



Designed for sustainable benefits

HCl synthesis units by SGL Carbon



CloroSur
2022

COSTA DO SAUÍPE



Agenda



- 1. HCl synthesis**
- 2. Heat recovery with hydrogen chloride (HCl) synthesis**
 - Membrane wall technology
 - New ECOSYN[®] technology
- 3. New central spin burner**
- 4. Hydrogen utilization**
- 5. Summary**



HCl Synthesis

Heat needs to be removed

Typical applications - HCl is used in:
Semiconductor, pulp & paper, silicone, fracking, EHC, chlor alkali industry

Hydrogen + Chlorine = Hydrogen Chloride (gaseous) + **Heat**

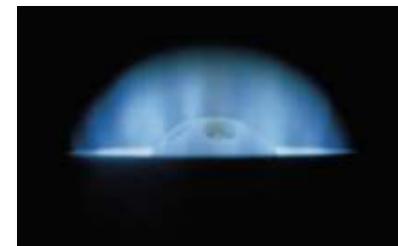
- Reaction enthalpy: 0.7 kWh/kg
- Hydrogen excess: 5 to 15%

Hydrogen + Oxygen = Water (gaseous) + **Heat**

- Reaction enthalpy: 3.7 kWh/kg

HCl absorption = Hydrochloric Acid (liquid) + **Heat**

- Absorption enthalpy: 0.5 kWh/kg

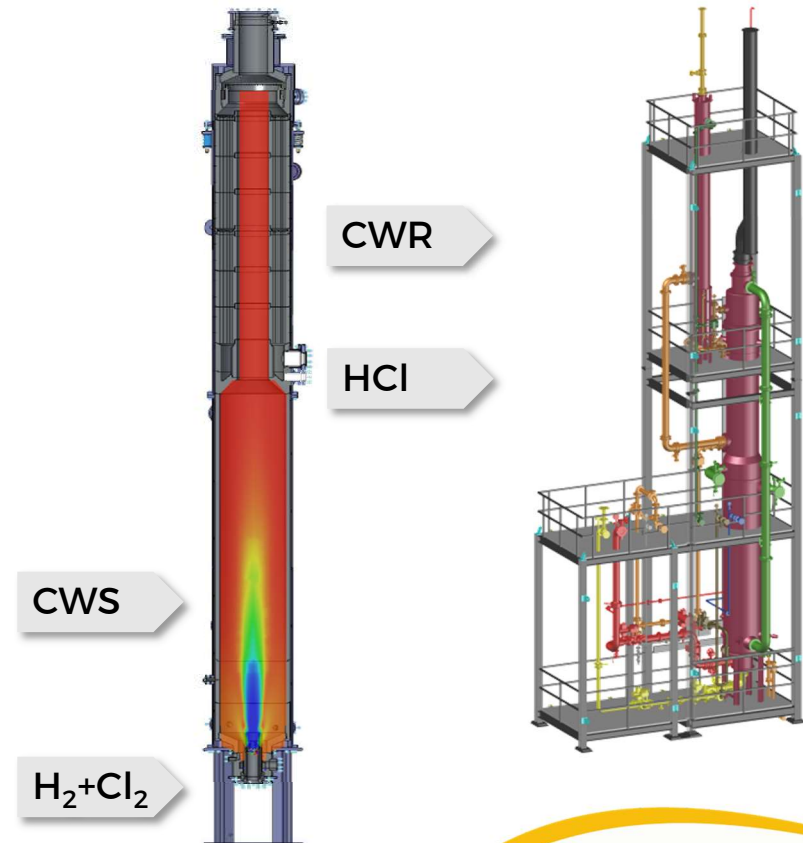


SGL's standard HCL synthesis

Performance data

Parameter	Unit	
Capacity (100% HCl)	TPD	0 - 160
HCl acid concentration	wt.%	37
HCl gas concentration	vol%	95
HCl gas pressure	barg	3,2
Cl ₂ content in acid	ppm wt.	< 1
HCl content in vent gas	mg/Nm ³	< 30
Cl ₂ content in vent gas	mg/Nm ³	< 3

