Ravebo BRIELLE

Scrubbers

Sustainability by Innovative Technology

Acid scrubber for a fertilizer plant

Gas sided construction of the scrubber:

- Spray section for wetting and keeping the rectifier clean. In the spray section, full cone spray nozzles are used that spray the entire surface so that any particles carried along cannot contaminate the profiles of the rectifier. The spray nozzles are connected to the pump of the washing section so components will be immediately washed out. The spray section is equipped with an inspection hatch.
- Rectifier, for laminating the gas flow. The rectifier is made up of cassettes, in which profiles are mounted, so that they can be easily disassembled for inspection and possible cleaning. A rectifier is necessary as the incoming turbulent airflow cannot be cleaned.
- Washing section in which washing water as a closed loop system. The washing section is equipped with an inspection hatch. The washing section consists of hollow cone spray nozzles, partly mounted co-current and counter current. The section is equipped with several spray arms that are mounted one after the other in order to obtain a long spray pattern. The section is constructed in such a way that the nozzles, due to their joint large flow rate, rinse the inside intensively the washing section. The nozzles are mounted with an overlapping spray image on several spray pipes in succession, creating a very intensive cleaning system. This means that the contaminated gas cannot pass through the spray section without being moistened and cleaned.
- Double droplet separator as a fine separator, for removing the entrained droplets. This is made of cassettes that can easily be disassembled for inspection and possible cleaning. The droplet separator cassettes are mounted in a rail system in the scrubber. The characteristics are a low pressure drop, high liquid load, insensitive to clogging and a large velocity potential so that the flow surface of the scrubber can be kept relatively small. The cassettes in which the profiles are mounted are kept compact (low weight) so that they can easily be removed via an access hatch. If the vanes need to be cleaned over time, this can be done very easily by removing the cassettes and cleaning them with a high-pressure syringe.

Gas flow rate	:	24,000 Nm3/h dry
Gas temperature	:	45°C
Pressure	:	4 mbarg
Gas composition	:	Air with Cl2, Br2, HCl, HBr, SO2 and SO3
Dimensions (l x w x h)	:	3.080 x 1.800 x 2.300 mm
Material	:	HDPE

Ravebo BV
't Woud 2
3232LN Brielle
the Netherlands
+31 (0)181 419-419
pe@ravebo.nl

Sustainability by Innovative Technology

www.raveboscrubber.com

Naphtha scrubber for vapor recovery (benzene)

The scrubber system is used in a tank park for the recovery of vapors which escape during transportation of liquids from vessel to tank and from tank to truck. This scrubber consists of a cylindrical vertical column which rests on welded legs. The scrubber consists of two sections where the naphtha particles are washed out.

The vapor enters at the bottom through half a pipe to obtain a laminar airflow. The random packings (Pall rings) above it serve to increase the contact area, with the aim of creating a better and longer exchange between the gas and the washing medium. The spray nozzle that ensures the flushing of the packings is a full cone type. Kerosene is used as a washing fluid to dissolve the benzene.

The resulting droplets in the housing cannot be discharged to the environment and must therefore be captured. The removal of the droplets is extracted with a wire mesh demister.

Gas flow rate	:	80 Nm3/h
Diameter	:	ø 600 mm
Height	:	± 3.500 mm
Material	:	AISI 316L
Pressure	:	ambient

Ravebo BV
't Woud 2
3232LN Brielle
the Netherlands
+31 (0)181 419-419
pe@ravebo.nl

NH3 Scrubber for Ammonia and VOC removal

A complete horizontal counter current scrubber installation, which will reduce emissions and odor load below legal limits as according to governmental laws. The counter current scrubber consists of a horizontal, rectangular housing made of AISI 316L which, seen in flow direction, is made up of three series-mounted washing sections in which spraying is done with a solution of sulfuric acid and sodium hypochlorite, then caustic soda and finally neutral washing water. All three sections are structurally identical. Each section is equipped with several spray arms in succession on which clogging-free nozzles are mounted to obtain a long spraying pattern.

Section 1: Oxidative washing section (acid corrected)

Acid corrected (sulfuric acid solution) wash section to neutralize ammonia and amines supplemented with a sodium hypochlorite solution to oxidize the (odor-forming) elements. The chemicals are dosed in the integrated buffer tank, the pH value, free chlorine value and conductivity of the washing water are measured in the press of the pump so that the required amount of sodium hypochlorite is automatically dosed. If necessary, sulfuric acid is dosed to regulate the pH value.

Section 2: Alkaline wash section

Basic washing section, which is structurally identical to the first wax section, with caustic soda solution, for neutralizing the acid-forming components and removing any free chlorine that may have been carried away from the previous section. The chemicals are dosed in the integrated buffer tank, the pH value and the conductivity of the washing water are measured in the press of the pump. Based on these measured values, the required amount of caustic soda is automatically dosed in the integrated buffer of the washing section.

Section 3: Neutral section

Washing section, which is structurally identical to the first and second washing sections, with clean washing water for a final capture / absorption of water-soluble gas particles and any fumes from the previous washing sections.

Ravebo BV
't Woud 2
3232LN Brielle
the Netherlands
+31 (0)181 419-419
pe@ravebo.nl

Package system

- Stainless steel 316 housing
- Siemens S7-1500 PLC in container
- BRL accredated dosing system
- Centrifugal pumps
- KSB centrifugal pumps
- Endress + Hauser instrumentation
- ECON valves

Length	:	7.200 mm
Width	:	2.200 mm
Height	:	3.200 mm
Operating weight	:	14,000 kg
Gas flow rate	:	20,000 - 50,000 Am3/h

Ravebo BV
't Woud 2
3232LN Brielle
the Netherlands
+31 (0)181 419-419
pe@ravebo.nl

Odor scrubber for baking ovens

A horizontal open scrubber made of stainless steel. This scrubber consists of a rectangular housing with rectifiers, three washing sections with integrated washing liquid collection and droplet separators. The washing sections are equipped with an access hatch. The housing is equipped with connection cones to a pipe diameter of Ø 630 mm. The connection cone at the gas entrance is also equipped with an inspection hatch.

