VGBE

WS FLUE GAS CLEANING 2024

FRANKFURT/MAIN GERMANY

LECHLER GMBH – GERMANY 2024

ENGINEERING
YOUR SPRAY SOLUTION

Challenging Conditions in Flue Gas Scrubbers

The Industries (almost) always have solutions

How the industries convert challenging conditions to technical solutions. The paper is intended to show solutions that the industries make available to operators of flue gas desulfurization systems in order to reduce operating costs, maintenance costs and emissions.

LECHLER GMBH 2024

EVERY SCRUBBER SYSTEM CAN BE IMPROVED

IF: YOU CAN REDUCE MAINTENANCE AND KEEP THE SPRAY PERFORMANCE

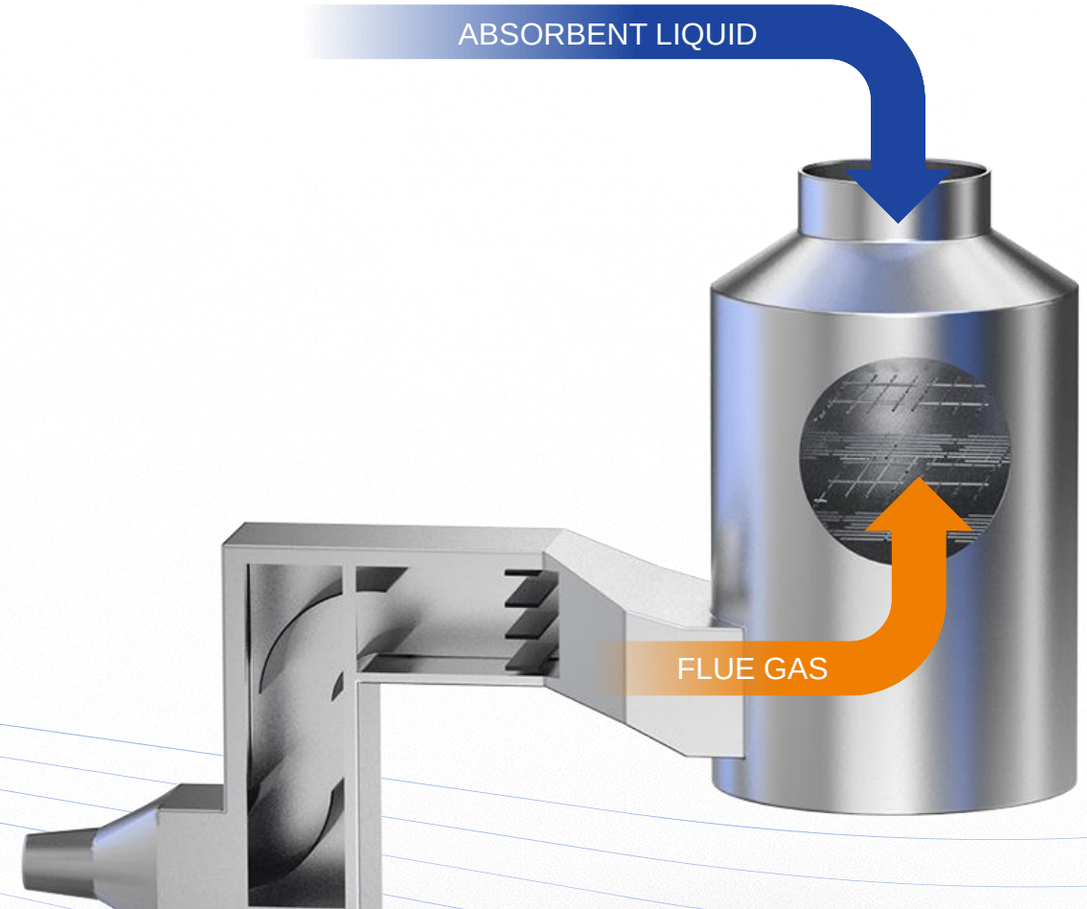
IF: YOU CAN INCREASE THE REACTIVE SURFACE OF THE INJECTED LIQUID

IF: YOU CAN BALANCE THE GAS DISTRIBUTION

The components influence highly the process performance due to several features of spray components.

Experience and knowledge about these features are an essential base to engineer customized spray solutions.

The presented spray solutions allow to follow stricter regulations coming with BREF limitations in line with the necessary need for operational cost reduction.



SPRAY NOZZLES

Small component – high influence on:

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Maintenance

Helix nozzles are characterized by very efficient drop formation and a small Sauter diameter (SMD 32), but they tend to clog.

Blockage are one of the worst conditions for an efficient operation.

Solution

Target was:

To enlarge the free passages (in this sample from 15 to 40 mm) while keeping the sauter mean diameter (SMD) on same size.

SPRAY NOZZLES

Small component – high influence on:

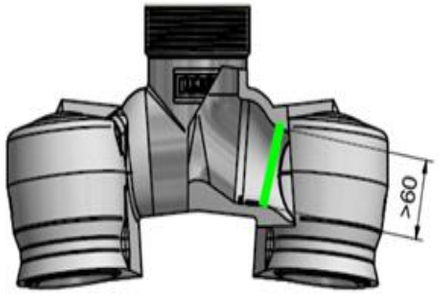
In some cases even Helix nozzles providing huge free passage (> 40 mm) get clogged due to the tough conditions at site.

Solution can be tangential fed nozzles arranged in a cluster.

In this case 20 mm were increased to 60 mm.

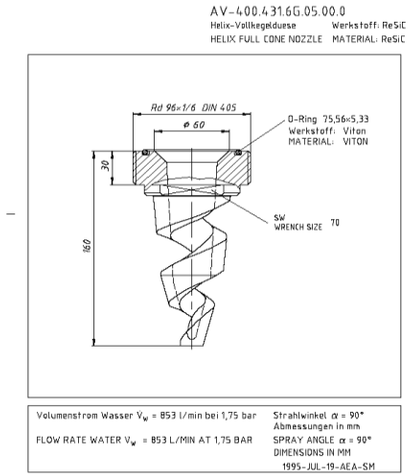
Additional feature:

Enhanced spray coverage, small SMD and support of secondary atomization.



SAMPLES

Before



After

SPRAY NOZZLES

Small component – high influence on:

In some plants the operator still have clogging issues even with 60 mm free passage.

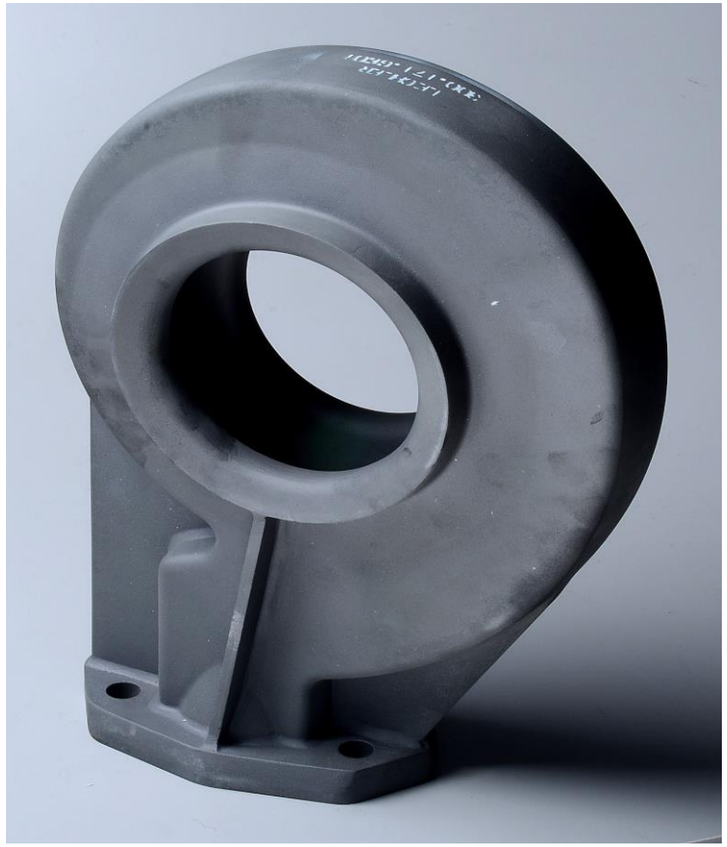
Solution

Increase the free passages to a maximum while compromising to the Sauter mean diameter (D32)

SPRAY NOZZLES

Small component – high influence on:

Wearing	Material always can be an option to change.
Solution	SiC / SiSiC instead of Alloy.