CWS: Cooling water supply; CWR: Cooling water return

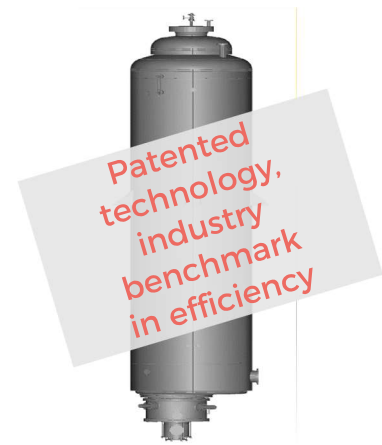
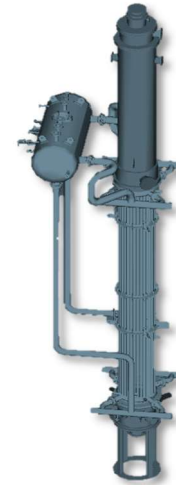


Options to gain efficiency

Heat recovery

	Standard	Hot water loop	Membrane wall	ECOSYN
Steam production	-	-	0,6 t/t HCl	0,9 t/t HCl
Hot water production	-	400 kWh/t HCl	-	-
Cooling water duty ⁽¹⁾	1200 kWh/t HCl	800 kWh/t HCl	800 kWh/t HCl	550 kWh/t HCl

Setup



(1) Cooling water duty can be further reduced by using the heat of absorption for e.g. boiler feed water pre-heating

Membrane wall technology

Performance data and requirements

Key performance data	Unit	
Capacity (100% HCl)	TPD	0 - 150
Steam production	t/t HCl	0,6
Steam pressure	barg	up to 10
Fe content	ppm wt.	< 3

Requirements

- Feed must be free of salt
- Steel combustion chamber must not cool down below the dew point for corrosion protection
- Boiler feed water according specification EN12952-12



Membrane wall technology

Customer benefits

- **No pumps**
 - Thermosiphon principle for boiler water circulation
 - Elevated acid outlet
- **High steam pressure**
 - Up to 10 barg due to the use of a steel furnace
- **High reliability**
 - Design is based on proven membrane wall technology
- **Highest safety level**
 - Same safety system used as per standard concept
- **Good accessibility**
 - Designed as standard bottom burner concept
- **References**
 - China, Canada, France, Italy, Korea, Malaysia, Romania