As a washing liquid for the first washing section, caustic soda can be applied. Sodium hypochlorite can be used as a washing liquid for the second washing section. For the third washing section, a neutral washing liquid should be used.

The scrubber is constructed, seen in flow direction, from the following sections:

- Caustic soda (NaOH) section, alkaline washing section with caustic soda solution, for removing the acid forming components and fats.
- Droplet separator, for preventing contamination of washing water of the sodium hypochlorite washing section
- Sodium hypochlorite (NaOCl) section, oxidative washing section with sodium hypochlorite solution, for washing out the odor components and any fumes from the caustic soda wash section.
- Droplet separator, for preventing contamination of washing water from the neutral washing section.
- Neutral section, washing section with clean washing water, for a final capture of water-soluble gas particles and any fumes from the sodium hypochlorite washing section.
- Fine separator, for removing the entrained droplets.

Technical specifications

Air flow rate	:	8,000 Am3/h
Dimensions (L x W x H)	:	5.000 x 1.250 x 1.750 mm
Material	:	Stainless Steel 316L
Location	:	outdoor
Empty weight	:	1,500 kg
Operating weight	:	4,500 kg

The system is completed with a Siemens S7-1500 PLC in a Rittal stainless cabinet.

Ravebo BV
't Woud 2
3232LN Brielle
the Netherlands
+31 (0)181 419-419
pe@ravebo.nl

Odor scrubber for drying ovens (food to feed)

Horizontal scrubber installation

The counter current scrubber consists of a horizontal, rectangular housing which is made of AISI 316L. In the event of counter current washing, the washing liquid, and the gas to be purified move in the opposite direction. The big advantage of counter current washing is that as the gas becomes cleaner, the concentration of the contamination in the washing liquid also decreases. In this way, the cleaning process throughout the installation remains particularly effective

The scrubber is constructed, seen in flow direction, of three sections which are technically identical. Each wash section consists of hollow cone spray nozzles, part of which co-current and counter current. Each section is equipped with several spray arms that are mounted one after the other to obtain a long spray path and are constructed in such a way that the nozzles rinse the inside of the washing section well at the same time due to their joint large flow rate. The nozzles are mounted with an overlapping spray pattern, creating a very intensive cleaning system. This means that the contaminated gas cannot pass through the spray sections without being moistened and cleaned. As a result, a random packings is completely unnecessary, so that the pressure loss is very low and, above all, remains low.

Caustic soda (NaOH) section

Alkaline washing section with caustic soda solution for washing out the acid-forming components and any fat fumes. Spray section with a caustic soda solution for wetting and keeping the rectifier clean. Rectifier for laminating the gas flow. The rectifier is made up of removable cassettes, so that the rectifiers can be easily removed for inspection and possible cleaning. Droplet separator for removing the droplets from the gas stream and preventing contamination with the second washing section.

Sodium hypochlorite (NaOCl) section

Oxidative washing section with sodium hypochlorite solution to oxidize the odor-forming elements so that they can no longer cause odor nuisance. The dosage of sodium hypochlorite is controlled by means of a free chlorine sensor with integrated pH correction. The chemicals are dosed directly into the integrated buffer tank, where the free chlorine of the washing water is also measured so that the right amount of sodium hypochlorite is automatically dosed. Droplet separator for removing the droplets from the gas stream and preventing contamination with the second washing section.

Neutral section

Washing section with clean washing water for a final capture of water-soluble gas particles and any fumes from the sodium hypochlorite washing section. Double droplet separator as a final separator for removing the entrained droplets.

Ravebo BV
't Woud 2
3232LN Brielle
the Netherlands
+31 (0)181 419-419
pe@ravebo.nl

Dimensions	:	6,200 x 2,500 x 3,000 mm
Weight	:	approx. 10,000 kg
Gas flow rate	:	45,000 - 80,000 Am3/h
Relative humidity	:	80 – 90 % RH
Gas temperature	:	58 – 65 °C
Maximum dust load	:	500 mg/Nm3

Package system

- Stainless steel 316 housing
- Siemens S7-1500 PLC in Rittal cabinet
- BRL accredited dosing system
- KSB centrifugal pumps
- Endress + Hauser instrumentation
- Centrifugal fan
- ECON valves
- Iwaki magnet drive dosing pumps

Ravebo BV
't Woud 2
3232LN Brielle
the Netherlands
+31 (0)181 419-419
pe@ravebo.nl

Odor scrubber for fragrances and flavors

A custom-made vertical scrubber for a gas flow of 8,500 Nm3/h made of PP which is specially configured with a diameter of 1,600 mm and a height of 6,500 mm.

The scrubber works according to a so-called closed loop system in which the washing section consists of an open spray system. The scrubber has removable spray lances equipped with tangential spray nozzles divided into two sections, an agglomerator, dividing redistributor plate and a wire mesh demister.