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PERFORMANCE TEST

Worn sample

Spray angle: Down 140°
Spray angle: Upwards 143°
Spray pattern: Skew/Unbalanced/Unqualified
Flowrate: 655 lpm @ 2,7 bar

New (Type 300.171.6F.11)

Spray angle: Down 136°
Spray angle: Upwards 140°
Spray pattern: Stable/Balanced/Qualified
Flowrate: 580 lpm @ 2,7 bar

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PERFORMANCE TEST

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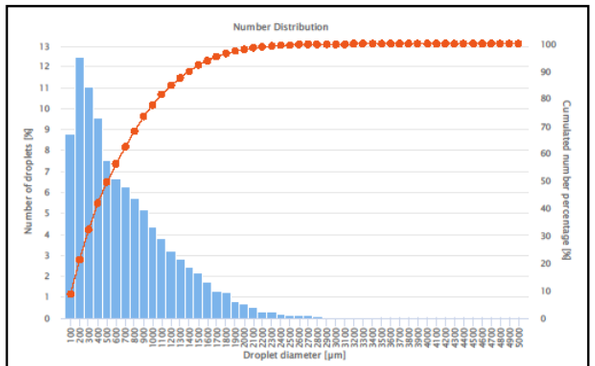
Droplet measurement



Lechler GmbH

Technical Data (measurement mode: PDA)

Pressure (water)	[bar]	2.70
Flow rate (water)	[l/min]	655
Pressure (air)	[bar]	-
Flow rate (air)	[m3/h i.N.]	-
Ratio air : water	-	-
Height	[mm]	1000
Sauter D_{32}	[µm]	1461
DV_{10}	[µm]	914
DV_{50}	[µm]	1669
DV_{90}	[µm]	2921

Remark

–

Measurement date: Oct 6, 2023	Subject to technical modifications: Oct 6, 2023 by Lechler GmbH	0.000.012.595

Document ID

Lechler GmbH · Präzisionsdüsen, Tropfenabscheider
Ulmer Straße 128 · 72555 Metzingen, Germany · Telefon 07123 962-0 · Telefax (07123) 962-444 · info@lechler.de · www.lechler.de

Worn sample

SMD: **D32 = 1.461 µm**

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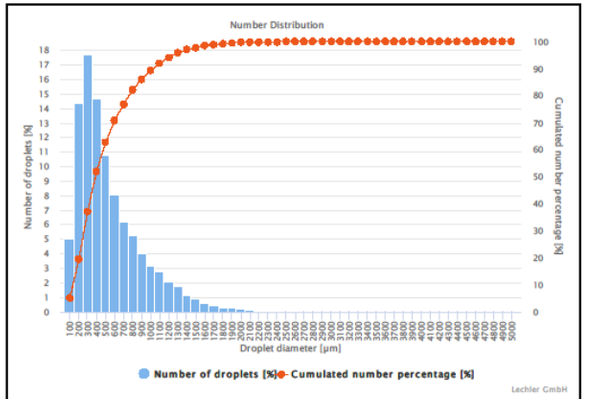
Droplet measurement
300.170.6F.00.00.0



Lechler GmbH

Technical Data (measurement mode: PDA)

Pressure (water)	[bar]	2.70
Flow rate (water)	[l/min]	580
Pressure (air)	[bar]	-
Flow rate (air)	[m3/h i.N.]	-
Ratio air : water	-	-
Height	[mm]	1000
Sauter D_{32}	[µm]	1107
DV_{10}	[µm]	669
DV_{50}	[µm]	1291
DV_{90}	[µm]	2466

Remark

–

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New (Type 300.171.6F.11)

SMD: **D32 = 1.108 µm**

SPRAY NOZZLES

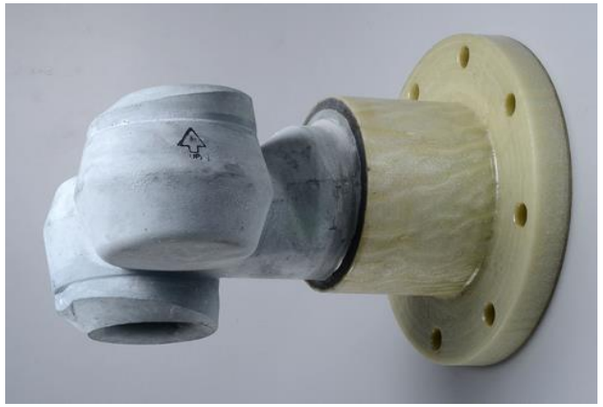
Small component – high influence on:

Weight

Original nozzles. 60 kg in weight!

Solution

Modified to light design with less than 15 kg while keeping the overall performance. Much easier to handle for cleaning or replacing.



SPRAY NOZZLES

Small component – high influence on:

Cost reduction	SiC Solid jet Nozzle
Solution	Alternatively made of rubber (EPDM)

SPRAY NOZZLES

Small component – high influence on:

Lifetime

FRP sockets

Solution

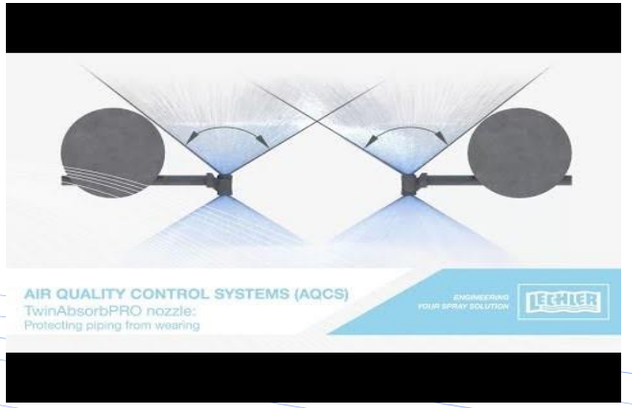
Enhanced with SiC reinforcement

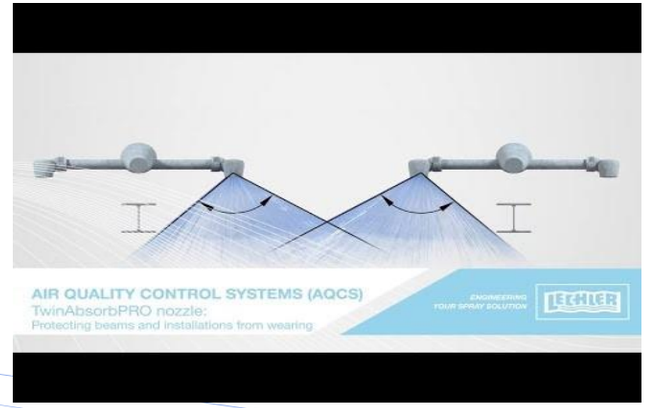
SPRAY NOZZLES

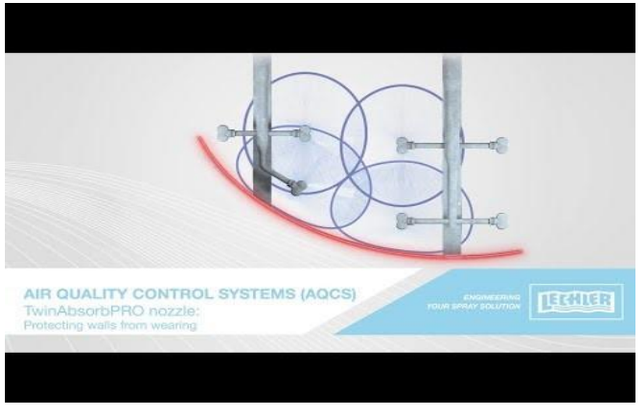
Small component – high influence on:

