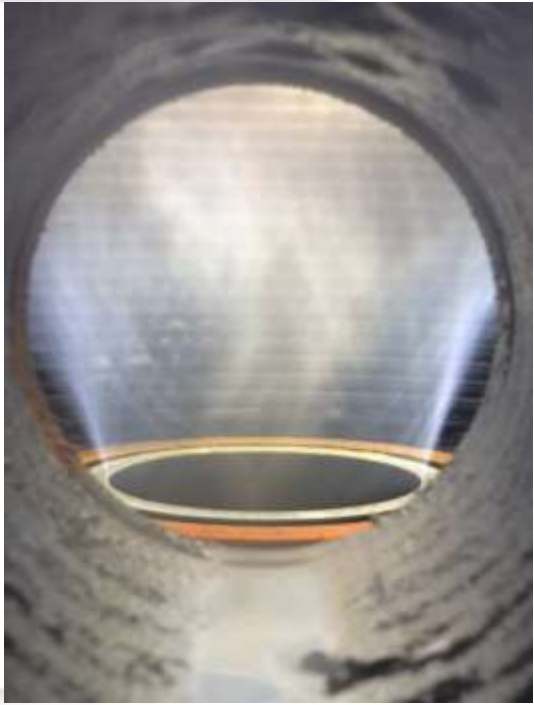
sgl carbon

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

State of the art HCl synthesis technology

Clorosur - XI Technical Seminar



Christian Bienhuels | Monterrey | Nov. 15, 2018

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Agenda

1 HCl Synthesis

- HCl synthesis process basics

2 State-of-the-art HCl Synthesis Technology

- SGL`s design capabilities – benchmark in technology
- SGL`s design features – unique product offerings
- SGL`s safety system – reliable & trendsetting

3 Summary

1 HCl Synthesis

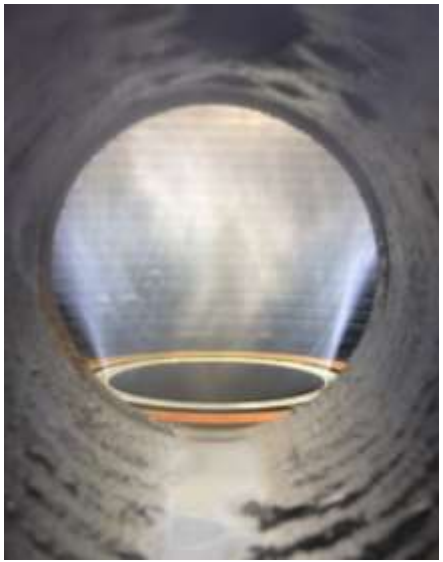
HCl synthesis

Hydrogen + Chlorine = Hydrogen Chloride (gaseous) + Heat

- $H_2 + Cl_2 \rightarrow 2\ HCl + energy$
- Reaction enthalpy: **0.7** kWh/kg (1100 BTU/lb)
- Flame temperature: > 2000°C (3630°F)
- Hydrogen excess: 5 to 15%

Hydrogen + Oxygen = Water (gaseous) + Heat

- $2\ H_2 + O_2 \rightarrow 2\ H_2O + energy$
- Reaction enthalpy: **3.7** kWh/kg (5700 BTU/lb)