Process description

- Alkaline wash section with caustic soda (NaOH) solution. The dosage of caustic soda will have to be based on the pH. The washing section is equipped with an inspection hatch. The washing section consists of spray nozzles which are mounted co-current and counter current. The blockage-free tangential spray nozzles create fine droplets to capture as many dust/gas particles as possible. The section is constructed in such a way that the nozzles, due to their joint large flow rate, rinse the inside of the washing section well at the same time. The nozzles are mounted with an overlapping spray image on several spray pipes in succession, creating a very intensive cleaning system. This means that the contaminated gas cannot pass through the spray section without being moistened and cleaned. As a result, packings are completely unnecessary, so that the pressure loss is exceptionally low and, above all, remains low. The chemicals can be dosed in the buffer tank, where the conductivity of the washing water must also be measured. Based on these measured values, it can then be automatically sprayed and supplemented from the second (neutral section) and then the required amount of caustic soda can be dosed in the scrubber.
- The pre-separator/ agglomerator is intended to separate the coarse droplets and relieve the wire mesh demister. It could clog or become overloaded without a pre-separator/ agglomerator. In addition, this separator also functions as an agglomerator, which means that the fine droplets that are normally inseparable are agglomerated. Small droplets coagulate into large(er); this allows the wire mesh demister to function optimally.
- The separation soil prevents washing water from the second section from running directly back to the first alkaline section.
- Above the separation bottom, again counter-current spraying nozzles have been mounted for a second wash.

Finally a wire mesh demister functions as a fine separator with a high degree of separation and a low pressure loss.

Ravebo BV
't Woud 2
3232LN Brielle
the Netherlands
+31 (0)181 419-419
pe@ravebo.nl

Odor scrubber for offal processing

A stainless-steel quench, based on an open-spray principle, based on a gas flow rate of 23,000 Nm3/h including a separate, attached, polypropylene droplet separator housing. The quench is equipped with removable spray pipes which are equipped with spray nozzles. The quench has its own internal washing water buffer. The droplet separator housing is attached to the bottom of the quench, whereby the customer must provide support for this drip catcher housing. The drip catcher has a drain that drains into the washing water buffer of the quench.

Quench	: AISI 316L
Droplet separator	: AISI 316L
Scrubbers	: Polyethylene
Quench	: Ø 600 mm, height 7M
Scrubbers (4 in line)	: Ø 2M, height 8M
Gas temperature incoming	: ± 80 °C

Package system

- Stainless steel 316 housing
- Siemens S7-1500 PLC in Rittal cabinet
- BRL accredated dosing system
- KSB centrifugal pumps
- Endress + Hauser instrumentation
- Centrifugal fan
- ECON valves
- Iwaki magnet drive dosing pumps

Ravebo BV
't Woud 2
3232LN Brielle
the Netherlands
+31 (0)181 419-419
pe@ravebo.nl

Odor scrubber for roasting ovens

The counter current scrubber consists of a horizontal, rectangular housing which is made of AISI 316L. In the event of counter current washing, the washing liquid, and the gas to be purified move in the opposite direction. The big advantage of counter current washing is that as the gas becomes cleaner, the concentration of the contamination in the washing liquid also decreases. In this way, the cleaning process throughout the installation remains particularly effective.

The scrubber is constructed, seen in flow direction, of three sections which are technically identical. Each wash section consists of hollow cone spray nozzles, part of which co-current and counter current. Each section is equipped with several spray arms that are mounted one after the other to obtain a long spray path and are constructed in such a way that the nozzles rinse the inside of the washing section well at the same time due to their joint large flow rate. The nozzles are mounted with an overlapping spray pattern, creating a very intensive cleaning system. This means that the contaminated gas cannot pass through the spray sections without being moistened and cleaned. As a result, a random packings is completely unnecessary, so that the pressure loss is very low and, above all, remains low.

1. Alkaline washing section with caustic soda solution for washing out fat fumes and fat-bound dust particles. The chemicals are dosed in the integrated buffer of the scrubber, where the pH value of the washing water is also measured so that the correct amount of caustic soda is automatically dosed.
2. Oxidative washing section with sodium hypochlorite solution to allow the possibly odor-forming elements to oxidize so that they can no longer cause odor nuisance. The sodium hypochlorite dosage is controlled by means of a free chlorine sensor. The chemicals are dosed in the integrated buffer of the scrubber, where the free chlorine of the washing water is also measured so that the correct amount of sodium hypochlorite is automatically dosed.
3. Washing section with clean washing water for a final capture of water-soluble gas particles and any fumes from the sodium hypochlorite washing section.

Minimum gas flow rate	:	20,000 Am3/h
Nominal gas flow rate	:	40,000 Am³/h
Maximum gas flow rate	:	60,000 Am3/h
Relative humidity	:	1 – 2 %
Temperature gas inlet	:	90 – 110 °C
Dimensions	:	7,500 x 2,000 x 2,920 mm
Operational weight	:	ca. 9,000 kg

Ravebo BV
't Woud 2
3232LN Brielle
the Netherlands
+31 (0)181 419-419
pe@ravebo.nl

Sustainability by Innovative Technology

www.raveboscrubber.com

Odor scrubber for the slaughterhouses

The scrubber consists of three centrifugal pumps, water treatment system and control based on Siemens S7-1500 PLC with Ethernet connection.

The horizontal cross-flow scrubber consists of a horizontal, rectangular housing which is made of stainless steel 316L.

The scrubber is constructed, seen in flow direction, of three sections which are technically identical. Each wash section consists of a structured PVC packing. The discharge of the contaminated washing water is regulated on the basis of the measured conductivity.

First oxidative wash section (NaOCl, corrected with H2SO4).

First oxidative washing section with a sodium hypochlorite solution which can be corrected with sulfuric acid to oxidize the odor-forming elements. The chemicals are dosed in the integrated buffer tank, where the pH value and free chlorine value of the washing water is also measured, so that the required amount of sulfuric acid and sodium hypochlorite are automatically dosed.