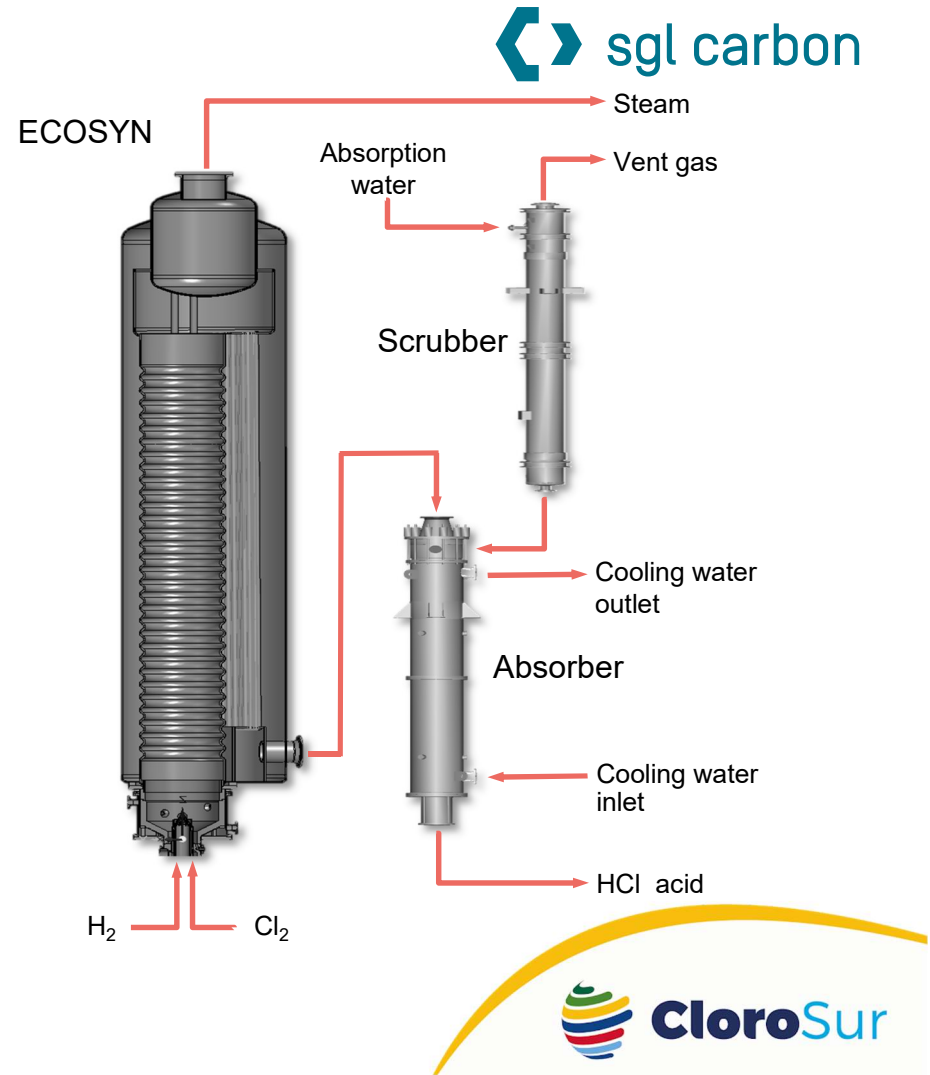
ECOSYN technology

Performance data and requirements

Key performance data	Unit	
Capacity (100% HCl)	TPD	90
Steam production	t/t HCl	0,9
Steam pressure	barg	up to 14
Fe content	ppm wt.	< 1,5

Requirements

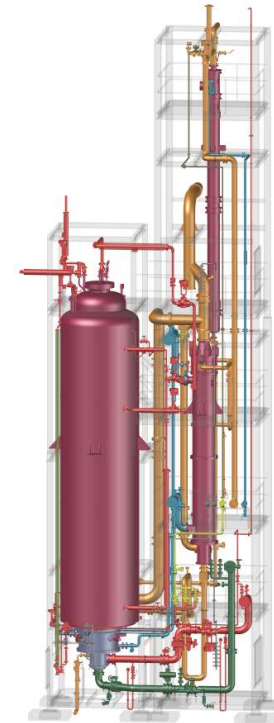
- Feed must be free of salt
- Steel combustion chamber must not cool down below the dew point for corrosion protection
- Boiler feed water according specification EN12953-10



ECOSYN technology

Customer benefits

- **Highest efficiency**
 - 0,9 t steam/t HCl
- **High steam pressure**
 - Up to 14 barg
- **High reliability**
 - Design is based on shell boiler technology
- **No boiler water pumps**
 - Thermosiphon principle for boiler water circulation
- **Good accessibility**
 - Designed as standard bottom burner concept
- **References**
 - Austria, Italy



Product quality boosting

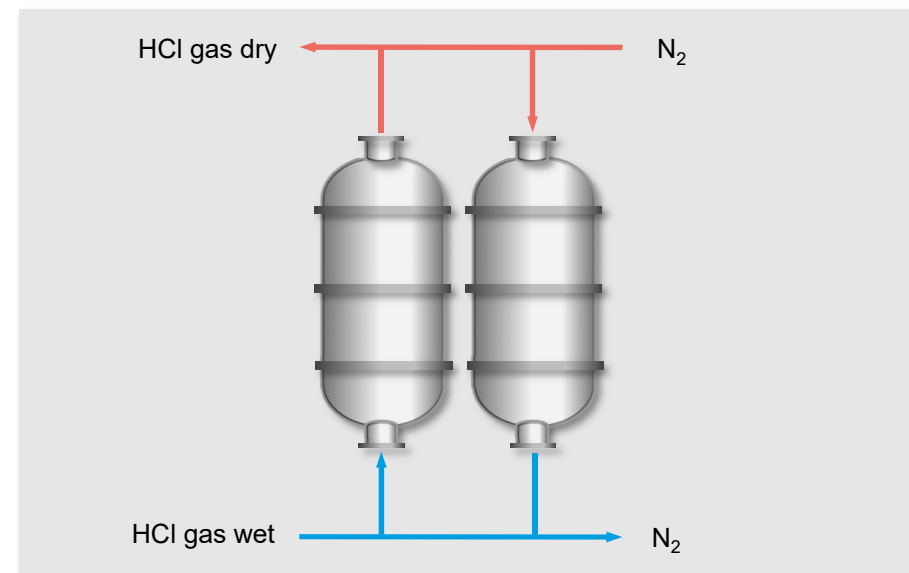
Reduction of contaminations to the absolute limits

Reduction of:

Fe, Cl₂, water, H₂

Available technologies and systems

- Adsorption units
- Molecular sieve drying
- H₂SO₄ drying
- Synthesis desorption systems
- Stripping



Example adsorption

Innovation in burner technology

Motivation and solution

Motivation

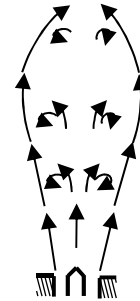
Development of burner completely made by SGL