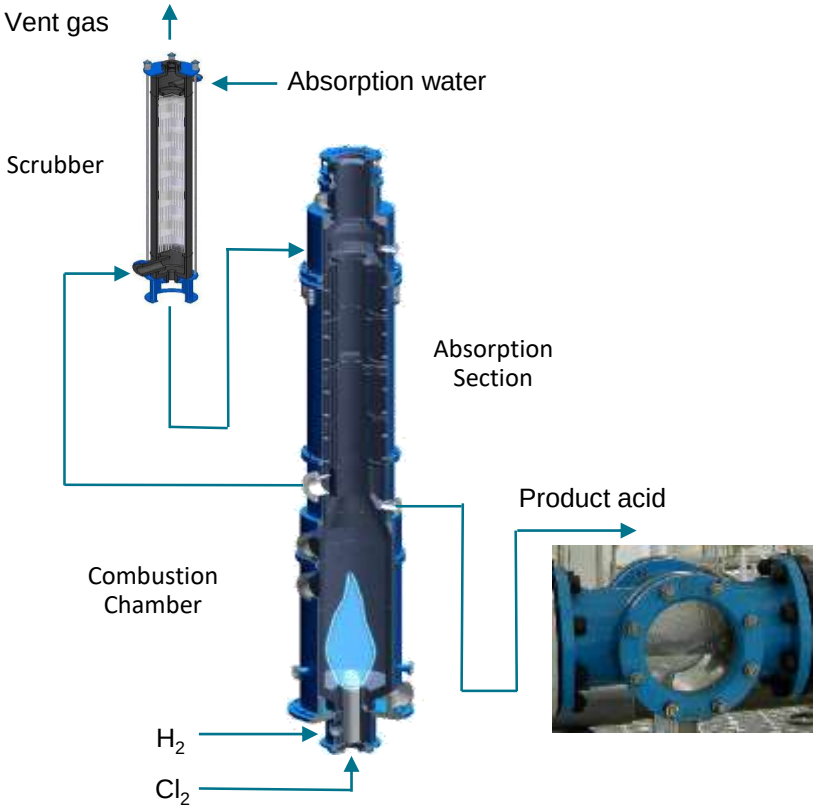


Reaction heat is removed by cooling water and /or steam generation!

2 State-of-the-art HCl Synthesis Technology

SGL`s design capabilities – benchmark in technology

SGL's HCl acid synthesis unit



Performance

- Capacity range 100% HCl basis (0 – 160 TPD)
- Steam generation up to 10 bar g possible

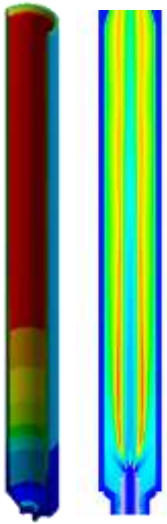
- HCl acid: up to 37 wt.%
- Cl_2 below 1,5 ppm
- Vent Gas acc. to TA-Luft:

HCl	< 30 mg/Nm³
Cl_2	< 3 mg/Nm³

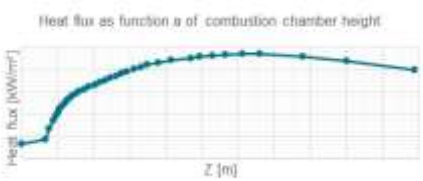
SGL's synthesis unit – thermal & mechanical component analysis

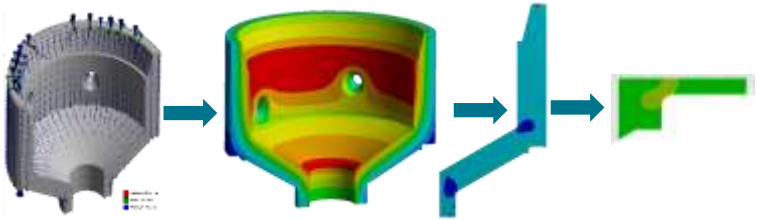
State of the art synthesis design:

- Individual process design to define temperature profile by state of the art simulation tools
- For non standard applications (i.e. high pressure / weak chlorine) not only code calculations but also FEM model of combustion chamber and lower part to estimate stress impact and wall temperature



Thermal process design	Thermal & mechanical analysis





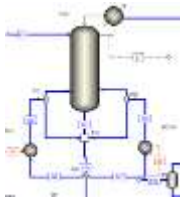
Safe & reliable component design ensures long lasting operation!

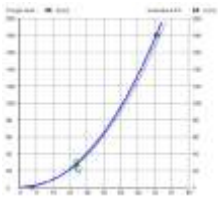
Scrubber - optimized process & component design

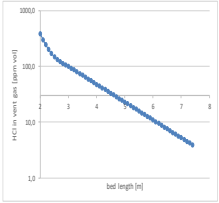
State-of-the-art scrubber design:

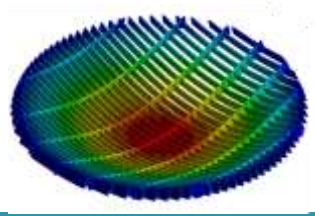
- Individual column design by state of the art simulation tools taking sensitivity studies into account (i.e. off spec start up / shut down conditions)
- Grid and distributor design aligned with packing design
- Integrated tailor made solutions such as cooled scrubber section or caustic scrubber system on demand

Hydraulic design and efficiency rating	Mechanical design	Production









Safe & reliable operation to ensure TA-Luft conform emissions!