Second oxidative wash section (NaOCl, corrected with H2SO4)

Second oxidative washing section with sodium hypochlorite solution which can be corrected with sulfuric acid to allow the remaining odor-forming elements to oxidize so that they can no longer cause odor nuisance. The sodium hypochlorite dosage is determined by means of a free chlorine sensor with pH correction. The chemicals are dosed in the integrated buffer tank, where the free chlorine and the pH of the washing water are also measured, so that the required amount of sodium hypochlorite and if necessary (to correct the pH) sulfuric acid is automatically dosed.

Third wash section (NaOH)

Basic washing section with caustic soda solution, for neutralizing the acid-forming components and removing any free chlorine that may have been carried away from the previous sections. The chemicals are dosed in the integrated buffer tank, where the pH value of the washing water is also measured. Based on these measured values, the required amount of caustic soda is automatically dosed in the washing section.

Dimensions (L x W x H)	:	8.800 x 3.000 x 4.000 mm
Gas inlet and outlet	:	Ø 1,800 mm
Housing material	:	AISI 316L
Operational weight	:	40 tons (estimate)

Ravebo BV
't Woud 2
3232LN Brielle
the Netherlands
+31 (0)181 419-419
pe@ravebo.nl

Sustainability by Innovative Technology

www.raveboscrubber.com

The complete chemical dosing installation consists of:

- Container with two compartments for a control cabinet and on the other side a dosing installation for the chemicals;
- Gaswasserpompen;
- Instrumentation for measuring: pH, free chlorine, conductivity, redox and level control;
- Dosage and storage of H2SO4, NaOH and NaOCl according to Kiwa BRL K 21009 and Kiwa BRL K 21011.

Package system

- Stainless steel 316 housing
- Siemens S7-1500 PLC in container
- BRL accredated dosing system
- Centrifugal pumps suitable
- KSB centrifugal pumps
- Endress + Hauser instrumentation

Ravebo BV
't Woud 2
3232LN Brielle
the Netherlands
+31 (0)181 419-419
pe@ravebo.nl

Odor scrubber for tobacco

Optimizing the existing scrubber while maintaining the open spray system principle but is converted to the best available technology.

The scrubber will be equipped with multiple spray arms with tangential flow spray nozzles mounted on them for better liquid-gas integration. The nozzles to be used in the scrubber are of the tangential type. The big advantage of this type of spray nozzle is that in this spray nozzle no insert is needed to generate the spray pattern. The result is that due to the large borehole, the chance of clogging or blockage is very small and in certain cases the spray nozzles are even self-cleaning. Tangential flow spray nozzles give a uniform droplet distribution of small to medium size drops over a ring-shaped surface. Compared to full cone nozzles, hollow cone spray nozzles have up to 30% smaller droplets, which generates at least 80% more droplets. At the same time, the spray surface is only a fraction relative to full cone spray nozzles. Because of this spray pattern, the droplets are so close together that a practically impenetrable screen is created. The positioning of the nozzles in the scrubber is create a large part of the nozzles spray against each other. The collision of the droplets creates secondary droplet formation, resulting in an even better exchange of particles.

The nozzles function at a higher pressure than the current system and a new pump was required as a result. The rectifier and the droplet separators were renewed by a high efficiency type.

The rectifiers generate a very small pressure drop due to the flow-advantaged lamellae, so that the gas will distribute itself over the total flow area. As a result, the turbulence of the entering gas will be annihilated and flows into the first washing section as a laminar gas flow. The droplet separator cassettes have openings at the bottom for draining the washing water to the central water collection of the washing section.

The aerodynamic shaped droplet lamellae redirect the airflow with liquid droplets. The gas will flow through the profiles. The liquid droplets cannot follow this deflection based on their mass inertia. As a result, the droplets come into contact with the separation surfaces of the profile. The droplets will remain here and agglomerate into larger droplets. The system is completed with a stainless control cabinet with an in-house programmed Siemens S7-1500 PLC.

Ravebo BV
't Woud 2
3232LN Brielle
the Netherlands
+31 (0)181 419-419
pe@ravebo.nl

Odor scrubbers for roasting oven

To clean the waste gas from the ovens from three production lines, a two-stage air scrubber has been set up. Since the gas contains odor-containing fat vapors and (dust) particles, the scrubber must be suitable for both applications. Given the problem of a relatively coarse cleaning of dust particles and the possibly occurring odor particles in aerosol, the scrubber will have to consist of several sections. The first stage uses caustic soda dissolved in water, if necessary. This is necessary to separate the (fat-bound) odor particles by means of saponified. The second wax stage only uses water to neutralize any chemical components.

A horizontal open washing section made of stainless steel 316L which serves as a scrubber. This scrubber consists of a rectangular housing with rectifiers, two washing sections with integrated washing liquid collection and droplet separators. Both wash sections are equipped with an access hatch. The connection cone at the gas entrance is also equipped with an inspection hatch. As a washing liquid for the first washing section, caustic soda can be used. For the second washing section, a neutral washing liquid should be used.

Air flow rate	:	20,000Nm3/ h
Dimensions (L x W x H)	:	4.000 x 1.500 x 1.500 mm
Housing material	:	Stainless steel 316L
Material separators	:	PP

The housing is equipped with connection cones to a pipe diameter of Ø 800 mm. As desired, the cassettes with rectifiers and droplet separators will be divided into two more manageable parts.

Droplet separators

The droplet separators are so-called vane types that are mounted in cassettes which are mounted in a rail in the scrubber. The characteristics are a low pressure drop, high liquid load, more or less clogging insensitive and a large velocity potential so that the flow surface of the scrubber can be kept relatively small. The cassettes in which the profiles are mounted are kept compact (low weight) so that they can easily be removed via an access hatch. If the slats need to be cleaned over time, this can be done very easily by removing the cassettes and cleaning them with a (high) pressure cleaner.