Requirements and basic assumptions

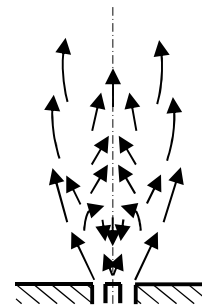
- Effective mixing of H_2 and Cl_2 for complete combustion
- Premixing - danger of flashback in mixing chamber and sensitive to salt and water contents
- Mixing in combustion chamber prevents flashback
- Graphite material must not be exposed to flame
- Mixing can be improved by swirling flows



Development of a swirling flow graphite burner



Jet burner



Spin burner



 sgl carbon

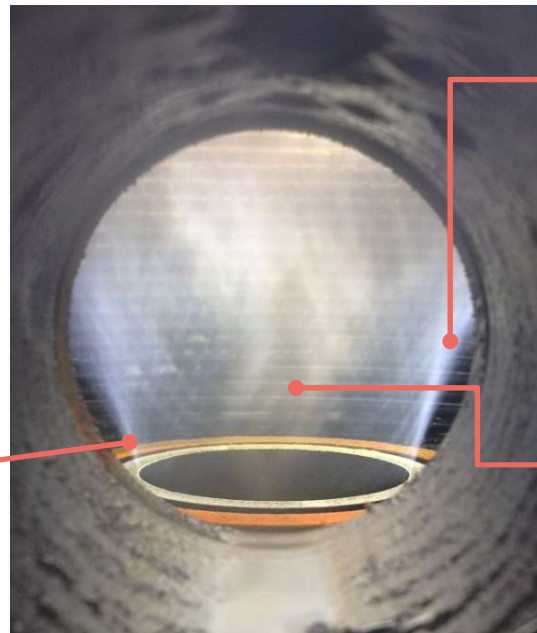
 **CloroSur**

Central spin burner

Proven performance in operation

- Strongly turbulent
- Recirculating flow
- Prevention of backburning

Stable conditions
shown by sharp flow
lines



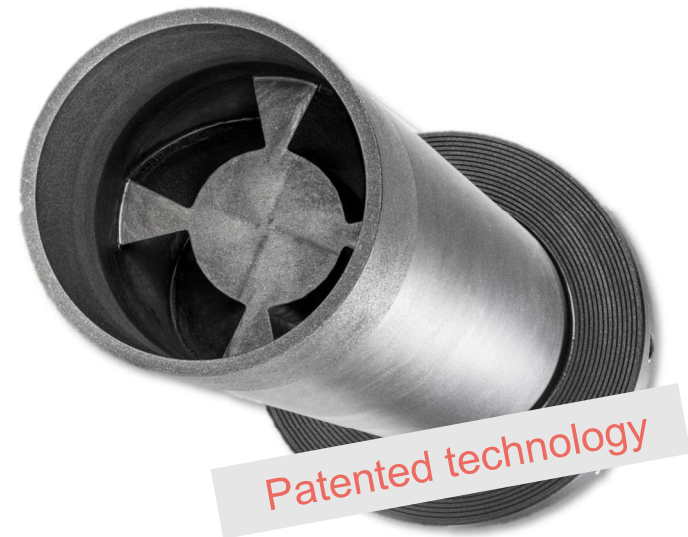
Excellent conversion
shown by white flame
color

Excellent gas mixing
shown by swirl in the
center

Central spin burner

Customer benefits

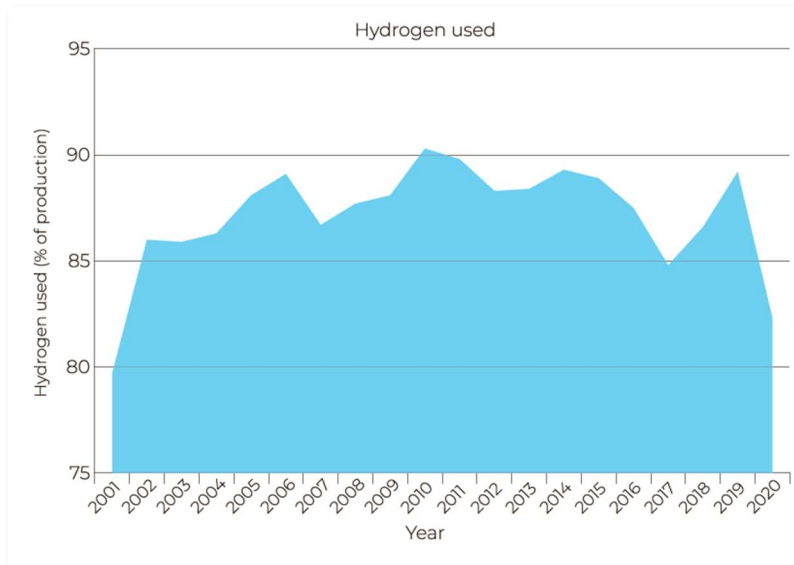
- **Long lifetime**
 - Robust design with no parts exposed to flame
- **Improvement of performance**
 - Reduction of free Cl₂ in the product
 - or reduction of H₂ excess
 - Better conversion rate of weak gases
 - Shortest delivery time - SGL production
- **Compatibility with SGL's superior key components**
 - Pilot burner
 - Burner flushing system
 - Flame guard system
- **Retrofit option**
 - Fits to most existing units