NEW TwinAbsorbPro©
patented

Efficiency and Wearing

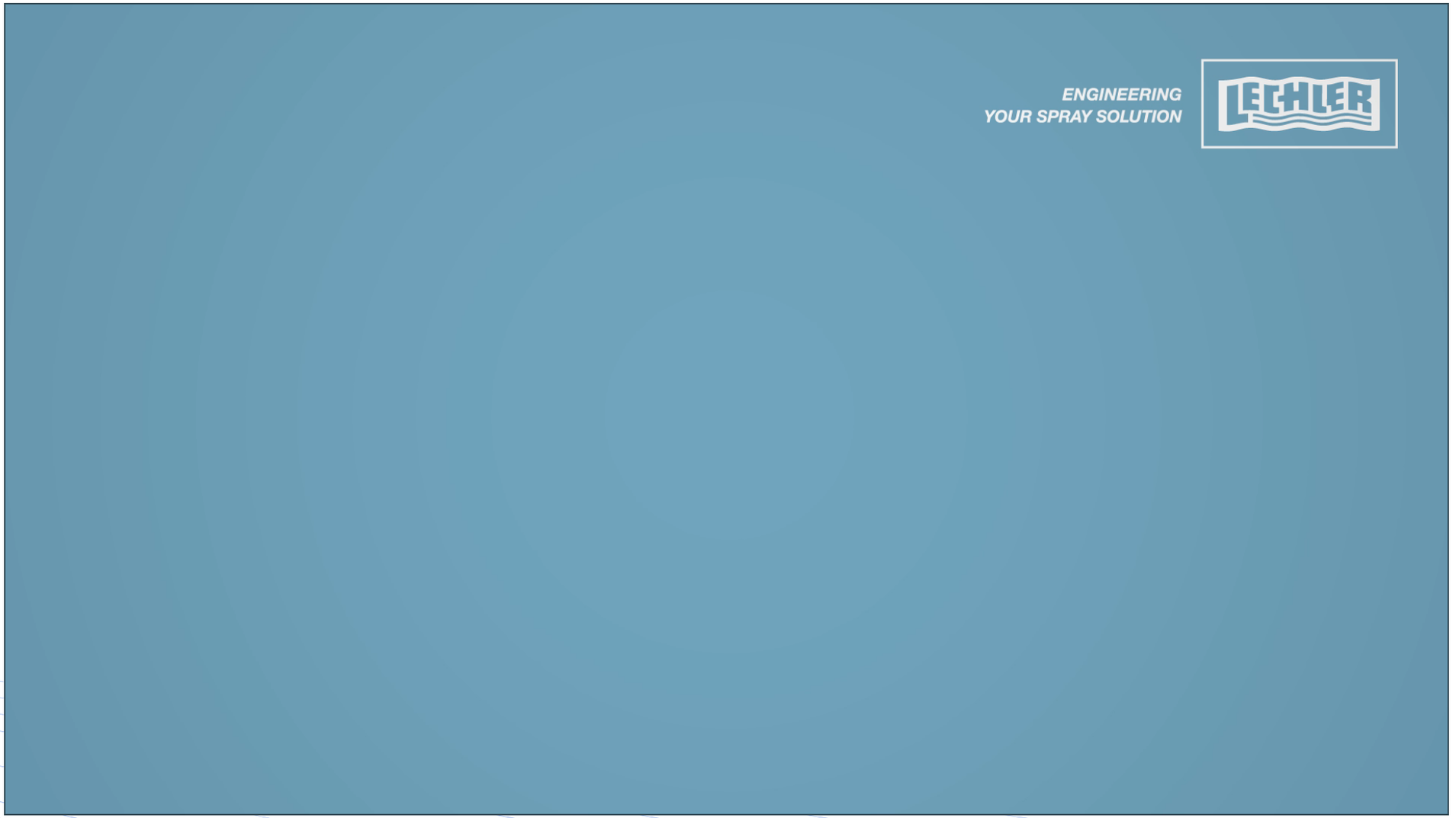






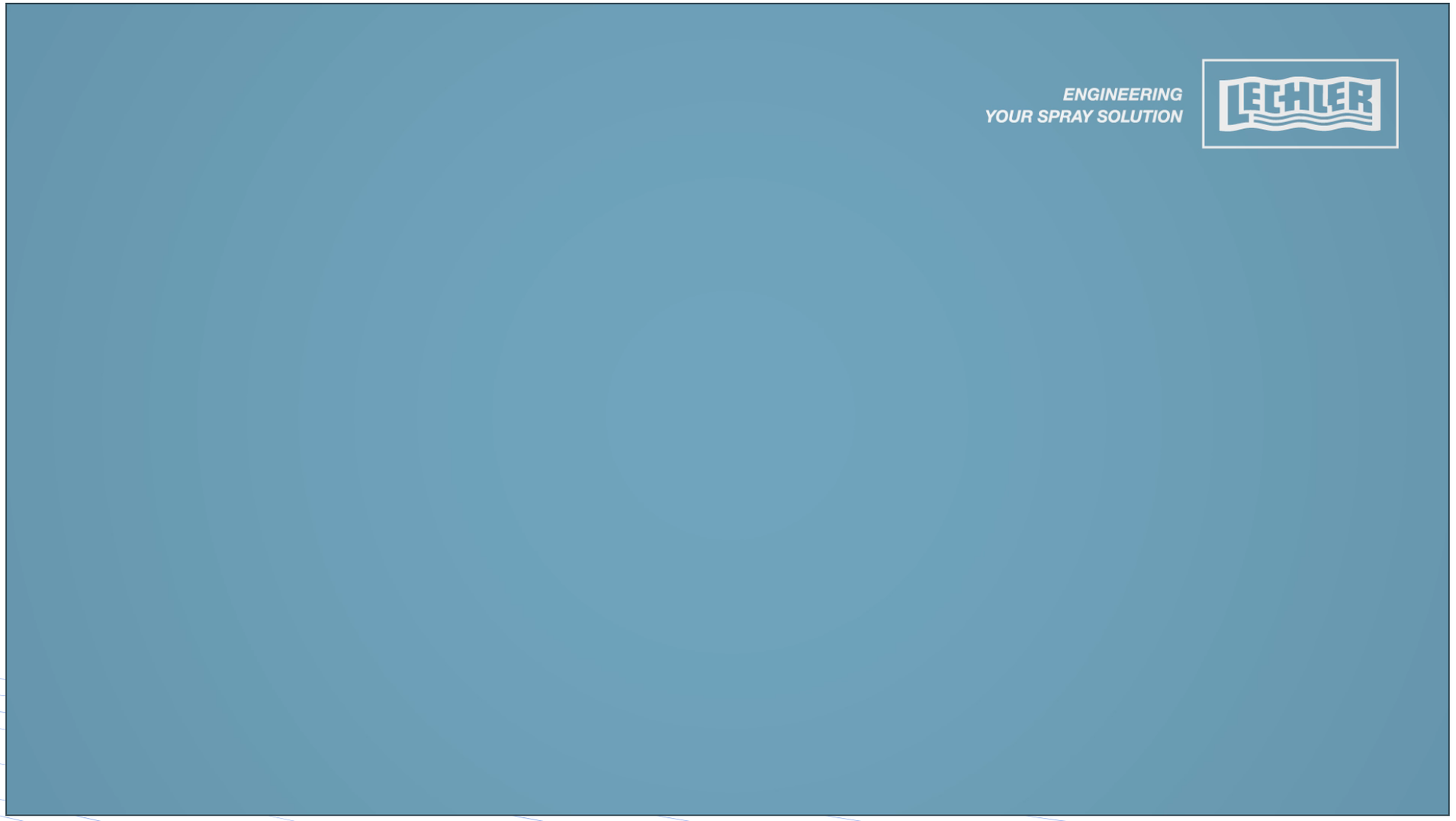
OPTIMIZED SPRAY SHAPE

TwinAbsorbPRO®-01_protecting-beams-and-installations



OPTIMIZED SPRAY SHAPE

TwinAbsorbPRO®-02_protecting-walls



OPTIMIZED SPRAY SHAPE

TwinAbsorbPRO®-03_protecting-piping

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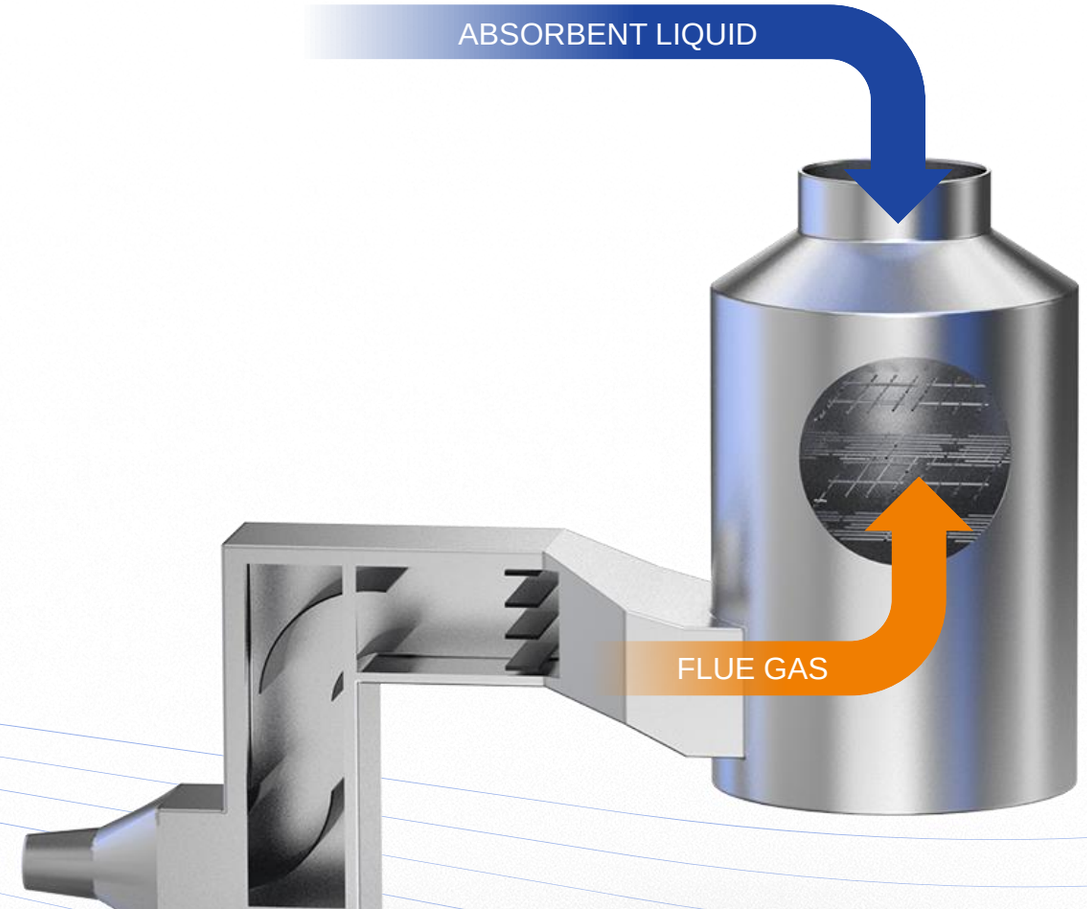

SPRAY NOZZLES

Small component – high influence on:

- Nozzles can increase of specific reactive surface
- Can enhance reactivity of injected absorbent
- Can multiply collision areas by using equilateral spray cones