Ravebo BV
't Woud 2
3232LN Brielle
the Netherlands
+31 (0)181 419-419
pe@ravebo.nl

Scrubber for acrylic acid removal

A custom-made vertical scrubber who is specially configured for the separation of acrylic acid from a process gas flow with a maximum throughput of 60 Am3/h. The scrubber works according to a closed loop system in which the washing section consists of tangential spray nozzles of which half is mounted co-current and the other half is mounted counter current.

The section is equipped with several spray arms that are mounted one after the other in order to obtain a long(er) spray path. The section is constructed in such a way that the nozzles, due to their joint large flow rate, rinse the inside of the washing section well at the same time. The nozzles are mounted with an overlapping spray image on several spray pipes in succession, creating a very intensive cleaning system. This means that the contaminated gas cannot pass through the spray section without being moistened and cleaned. As a result, a random or structured packing is completely unnecessary, so that the pressure loss is very low and, above all, remains low.

Process water is used for washing. The washing water is sprayed after each batch. The installation is equipped with a:

1. Stainless steel 316 column
2. Siemens S7-1500 PLC in EX-P cabinet
3. Integrated buffer
4. Four removable spray lines equipped with six tangential hollow cone spray nozzles and one tangential solid gel sprayer;
5. Agglomerator / droplet separator
6. Wire mesh demister
7. Centrifugal pump suitable for ATEX zone II 2G Eex-d IIA T3,
8. pH sensor

Gas flow rate	:	60 Nm3/h
Nominal temperature	:	20-25 °C
Maximum temperature	:	50 °C
Maximum pressure	:	50 mbar
Nozzle pressure	:	3 bar

Ravebo BV
't Woud 2
3232LN Brielle
the Netherlands
+31 (0)181 419-419
pe@ravebo.nl

Scrubber for Ethanol removal

One three-stage countercurrent scrubber installation (horizontal construction, outdoor arrangement), including three separate internally installed liquid buffers for the three washing sections of the scrubber, which is specially configured for a process gas flow with a maximum throughput of 1,950 Am3/h. The three separate washing sections are required to achieve a high ethanol removal efficiency from the gas flow. The installation is equipped with pumps, instrumentation and fittings.

Package system

- Stainless steel 316 housing
- Siemens S7-1500 PLC in Rittal cabinet
- BRL accredited dosing system
- KSB centrifugal pumps
- Endress + Hauser instrumentation
- Centrifugal fan
- ECON valves
- Iwaki magnet drive dosing pumps

Gas analyzer

The cleaned water-saturated gas is sampled via a probe mounted after the last washing section. The saturated airflow is drawn in through heated pipes to prevent condensation in the system. The molecules in the gas are exposed to infrared radiation. The ethanol molecules absorb some of the radiation. The absorption of the radiation is directly proportional to the concentration. The analyzer which is used is an infrared type.

Maximum gas flow rate	:	2,250 Am3/h
Gas temperature	:	20°C
Operating pressure	:	atmospheric
Gas composition	:	air loaded with ethanol

Ravebo BV
't Woud 2
3232LN Brielle
the Netherlands
+31 (0)181 419-419
pe@ravebo.nl

Scrubber for gas cleaning of a pyrolysis oven

A custom-made vertical scrubber with Siemens S7-1500 PLC who is configured according to the specifications of the installation already present on site. The scrubber works according to a so-called pump-through system in which the washing section consists of tangential hollow cone spray nozzles, half of which are most creams and half are mounted counter current. The scrubber is complete with agglomerator, removable spray pipes equipped with tangential cone nozzles and a wire mesh demister;

Gas flow	:	3,000 Nm3/h
Diameter	:	Ø 1,200 mm
Total height	:	3,300 mm

In the configuration proposed by Ravebo, the fan is mounted behind the scrubber to prevent contamination. This fan ensures that the pressure drop in the scrubber is overcome and also ensures a slight dynamic vacuum in the pipework. In this way, the released vapors will be passed through the scrubber. The flow rate of the installation is 10,000 Am3/hour.

The washing medium is recirculated. At the customer's request, the scrubber is equipped with a bubbler separator that acts as a water lock and quench.

The principle of operation of the installation is as follows. The fumes enter at the bottom of the scrubber through the quench. The quench has the function of protecting the scrubber against feverish temperatures. This stainless-steel quench is equipped with spray nozzles to cool the extracted vapor adiabatic. The liquid used for this is the same process water as used for the washing ladder.

The fumes then enter the bubbler to ensure that a somewhat laminar airflow is created. This is necessary because the incoming turbulent airflow cannot be cleaned sufficiently. The gas flow is then passed along several spray arms that are mounted one after the other in order to obtain a long(er) spray path. These nozzle arms are equipped with spray nozzles, mounted co-current and counter current. The section is constructed in such a way that the nozzles, due to their joint large flow rate, rinse the inside of the washing section well at the same time. The nozzles are mounted with an overlapping spray image on several spray pipes in succession, creating a very intensive cleaning system. This means that the contaminated gas cannot pass through the spray section without being moistened and cleaned. As a result, a random packings is completely unnecessary, so that the pressure loss is exceptionally low and, above all, remains low.

Ravebo BV
't Woud 2
3232LN Brielle
the Netherlands
+31 (0)181 419-419
pe@ravebo.nl

The droplets caused by the sprayer must of course not be discharged to the outside air and must therefore be captured. This removal of the droplets is done with the help of a wire-woven demister which functions as a fine separator and in this configuration combines a high degree of separation with a low-pressure loss. It also limits the loss of the washing medium. After the demister, the cleaned gas flow passes through the fan and can be emitted atmospherically without any problems.

