cleaning and hygiene is of high importance → EuroChlor TSEM 05/305 →
- Create separation between normal operating area and new construction area



Experiences

Example:

wooden wall for separation of Hg electrolysers (in operation) and construction site

Overview

Conclusions

Conclusion / summary

- Conversion from mercury to membrane technology is beneficial in terms of operating costs and from environmental point of view
- Cell room building and some equipment can be re-used (after decontamination) to reduce investment costs
- It should be evaluated carefully how much of the existing equipment is re-used and how the conversion should be done (time schedule)
- Training of operating personnel is also very important because requirements for brine quality are higher

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Thank you for your attention!

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