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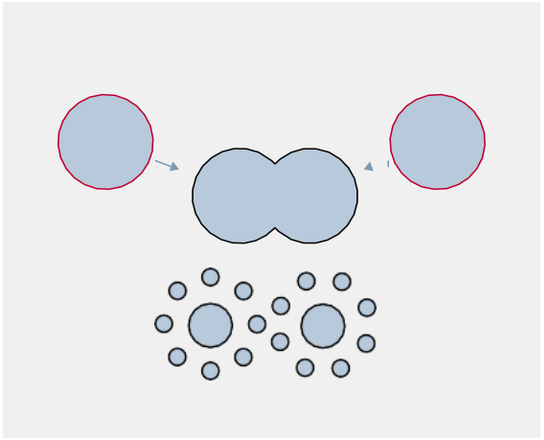
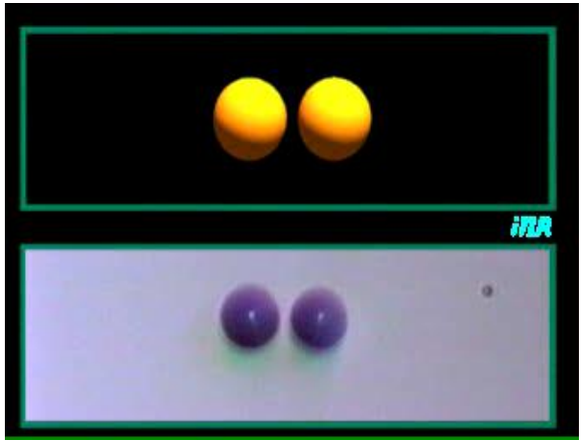
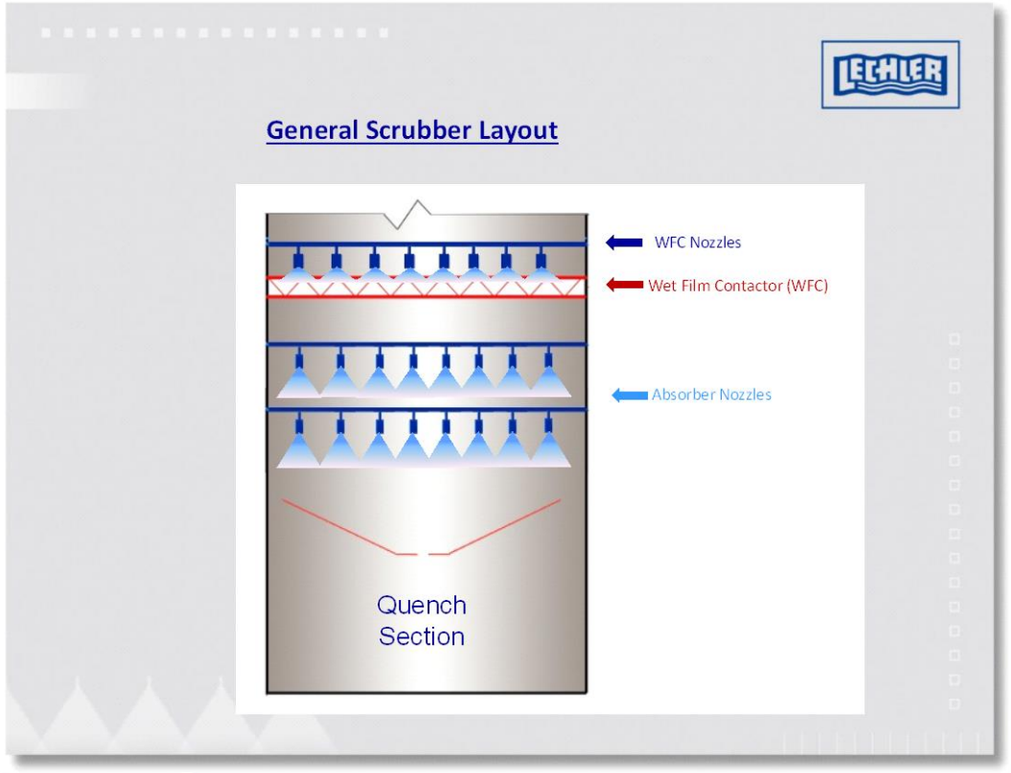
Reactive surface



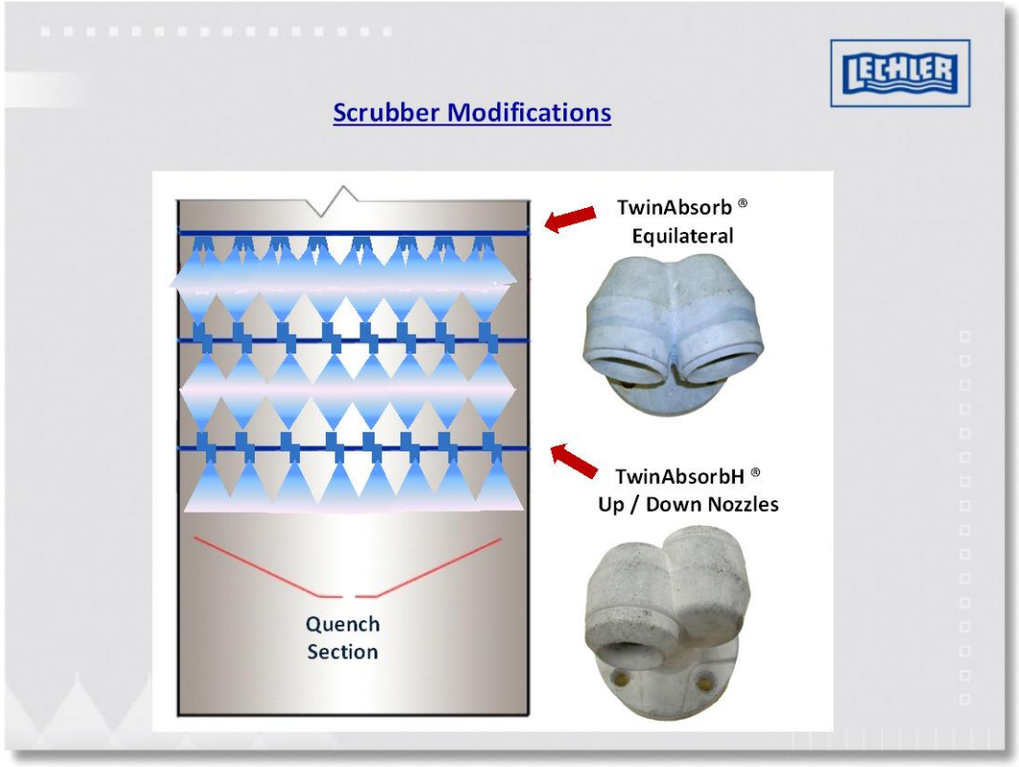


SCRUBBER MODIFICATION BY HYDRAULIC SPRAY LEVEL

Before



After



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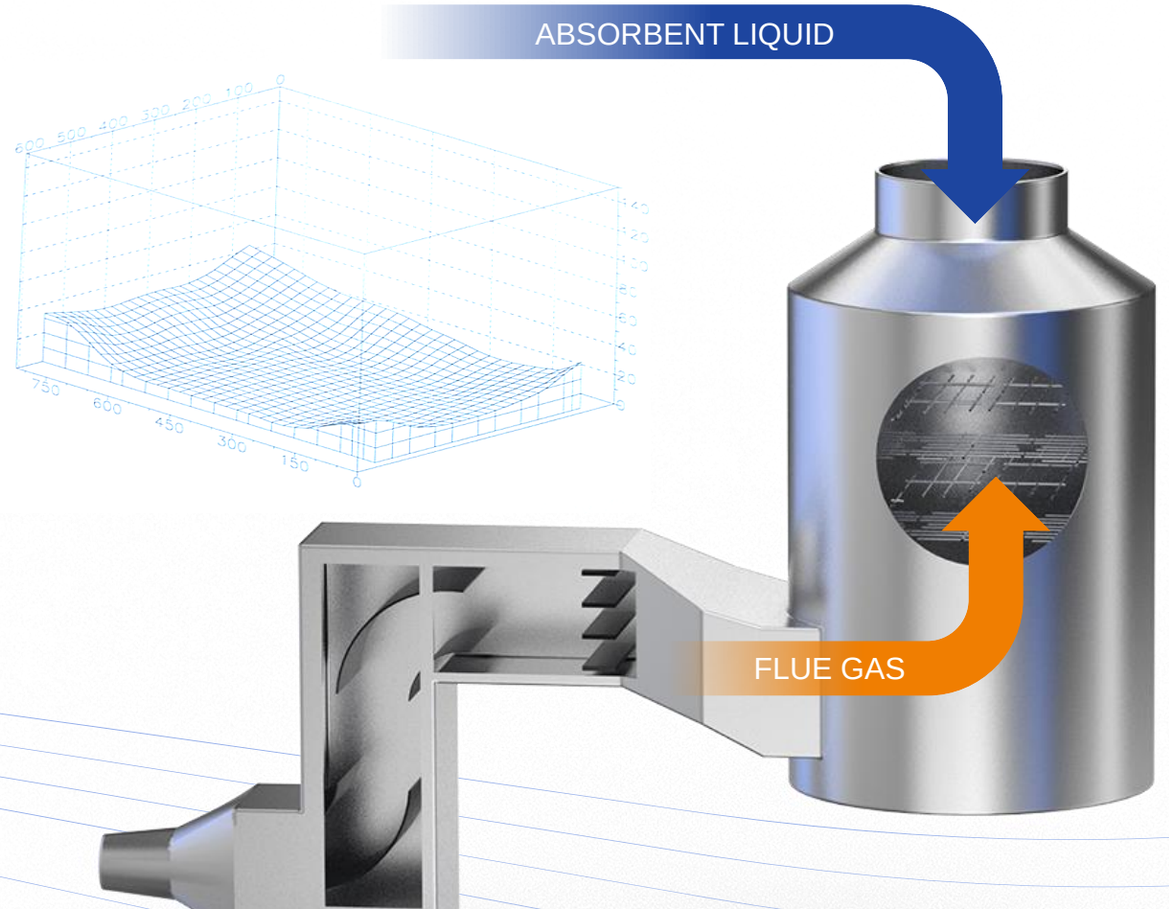

SPRAY NOZZLES

Small component – high influence on:

- How to increase of relative velocity
- How to support of even gas distribution
- How to increase of turbulence due to counter rotating sprays