Ravebo BV
't Woud 2
3232LN Brielle
the Netherlands
+31 (0)181 419-419
pe@ravebo.nl

Scrubber for gas cleaning of pyrolysis ovens

A custom-made vertical scrubber who is completely made of AISI 316L. The scrubber works according to a closed loop system in which the washing section consists of an open spray system. The scrubber is supplied complete with removable spray lances equipped with tangential cone spray nozzles divided into two washing sections, an agglomerator, separation bottom, end separator and an external water buffer for the second washing section.

Alkaline-oxidative wash section with caustic soda (NaOH) and sodium hypochlorite (NaOCl) solution. The dosage of caustic soda takes place on the basis of the measured pH value since the dosage of sodium hypochlorite takes place on the basis of the measured free chlorine value.

The system is completed with a Siemens S7-1500 PLC in a Rittal stainless cabinet.

Total height	:	approx. 6,000 mm
Diameter	:	ø 800 mm
Gas flow rate	:	1,500 – 3,000 – 4,500 Nm3/h
Gas temperature	:	326 °C
Pressure	:	ambient

Gas composition

O2	:	10,7 %
CO2	:	5,9%
CO	:	2,2 mg/Nm3
NOx	:	86,6 mg/Nm3
SO2	:	0,77 mg/Nm3
VOC	:	3,1 mg/Nm3
HCl	:	0,4 mg/Nm3
HF	:	0,037 mg/Nm3
NH3	:	0,035 mg/Nm3
Hg	:	1,5 mg/Nm3
Metals	:	181 mg/Nm3
Fine dust	:	1,6 mg/Nm3

Ravebo BV
't Woud 2
3232LN Brielle
the Netherlands
+31 (0)181 419-419
pe@ravebo.nl

Sustainability by Innovative Technology

www.raveboscrubber.com

Scrubber for MBS removal

The customer would like to dedust the vent gas released by the new sodium metabisulphite (MBS) dosing installation. It is a discontinuous process with an air flow rate between 140 and 900 Nm3/h

The custom-made vertical plastic (PP) dust scrubber is specially configured for the separation of MBS (sodium metabisulphite) dust particles from a process gas flow with a maximum throughput of 900 Nm3/hour. The scrubber works according to a so-called closed loop system. The section is equipped with several spray arms that are mounted one after the other in order to obtain a long(er) spray path. The section is constructed in such a way that the spray nozzles, due to their joint large flow rate, rinse the inside of the washing section well at the same time. The nozzles are mounted with an overlapping spray image on several spray pipes in succession, creating a very intensive cleaning system. This means that the contaminated gas cannot pass through the spray section without being moistened and cleaned. As a result, a random packing is completely unnecessary, so that the pressure loss is very low and, above all, remains low.

The droplets caused by the sprayer must of course not be discharged to the outside air and must therefore be captured. This removal of the droplets is done with the help of a thread-woven demister. For washing, process water is used to which NaOH is added that ensures a concentration higher than pH 11. The washing water is sprayed after each batch.

Gas flow rate	:	140 – 900 Nm3/hour
Inlet temperature	:	ambient
Gas composition	:	Air with MBS dust particles
Washing fluid	:	Process water with NaOH
Total height	:	8.300mm

Ravebo BV
't Woud 2
3232LN Brielle
the Netherlands
+31 (0)181 419-419
pe@ravebo.nl

Scrubber for methanol removal

The vertical scrubber is a column in which the air is humidified directly by means of a counter current spray system by using random packings. The vapor enters at the bottom through half a pipe to obtain a laminar airflow. The random packings (Pall rings) above it serve to increase the contact area, with the aim of creating a better and longer exchange between the gas and the washing medium. The spray nozzle that ensures the flushing of the packings is a full cone type.

The resulting droplets in the housing cannot be discharged to the environment and must therefore be captured. The removal of the droplets is extracted with a wire mesh demister. The spray water including the droplets collect in the wire mesh demister and by gravity end up at the bottom of the column. From here it is pumped back to the spray nozzle (closed loop system).

Gas flow rate minimum	:	400 Nm3/h
Gas flow rate nominal	:	700 Nm3/h
Gas flow maximum	:	1,000 Nm3/h
Gas composition	:	methanol
Design temperature installation	:	85 °C
Current pressure	:	0 – 100 mbarg

Process water is used for washing. The washing water is drained after each batch. The installation is equipped with a:

- Stainless steel 316 column
- Siemens S7-1500 PLC in EX-P cabinet
- Integrated buffer
- Agglomerator / droplet separator
- Wire mesh demister
- Centrifugal pump suitable for ATEX zone

Ravebo BV
't Woud 2
3232LN Brielle
the Netherlands
+31 (0)181 419-419
pe@ravebo.nl

Sustainability by Innovative Technology

www.raveboscrubber.com

Scrubber for pickling baths

By means of pickling, the metal surface is affected and will be cleaned to remove dirt and fat and acids provide a good surface preparation for the next process steps. Anodizing is the electrochemical treatment of the surface of aluminum. The natural oxide layer is remounted by an artificial oxide layer. The alumina layer thus formed is molecularly connected to the base material and therefore provides the best adhesion for a second surface treatment (e.g. lacquer). The oxide layer provides good protection against corrosion and wear.

The polypropylene horizontal scrubber including integrated buffer tanks. The scrubber consists of two stairs. The contaminated gas enters the first stage via a side entry through a rectifier to obtain a laminar air flow. The gas will be guided through washing water droplets and mist with dissolved NaOH which is distributed using spray nozzles. This first stage has its own water buffer from which it must be pumped around. The gas is then stripped of droplets by an intermediate separator. The intention is that a first separation of droplets will take place here.