Hydrogen utilization

Chlor-alkali industry review 2020-2021

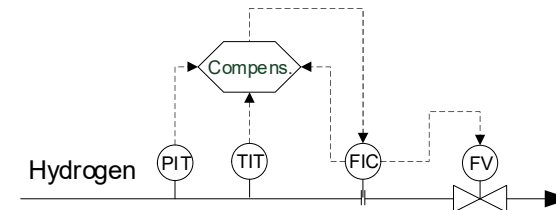
- Ambition for 2030 is to use 100% of the hydrogen



Source: Chlor-alkali industry review 2020-2021 page 16

SGL solutions to support this ambition

- New central spin burner
 - Up to 50% reduced hydrogen excess
- State of the art control
- Density compensated flow measurement
- H₂ recycle
 - Conceptual phase
- H₂ after combustion with steam generation
 - Conceptual phase



SGL's offer to our customers

Your benefit

Industry benchmark in



Safety

Reliability

Efficiency

Service

Innovation

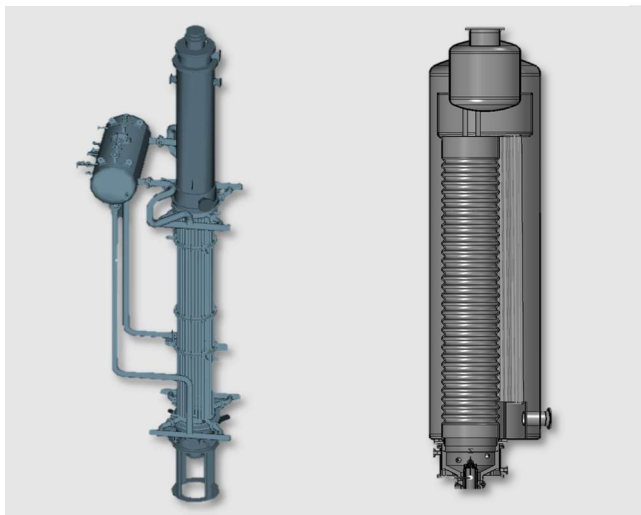
Quality

Summary - Designed for sustainable benefits



Your benefit: Reduced CO₂ emissions - Reduced OPEX - Less dependence from energy prices

Heat recovery



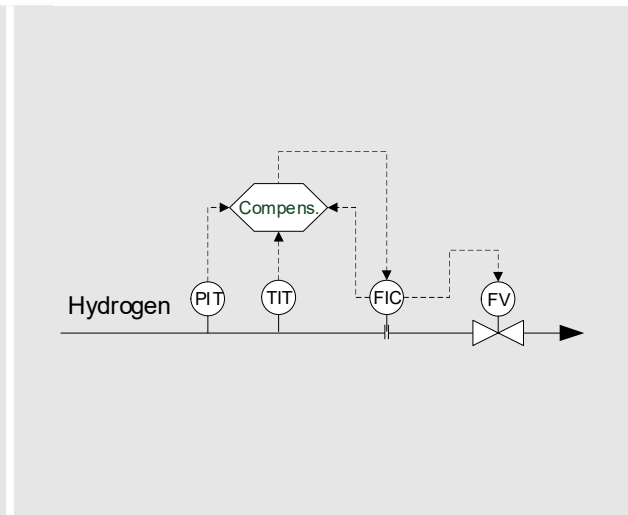
Membrane wall - 0,6 t steam/t HCl
ECOSYN - 0,9 t steam/t HCl

Central spin burner



Up to 50% reduced H₂ excess

Hydrogen utilization



A tropical landscape featuring a body of water in the foreground, a line of palm trees on a small island in the middle ground, and a blue sky with scattered white clouds. The scene is partially obscured by a large, light orange diagonal shape that serves as a background for the text.

Thank you!

 sgl carbon

 **CloroSur**