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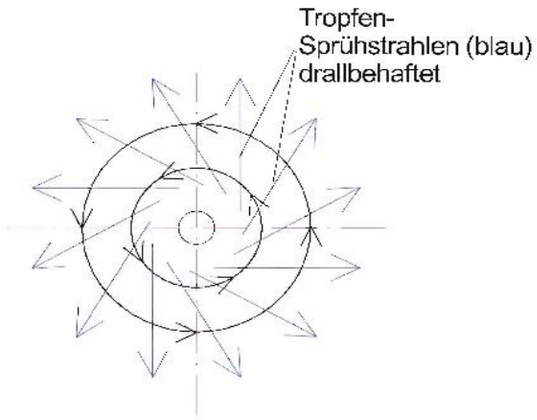
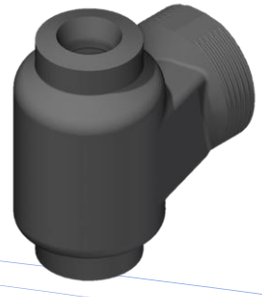
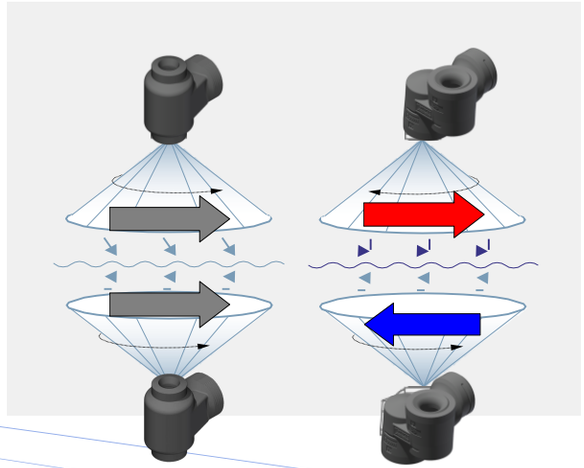
Gas distribution





Standard



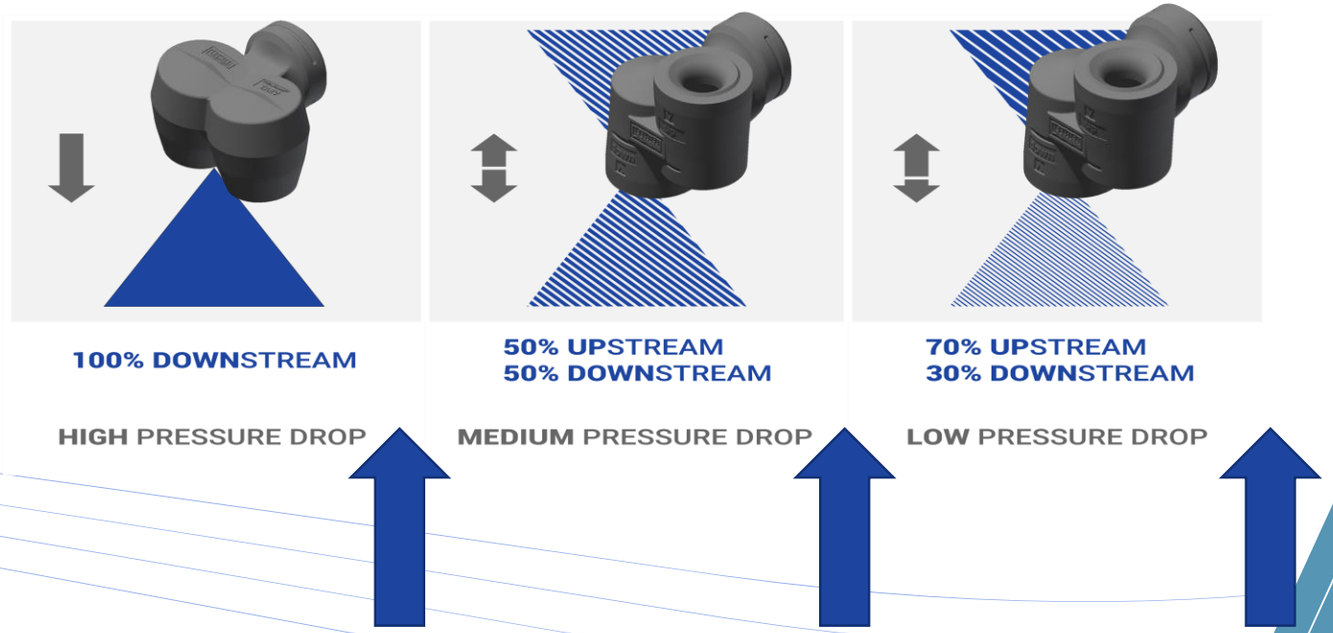
TwinAbsorb

SPRAY NOZZLES

Small component – but high influence on:

Pressure drop

- Assist reduction of pressure drop when using a **tray**.
- Up 0,2 – 1 mbar savings per spray bank possible
- Up to 20-100 ++ KW (el.) savings in electricity demand for ID fan possible



TRAY: Steinmüller Engineering-Gummersbach

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Challenging Conditions in Flue Gas Scrubbers

The Industries (almost) always have solutions

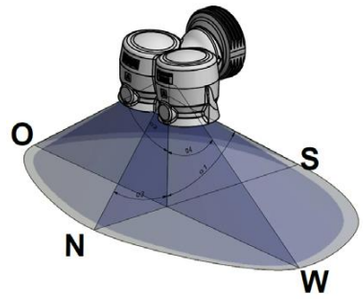
RETROFIT SAMPLES

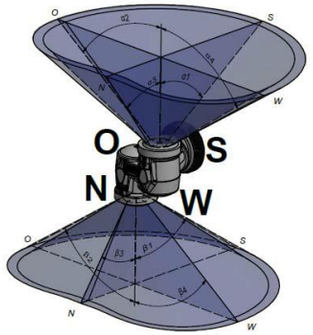
ENGINEERING
YOUR SPRAY SOLUTION

Challenging Conditions in Flue Gas Scrubbers

The Industries (almost) always have solutions

RETROFIT TPP BELCHATOW



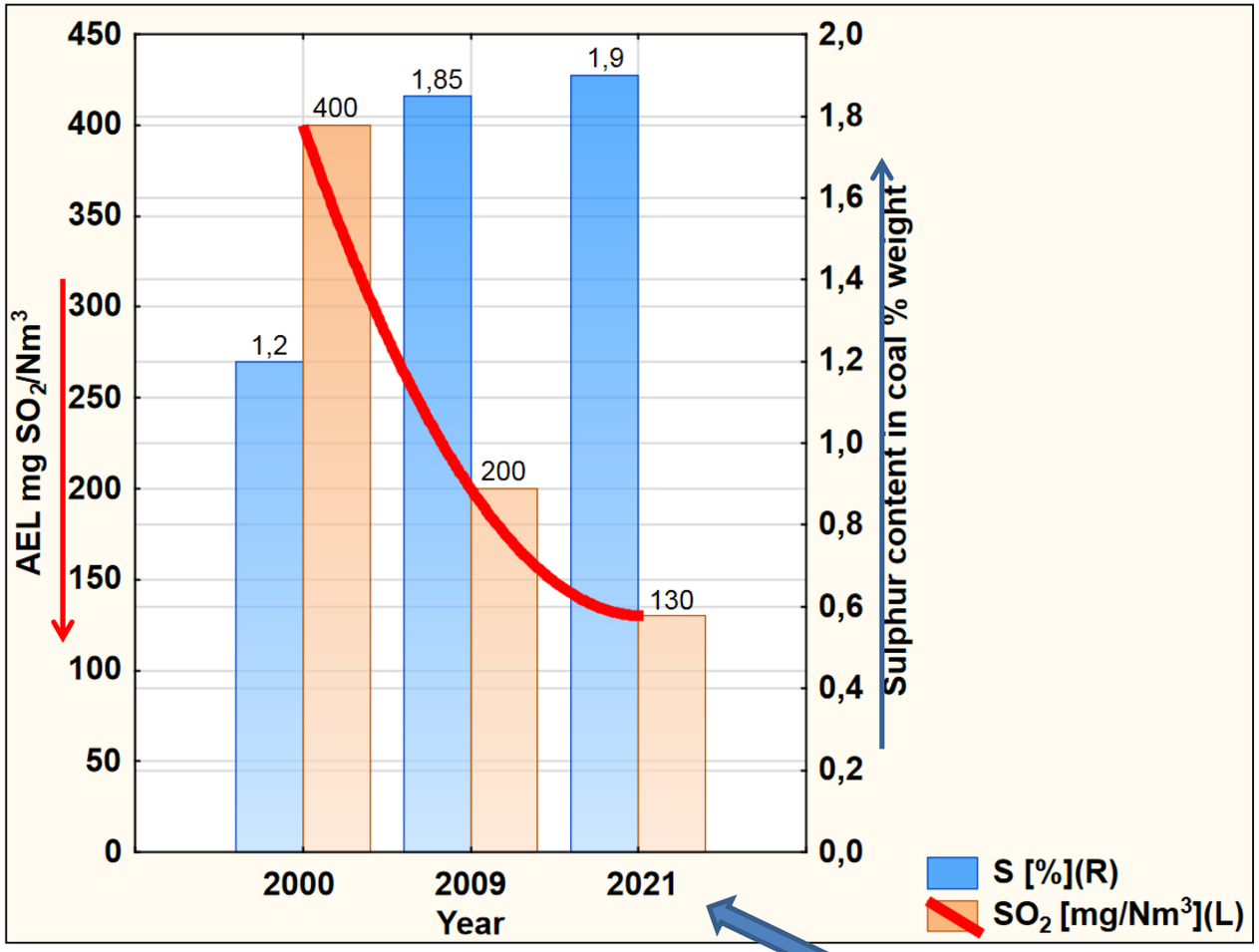


CO-AUDITOR

RAFAKO S.A.

Dip.-Ing. Jerzy Mazurek

Genesis of the project: Increase in sulphur content in fuel due to reduction of SO_2 emission limit (AEL)



Belchatow Power Plant is the largest lignite-fired power unit both in Poland and in Europe.

Total electrical power of boiler units operated in Belchatow PS is 4732 MW_e.