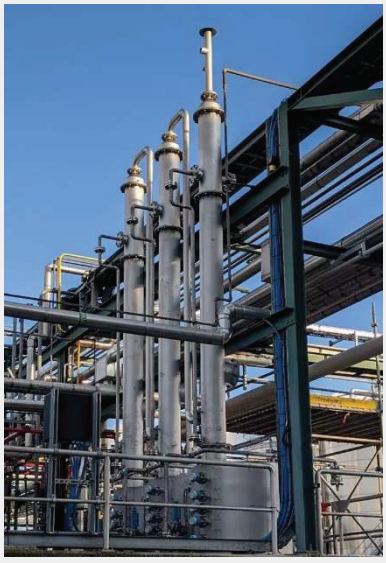
After this, the gas will be guided over a second washing stage with its own water buffer. At this washing stage, fresh water is distributed without additives by spray nozzles. Finally, the resulting droplets will be separated by a droplet separator.

Gas flow rate : 3,000 Nm3/h
Gas : HCl in air

- Iwaki chemical resistant pump
- Endress + Hauser flow meter on the distribution pipe
- Endress + Hauser pH transmitter, pressure transmitter and temperature transmitter in the external buffer
- The system is completed with a Siemens S7-1500 PLC in a Rittal stainless cabinet.

Ravebo BV
't Woud 2
3232LN Brielle
the Netherlands
+31 (0)181 419-419
pe@ravebo.nl

Scrubber for reduction of ethylene oxide



A complete scrubber installation consisting of three vertical columns, including integrated liquid buffers, which is specially configured for a process gas flow with a nominal throughput of 30 - 150 Nm3/h.

First and second stage acid scrubber (H2SO4)

The contaminated gas enters via a side entry at the bottom and then passes through a packed bed of random packings where washing water with dissolved sulfuric acid (H2SO4) is distributed by means of a sprayer to be able to wash out EO and PO.

Alkaline scrubber (NaOH)

The contaminated gas enters the third stage via a side entry at the bottom and also passes through a packed bed of random packings bodies. However, washing water containing dissolved caustic soda (NaOH) is distributed over this.

Package system

- Stainless steel 316 columns
- Siemens S7-1500 PLC in EX-P cabinet
- Integrated buffers
- Agglomerator / droplet separators
- Wire mesh demisters
- Centrifugal pumps suitable for ATEX zone
- Endress + Hauser instrumentation for ATEX zone

Column diameter	:	250 mm
Total height	:	4.500 mm
Gas inlet/outlet	:	DN100
Temperature	:	ambient
Pressure	:	atmospheric

Ravebo BV
't Woud 2
3232LN Brielle
the Netherlands
+31 (0)181 419-419
pe@ravebo.nl

Scrubber for removal of AMD and ACN

A custom-made scrubber that is specially configured for the removal of AMD and ACN from a purge flow which has a maximum throughput of 450 Nm3/h at ambient temperatures. The scrubbing operation is based on a half water recirculation by a centrifugal pump. The wash fluid container is also being used as a first stage gas cleaning by a bubbling principle and as a seal pot.

The bubbler develops a laminar flow of the vapor entering the scrubber (it is not possible to wash a turbulent flow). The laminar flow is then washed by several layers of spray pipes with tangential nozzles which are mounted co-current and counter current. The spray pattern is very homogeneous, and the water distribution is equal. This makes it possible to clean the gas with a very low and steady pressure drop without using packings which normally create a high pressure drop.

The droplets with captured particles are now separated from the gas by a wire mesh demister after which the clean gas can pass through the chimney to the environment. The half water used for the washing of the gas has to be purged if the level of contamination gets too high. This washing water can now be reused in the process.

Above installation is being delivered on a skid and consists of:

- PE housing with an integrated fluid container which also functions as an inbuilt bubbler
- Iwaki chemical resistant pump
- Six dismountable spray pipes with tangential nozzles;
- Agglomerator;
- Wire mesh demister for the separation of droplets from the gas flow;
- Endress + Hauser flow meter on the distribution pipe;
- Flow control valve on the distribution pipe;
- Return pipe with an orifice for the washing water between the pump and the seal pot;
- Endress + Hauser pH transmitter, pressure transmitter and temperature transmitter in the buffer;
- Measuring tube which acts as a communicating vessel provided with a radar level transmitter;
- Chimney through the roof with a rain cap and a sampling point;

Gas flow rate	:	18 – 450 Am3/h
Temperature	:	60 °C
Design pressure column	:	10 mbar

Ravebo BV
't Woud 2
3232LN Brielle
the Netherlands
+31 (0)181 419-419
pe@ravebo.nl

Scrubber for removal of HCN

The contaminated gas enters through a side entry at the bottom by means of half a pipe to obtain a laminar air flow. The gas will then be passed through a packed bed of random packings (pall rings), where washing water containing caustic soda (NaOH) and sodium hypochlorite (NaOCl) is dissolved by means of tangential full cone spray nozzles to be able to wash out the hydrocyanic acid (HCN) and other acidic components. The scrubber, manufactured from PP (polypropylene), has its own water buffer from which the washing water must be pumped in a closed loop. Finally, the resulting droplets will be separated by a very fine end separator consisting of a slat separator in combination with a wire mesh demister.

The quench and scrubber pump are built directly next to the quench and scrubber column and pump the washing water around with a constant pressure and liquid flow. The pumps are equipped with a block option by means of flanged manually operated ball valves and a pressure transmitter on the press side to assess the status of the nozzles. As an extra safety, the scrubber pump is also equipped with a flow switch which generates an alarm if the flow over the packed bed becomes too low. A higher pump pressure compared to the initial pressure may mean that nozzles may be clogged. When the pump pressure becomes lower than the initial pressure, this may indicate worn nozzles or leakage.