2 State-of-the-art HCl Synthesis Technology

SGL`s design features – unique product offerings

SGL's unique new Central Spin Burner

State-of-the-art burner tube design:

- Inner and outer burner tube made of graphite (SGL product)
- Very robust construction
- Nearly no risk of damage during maintenance
- Higher resistance than glass applications in case of wet feeds
- Better conversion rate of Cl_2 and H_2 due to higher turbulences
- Burner flushing device for H_2 and Cl_2 side available
- H_2 excess can be reduced while keeping lowest Cl_2 values in the product
- Homogeneous and stable flame even at lowest turn down
- Short delivery time for spare parts

Safe & reliable operation at minimized H_2 excess ensured!

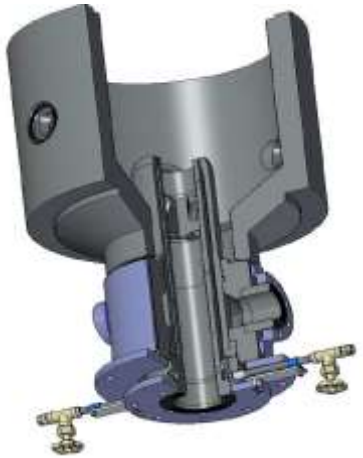
In-situ burner flushing system

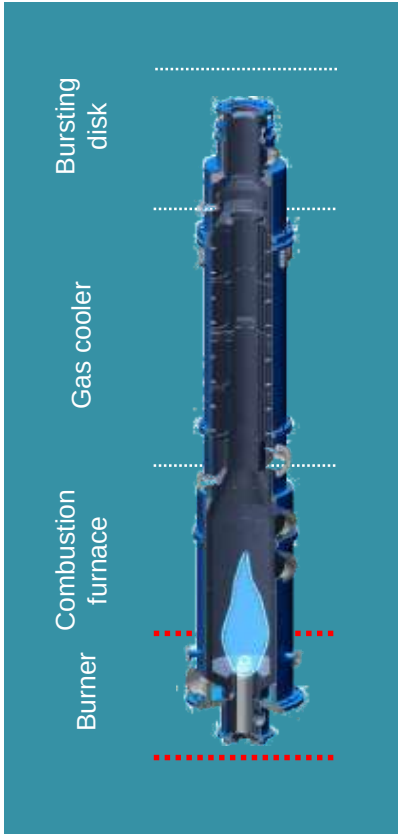
In case of burner scaling risk of

- Misalignment of flame to burner wall
- Increased pressure drop (shortage of H_2 excess)
- Incomplete reaction due to bad feed gas distribution
- Damage of burner tubes

State-of-the-art scaling prevention

- Flushing devices on H_2 and Cl_2 side allow regular burner tube cleaning during operation



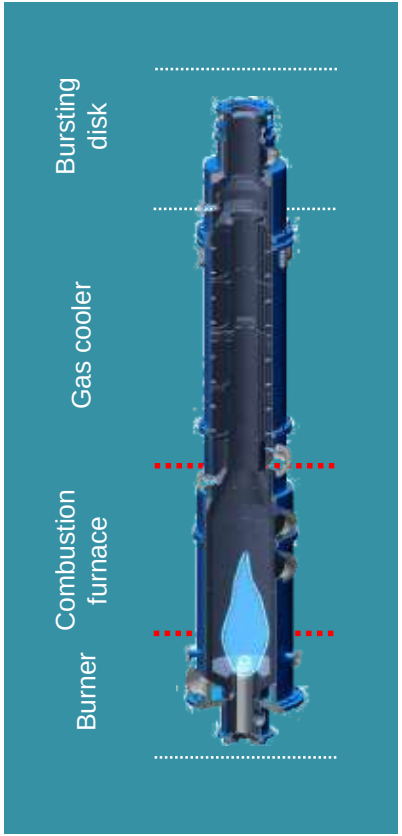


Safe & reliable operation! In-situ preventive maintenance!

Combustion chamber – long, dry and big diameter

State-of-the-art combustion chamber design:

- Due to big diameter no liquid film for cooling required
- No quenching effect by dry combustion chamber possible
- Low chlorine content in product due to long residence time



Long life time of membranes in electrolysis and ion exchanger due to best product quality!