TARGET:

	AEL [mg/Nm³]		Eff. SO_2 removal	
Before	200		98,0%	
After	130	-35%	98,7%	+0,7%

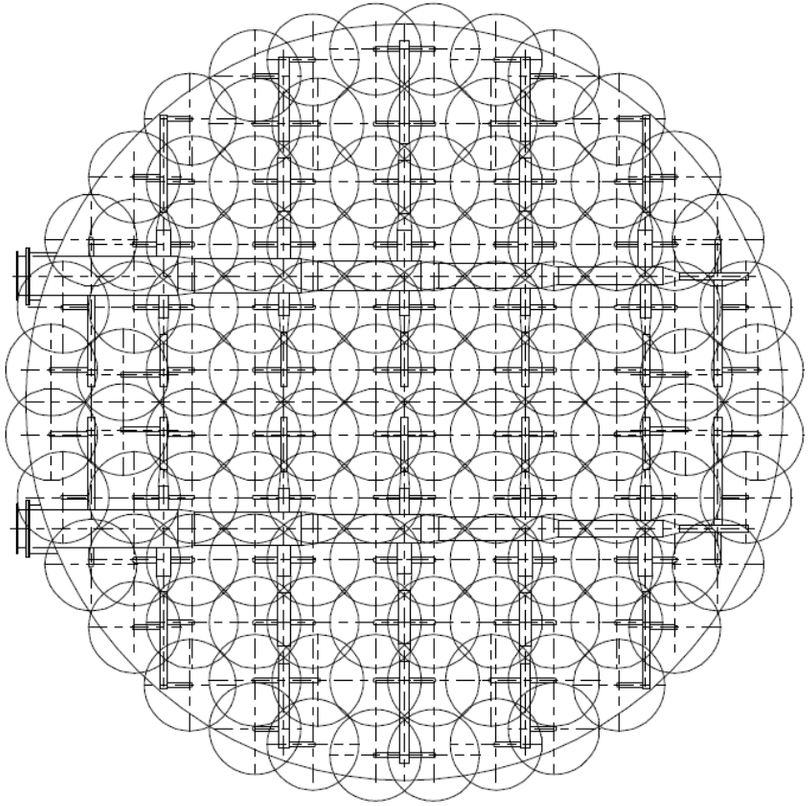
2021: Start of Implementation Best Available Techniques Reference Document for the Large Combustion Plants (BAT Conclusion)

Technology used for increase efficiency SO_2 removal

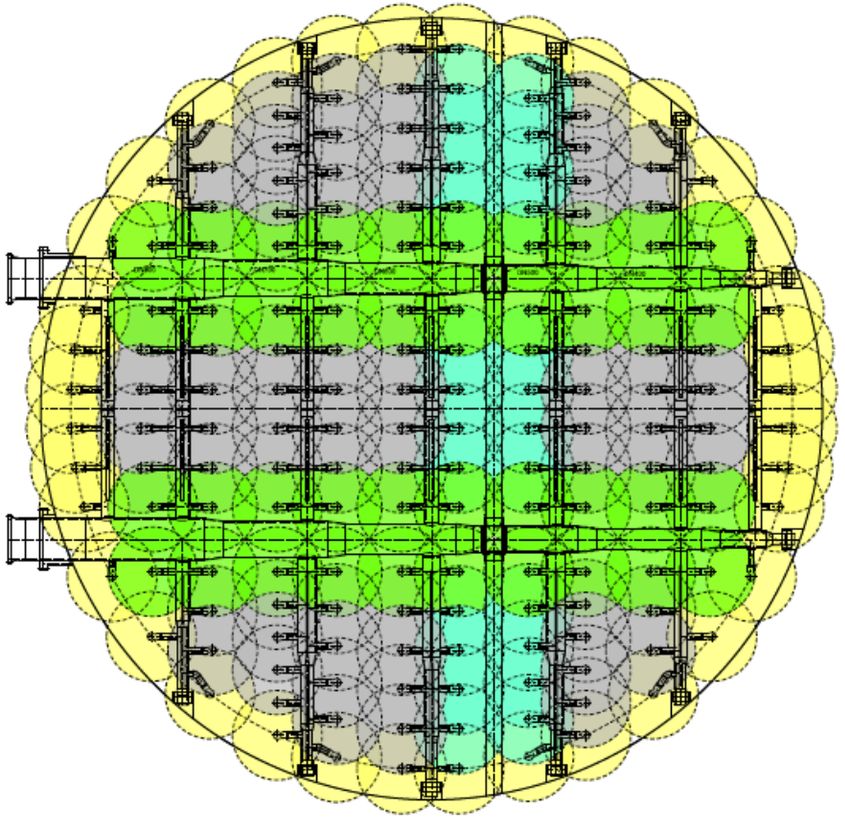
Unit No Unit Power Absorber diameter	Year of start FGD operation (basic project)	Technology for increase eff. SO_2 removal		Date of commissioning after modernization
		New concept and new nozzles for spray level	Additional used technology	
7 / 390 MW / 15,7 m	2003	TwinAbsorb-EH, -H	**FGD_2.0 (RAFAKO)** **Research project**	12.2017
9 / 390 MW / 15,7 m	2003	TwinAbsorb-EV, -H, -EH	**FGD_2.0 (RAFAKO)**	09.2020
10 / 390 MW / 18,7 m	1994	TwinAbsorb-EV, -H, -EH	**FGD_2.0 (RAFAKO)**	09.2020
5 / 380 MW / 15,7 m	2000	TwinAbsorb-EV, -H, -EH	**FGD_2.0 (RAFAKO)**	12.2020
6 / 394 MW / 15,7 m	2000	TwinAbsorb -EV, -H, -EH	**FGD_2.0 (RAFAKO)**	12.2020
12 / 390 MW /18,7 m	1996	TwinAbsorb-EH, -H **TwinAbsorbPRO**	**FGD_2.0 (RAFAKO)**	10.2021
11 / 390 MW / 18,7 m	1996	TwinAbsorb-EH, -H **TwinAbsorbPRO**	**FGD_2.0 (RAFAKO)**	10.2021
3 / 380 MW/ 17,0 m	2007	TwinAbsorb-EV, -H, -EH	**FGD_2.0 (RAFAKO)**	11.2021
8 / 390 MW / 18,7 m	1995	TwinAbsorb-EV, -H, -EH	**FGD_2.0 (RAFAKO)**	11.2021
4 / 380 MW / 17,0 m	2007	TwinAbsorb-EV, -H, -EH	**FGD_2.0 (RAFAKO)**	12.2021
14 / 858 M / 2x16,0m	2011	TwinAbsorb-EH, -H **TwinAbsorbPRO**	-	Planned 12.2023

Spray levels modernization concept
Example for unit 7
Generally: Individual design for each absorber

Before … After



Quantity of nozzles per one level: 120 pc
Types of nozzle: 2
Nozzle capacity: 1583 l/min
Connection type: lamination DN125



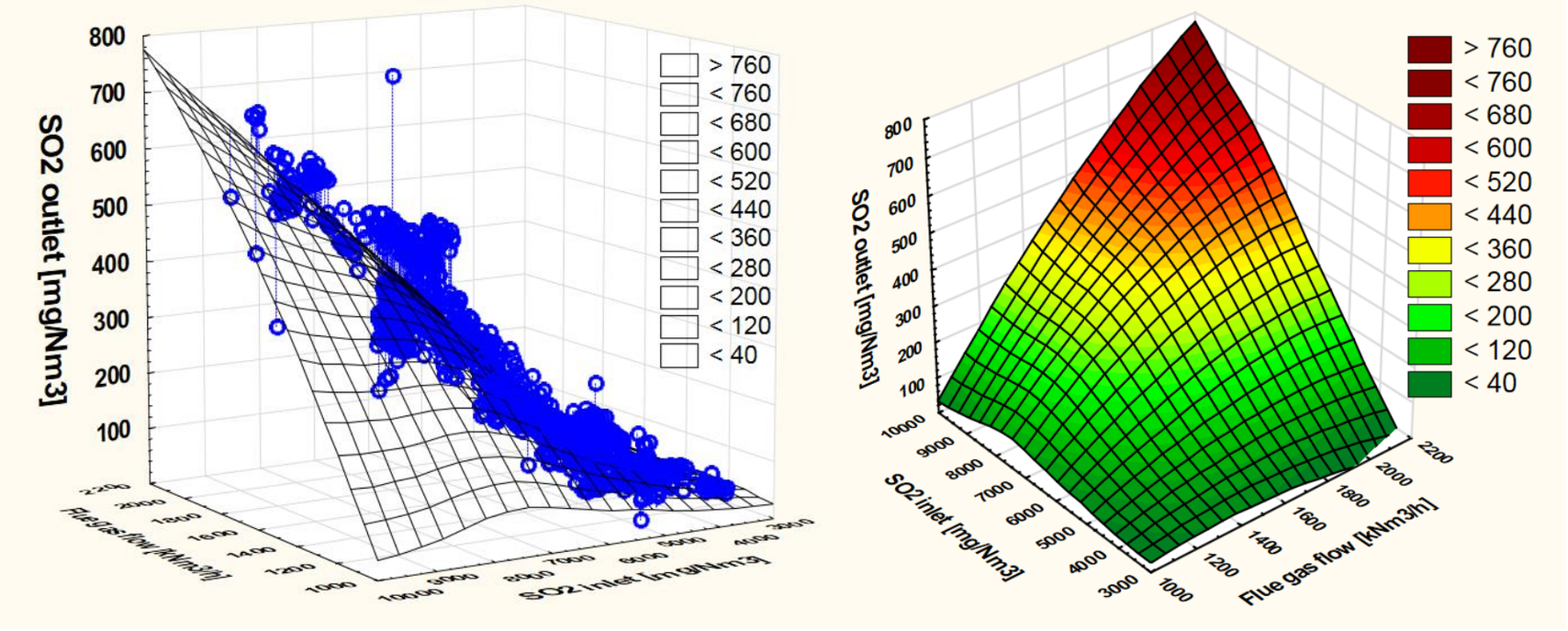
Quantity of nozzles per one level: 172 pc
Types of nozzle: 5
Nozzle capacity: 1105 l/min
Connection type: Victaulic, DN100

Spray levels modernization concept and FGD_2.0 process technology
Photos for unit 7 after modernization

Visualization of the effects of absorber modernization on the example of unit 7.
Synergistic effect of using new nozzles and FGD_2.0 process technology.
Developed on the basis of data from field equipment (continuous measurements of gas parameters)

3D diagram of SO_2 concentration in the clean gas at the chimney relative to the raw flue gas volume flow and SO_2 concentration at the FGD inlet for 3 spray banks in operation.

~2000 measuring points → … → Curve fitting



Developed on the basis of the analysis of data from 1 full month of work before and after modernization (sampling period: 60s).

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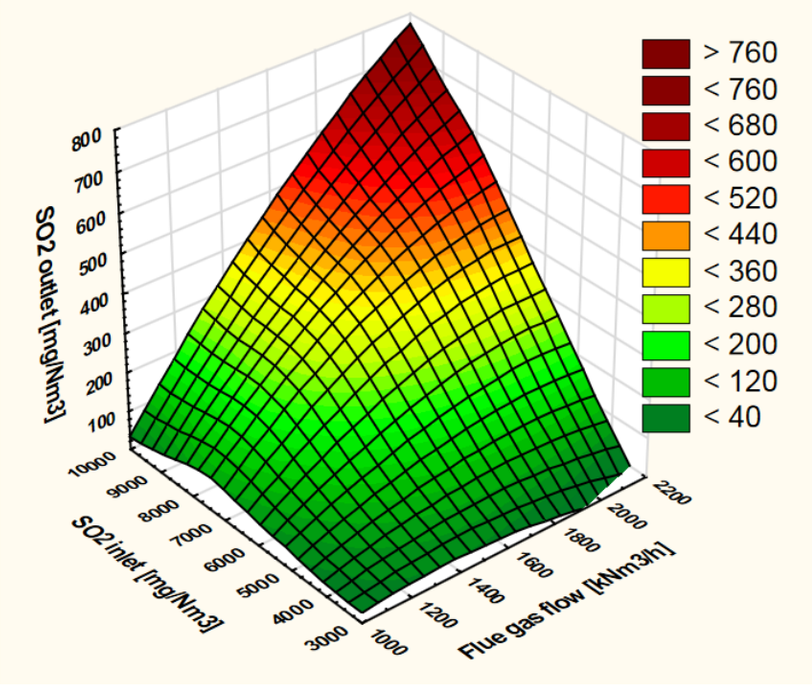
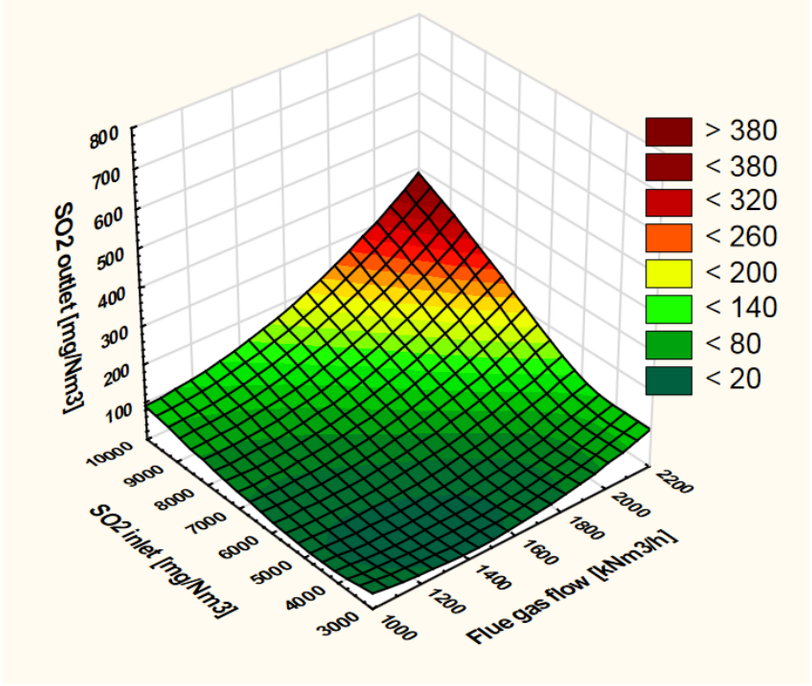




Developed on the basis of the analysis of data from 1 full month of work before and after modernization (sampling period: 60s).

Comparison of the results of work from the monthly period before and after modernization allows us to conclude that the outlet concentration of SO_2, and thus SO_2 emissions, has been reduced by over 50%.

Results of warranty measurements made by an independent measuring company

Unit	Date of warranty measurements	SO_2 inlet [mg/Nm³]	SO_2 outlet [mg/Nm³]	SO_2 removal efficiency [%]
7	21.04 - 23.04.2020	9396	68	99,3
9	17.05 - 21.05.2021	7188	50	99,3
10	17.05 - 21.05.2021	7485	79	98,9
6	27.09 - 01.10.2021	8017	49	99,4
12	05.12 - 09.12.2021	9928	82	99,2
11	05.12 - 09.12.2021	9028	81	99,1
3	08.06 - 09.06.2022	9152	11 *)	99,9
4	08.06 - 09.06.2022	9458	120	98,7
5	10.08 - 11.08.2022	8328	84	99,0
8	05.10 - 06.10.2022	9324	107	98,9
	on average	**8730**	**73**	**99,2**

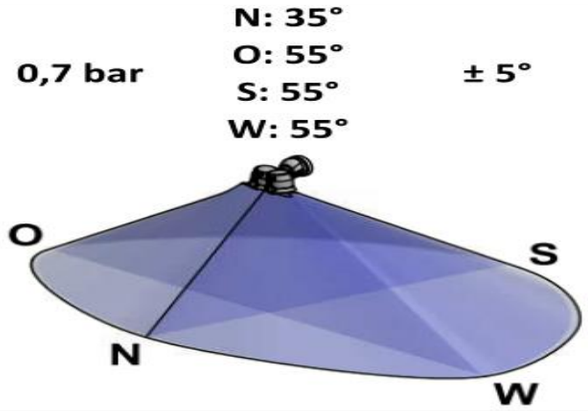
The measurements were made at full power of the unit and all spray levels in operation (stable operation minimum 4 hours). Measurement based on measuring grids (multi-point measurement).

*) Result for high pH level and high organic acid concentration.

CONCLUSION:

- **After modernization, the absorbers achieved the assumed ability to maintain the outlet concentration of SO_2 below 130 mg/Nm³ for SO_2 concentrations at the inlet up to 10000 mg/Nm³ as a function of the pH of the absorber suspension and the volume flow of the raw flue gas.**

Special solutions for upgrade wet FGD systems

SKETCH	TECHNOLOGY	COMPANY
	TwinAbsorbPRO	LECHLER GmbH For details please contact with: Thomas Schröder T: +49 (0) 7123 962- 315 M: +49 (0) 172 720 1993 E: Thomas.Schroeder@lechler.de
	FGD_2.0 process technology	RAFAKO S.A. For details please contact with: Jerzy Mazurek T: +48 32 410 1394 M: +48 602 760 006 E: Jerzy.Mazurek@rafako.com.pl

ENGINEERING
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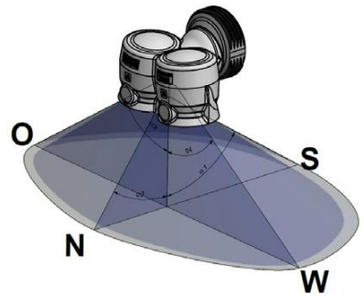
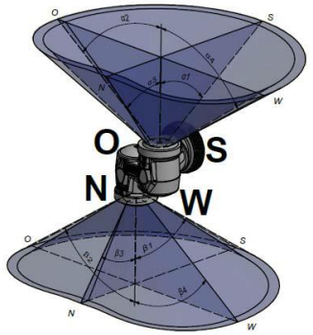
The Industries (almost) always have solutions

RETROFIT TPP MARITSA EAST III





CO-AUDITOR

STEINMÜLLER ENGINEERING GMBH

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Upgrade of 2 SO_2 scrubbers in Maritsa East 3 power station