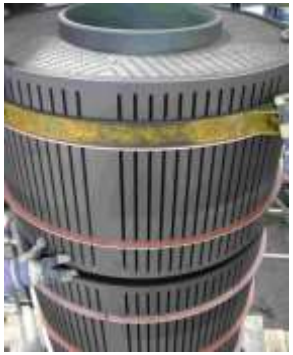
Absorber section

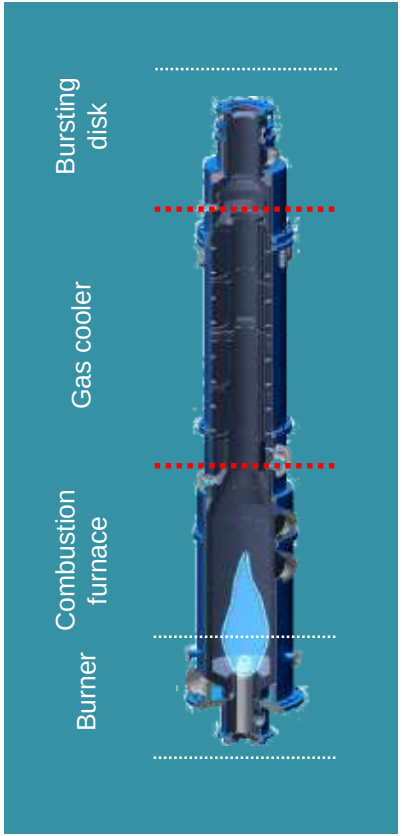
Risk of failure of first absorber block at top burner:

- Certain risk to damage/burn first block in case of damaged burner tube or misalignment
- Blocked gas cooler (e.g. by burner parts) can cause insufficient HCl gas cooling -> overheating
- Burner tube fragments difficult to remove

State-of-the-art absorption section at bottom burner:

- Damage of first cooler block is prevented by long combustion chamber design
- Blocking by burner parts impossible
- No need of spare block





High uptime! Low maintenance cost & efforts!

2 State-of-the-art HCl Synthesis Technology

SGL`s safety features – reliable & trendsetting

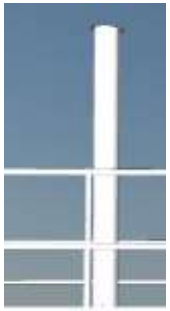
Rupture disc – prepared for the worst

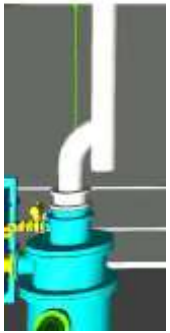
Risk of overpressure:

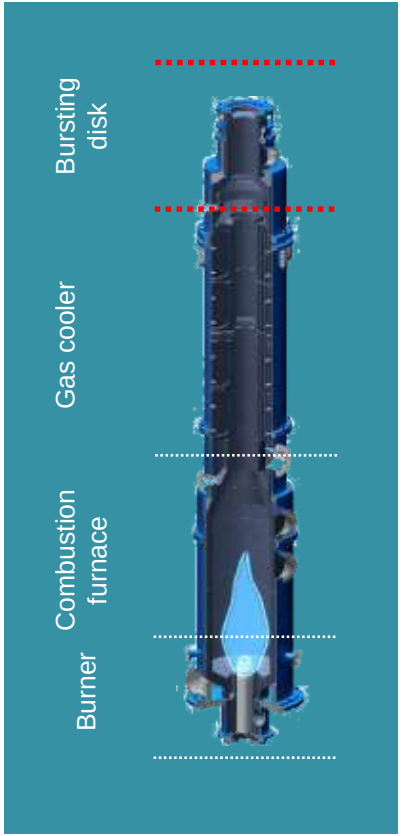
- By unwanted reaction
- Blocked off gas system
- Instrumentation failure

State-of-the-art over pressure protection:

- Rupture disc at top of synthesis unit with sensor and rupture disc chimney
- Set pressure as low as possible
- In case of rupture disc failure HCl gas/fumes are released at the top of the unit
- No liquid can escape in case of rupture disc failure
- Rupture disc chimney on top with special device to collect rupture disc membrane pieces





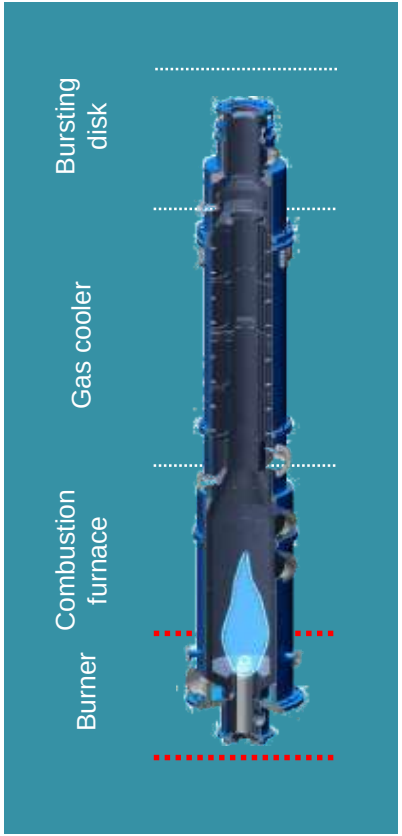


Safety first!