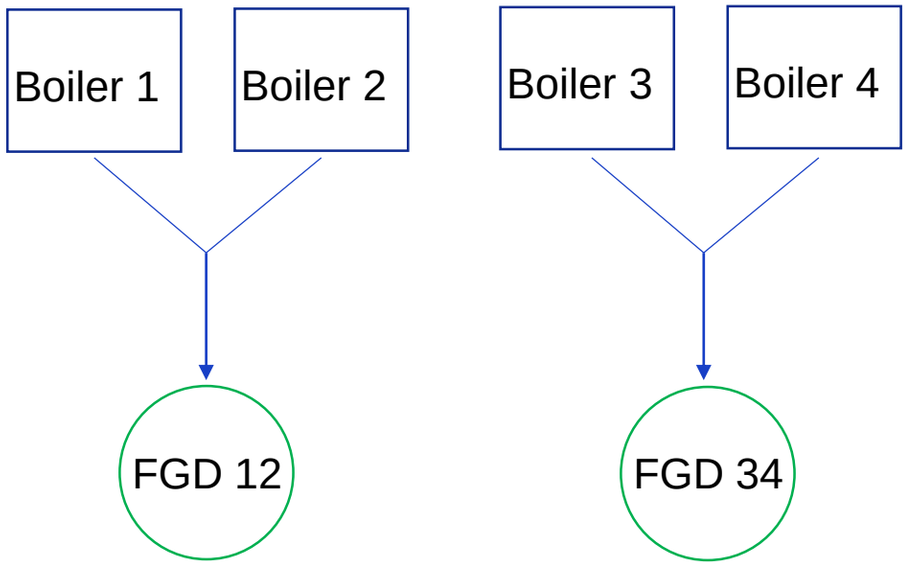
Rely on good experience with

steinmüller engineering

The Engineers Company

Description of Power Plant

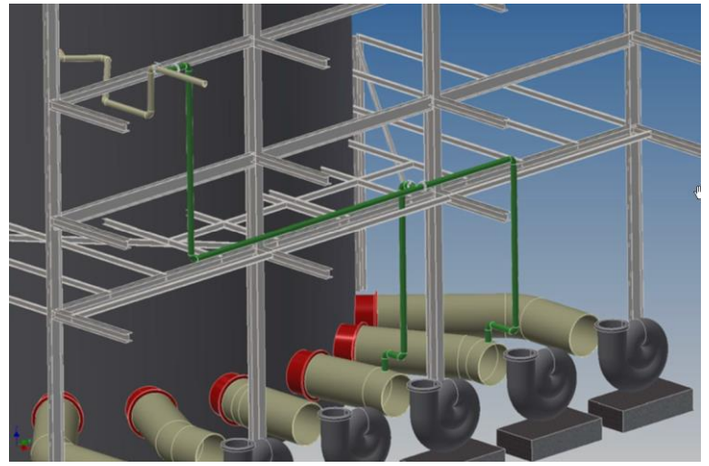
- Maritsa East 3 Power Plant (operated by Contour Global in Bulgaria)
- 908 MWe (total) lignite-fired power plant with 4 x 227 MWe units
- Two wet-limestone FGDs

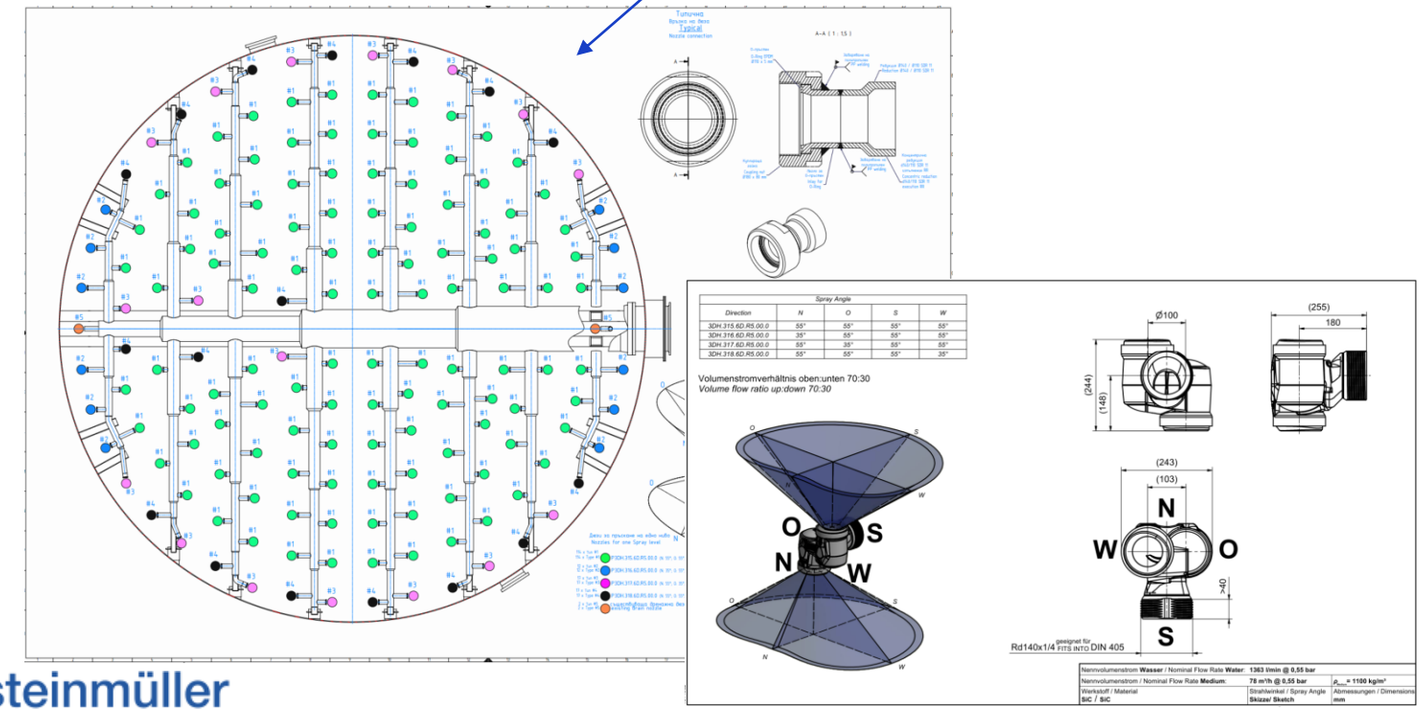


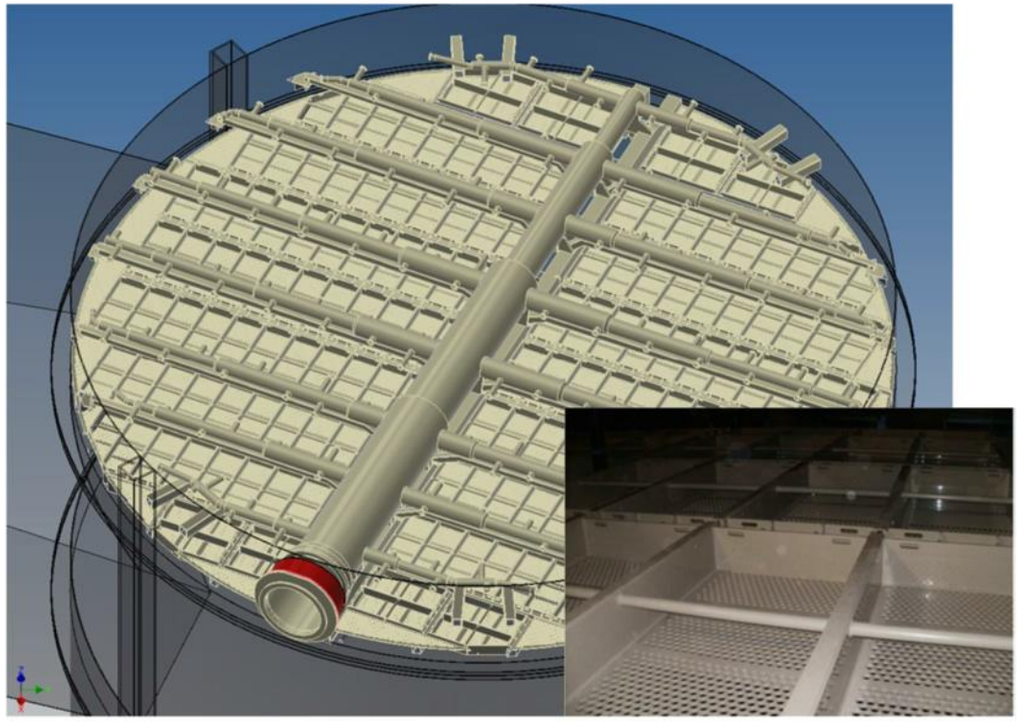
Characteristic	Unit	Value
Flue gas flow rate (wet)	m^3/h (Normalized, wet, act O2)	3 223 451.19
Flow rate (dry)	m^3/h (Normalized, dry, act O2)	2 542 107.24
SO_2	mg/m^3 (Normalized, dry)	15 415.57
SO_2 @ 6% O_2	mg/m^3 (Normalized, dry)	18 500
Dust @ 6% O_2	mg/mg (Normalized, dry)	50
N_2 + Ar content	Vol. %, dry	79.9
O_2 content	Vol. %, dry	8.5
CO_2 content	Vol. %, dry	11.0
H_2O content	Vol. %, wet	21.1
Temperature	˚C	179
Density	kg/m^3 (Normalized, wet)	1.236
Suspension flow each spray bank	m^3/h	12.000
Spray banks per absorber	-	6
		(spraybank 1-5 with 50:50 up:down nozzles
Limestone suspension feeding	-	Directly into absorber

Optimisation measures

- Increase of SO_2 removal efficiency by > 2 % **(to min 97 %)**
- Combination of 3 upgrades:
  1. Limestone dosing directly into recirculation lines
  2. Implementation of a tray level below the first spray bank
  3. Replacement of spray nozzles at spray level 1-5







Results:

- Improvements by tray installation:
  - Homogenization of the flue gas flow through the complete absorber
  - Increase of SO2 removal efficiency
  - Better utilization of limestone

  → due to maximized reaction surface

- Improvements by feeding limestone suspension into recirculation lines:
  - Direct contact of the absorbens with the flue gas → better utilization of the absorbent

- Improvements by changing the spray nozzles:
  - 70:30 ratio (up:down) increases the amount of upwards sprayed droplets and thus the reaction time with the flue gas → improvement of SO2 efficiency
  - Decrease of pressure drop of the complete system due to higher portion of upwards directed droplets
  - Less abrasion of absorber wall and support beams due to asymmetric spray cones

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FOR MORE INFORMATION PLEASE CONTACT US

WE WILL BE GLAD TO ASSIST YOU

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YOUR SPRAY SOLUTION

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