Automatic ignition – safe operation right from the start

State-of-the-art ignition:

- Fully automatic ignition of pilot flame with air and hydrogen
- Safe and trouble free ignition of the main burner
- No open flame (H_2 lance) required
- No vacuum (no ejector, no start-up fan) required
- The pilot burner is fully corrosion resistant (made of PTFE, tantalum, ceramic and graphite)
- Developed and produced by SGL



Safety first!

Flame guard – reliable control during operation

State-of-the-art flame detection

Pilot Flame:

- $H_2 + O_2$ → H_2O
- IR not sensitive to spark
  - ➢ IR-Sensor

HCl Flame:

- $H_2 + Cl_2$ → 2 HCl
- $H_2 + O_2$ → H_2O
- Mainly UV but also some IR- Emission
  - ➢ IR- & UV-Sensor

New

Safety first!

SGL’s safety system – your security for safe operation

State-of-the-art PILZ PSS3000 / PSS4000*

- Failsafe and standard modules
- Approved program routines
- TÜV approved
- Powerful CPU processes programs at high speed
- Continuous supervision of input / output loops
- SIL2/SIL3 Safety Integrated Level
- LEDs and a 4-digit display provide information on status and diagnostics

PSS 4000
(source: www.pilz.com)

Safety first!

* Allen Bradley / Siemens / HIMA safety systems can be supplied as option

SGL’s control panel – a perfect frame

State-of-the-art setup of safety system

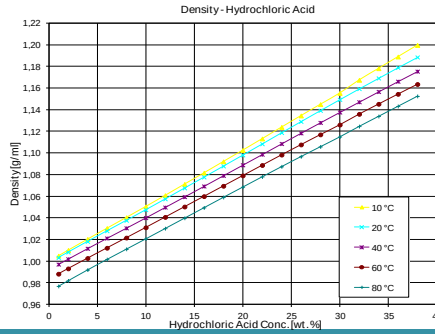
- The fully automatic ignition, start up and shut down sequences are completely controlled by the safety system
- The unit can only be started if all start pre-conditions are fulfilled
- In case of failure detection the safety system immediately shuts down the unit fully automatic in a safe way
- The control and block valve shut off time is less than 2 sec.
- The shutdown action includes nitrogen purge of the unit
- An emergency shutdown of the unit is always possible by pushing the button „EMERGENCY STOP”

Safety first!

Density measurement – easy & safe operation

State-of-the-art acid concentration measurement by density meter

- Linearity of density versus concentration
- No unspecific concentration area – as in case of conductivity measurement
- Especially at the “slope change” (18-22 % wt. HCl) no concentration measurement by electric conductivity is advisable.
- Integrated thermo-element allows temperature compensation
- Measuring principle variation of natural frequency (density depending) induced by oscillation of the liquid

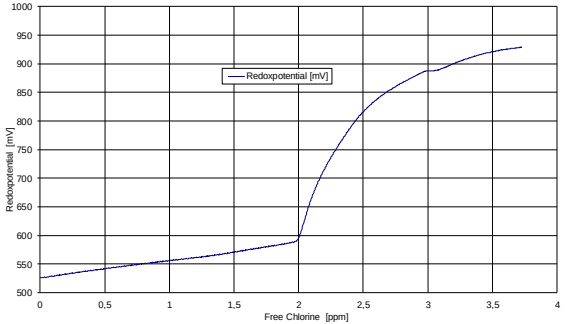


Safe & reliable operation ensured!

ORP control – easy & safe operation

State of the art free chlorine acid control

- Online monitoring of redox potential
- Qualitative detection free chlorine >= 2ppm
- Fast response time
- Independent qualitative incineration control
- Integrated sensor diagnostics
- State-of-the-art gel electrolyte
- Integrated temperature detector



Safe & reliable operation ensured!

3 Summary

State-of-the-art HCl synthesis “Bottom Burner”

- Safe accessibility, control, inspection and operation on ground level
- Burner and sight glass for flame inspection
- Pilot burner
- Feed gas lines
- Control and safety instrumentation
- Short rescue ways
- Condensate outlet at bottom allows easy separation of condensate from HCl gas stream for best product quality

Safe & reliable operation ensured!

Summary

SGL’s HCl synthesis technology is the benchmark

- **Highest safety level**
- **Best product quality**
- **State-of-the-art components**
- **Low and easy maintenance**

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Thank you!

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