Package system

- Scrubber for removal of HCN 1
- Polypropylene column
- Siemens S7-1500 PLC in Rittal cabinet
- KSB centrifugal pumps
- Endress + Hauser instrumentation
- ECON valves
- Centrifugal fan
- Iwaki dosing pumps

Gasdebiet (maximaal)	:	20.000 Nm3/h
Temperatuur gas in	:	17 – 25 °C
Ontwerptemperatuur	:	25 °C
Maximale overdruk	:	40 mbar
Diameter scrubber	:	2.000mm
Scrubber height	:	5,500 mm

Ravebo BV
't Woud 2
3232LN Brielle
the Netherlands
+31 (0)181 419-419
pe@ravebo.nl

Scrubber for removing fine dust

A custom-made horizontal open wash scrubber made of polypropylene. The scrubber works according to a so-called closed loop system in which the washing liquid, consisting of water, is pumped over very fine spray nozzles. The washing liquid is discharged on the basis of dirt load at a time interval to be determined and water is automatically replenished to maintain the washing water level.

The scrubber is designed for an interior setup. The scrubber consists of a rectangular housing with a rectifier, a washing section with integrated washing liquid collection and a drip catcher. The laundry section is equipped with an access hatch. As a washing liquid for the first washing section, a neutral washing liquid can be used. The scrubber is constructed, seen in flow direction, from the following sections:

- Spray section, for wetting and keeping the rectifier clean. In the spray section, tangential solid hedgehog spray nozzles are used that spray the entire surface so that carried (dust) particles cannot contaminate the slats of the rectifier. The spray section is equipped with an inspection hatch.
- Rectifier, for laminating the gas flow. The rectifier is made up of cassettes, in which slats are mounted, so that they can be easily disassembled for inspection and possible cleaning. A rectifier is necessary to laminate the incoming turbulent airflow, otherwise the airflow cannot be cleaned.
- Washing section, consisting of tangential hollow cone spray nozzles of which half are most creams and half are mounted counter current. The section is equipped with several spray arms which are mounted one after the other to obtain a long (er) spray path. The section is constructed in such a way that the nozzles also rinse the inside of the washing section well at the same time due to their joint large flow rate. The nozzles are mounted with an overlapping spray image on several spray pipes in succession, creating a very intensive cleaning system. This means that the contaminated gas cannot pass through the spray section without being moistened and cleaned. As a result, a so-called random packing is completely unnecessary, so that the pressure loss is extremely low and, above all, remains low. The washing section is equipped with an inspection hatch.
- Fine separator, for removing the entrained droplets. The fine separator is made up of cassettes so that they can easily be disassembled for inspection and possible cleaning.

Dimensions (L x W x H)	:	3,500 x 2,000 x 2,500 mm
Gas temperature	:	20 °C
Gas flow	:	35.250 Am3/h
Pressure drop	:	400 – 500 Pa

Ravebo BV
't Woud 2
3232LN Brielle
the Netherlands
+31 (0)181 419-419
pe@ravebo.nl

Sustainability by Innovative Technology

www.raveboscrubber.com

Scrubber for silicates (dust)

The dust is created during the grinding process and is extracted to an existing cyclone, here a first separation of coarse dust particles takes place, the dust particles that are not captured by the cyclone consists of a large number of very wide spectrum of fine dust particles that are well soluble in water. For this ultra fine particles a wet scrubber is installed where water is used as a transfer medium.

The solid silicate dust particles dissolve very well in the water of the scrubber and are filtered out of the air in this way.

In order to achieve intensive contact between air and water, hollow cone spray nozzles with a fine droplet size distribution are used in the scrubber in the first stage to ensure that the fine particles are completely wet which are then guided through a bed random packings in the second stage. These Pall rings, with their large contact surface, ensure a very efficient transfer of the dust particles (captured by the waterdroplets) from the gas phase to the aqueous phase.

Gas flow rate	:	5,750 Nm3/h
Gas temperature	:	max. 50°C
Gas pressure	:	973 mbar
Relative humidity	:	approx. 60%
Dust load	:	3.5 g/Nm3
Diameter column	:	ø 1,300 mm
Height column	:	5,500 mm
Material column	:	PP

Ravebo BV
't Woud 2
3232LN Brielle
the Netherlands
+31 (0)181 419-419
pe@ravebo.nl

Sustainability by Innovative Technology

www.raveboscrubber.com

Scrubber for starch removal

The scrubber who is mounted behind the typesetting measuring dryer is intended to keep the emission of starch within the permitted requirements, but measurements have shown that the emission requirements are exceeded and therefore a new wet scrubber will be desired.

In the current scrubber, who has been switched behind the starch dryer, the air velocities are so high that no good capture of starch particles can be achieved here in combination with the high input concentrations. Based on this information, we recommend installing a horizontal washing section for the current wet scrubber so that a first separation of starch particles can take place.

In addition, the current scrubber of the dryer will also have to be optimized.

This optimization involves the application of an agglomerator in combination with a spray system. This spray system ensures wetting of the agglomerator so that it has an optimal efficiency, and no deposition of starch will take place. After the airflow has passed through the agglomerator, the entrained droplets will be captured by means of a fine separator.

Flow	:	7,500 Nm3/h
Length	:	4.000 mm
Width	:	3.100 mm
Height	:	3.200 mm
Material	:	AISI 316L

Three vertical scrubbers, per scrubber consisting of:

- Column
- wire mesh demister
- random packings
- support plate and hold down plate
- air driven pomp
- integrated buffer tank
- demountable spray pipe with the spray nozzle

Ravebo BV
't Woud 2
3232LN Brielle
the Netherlands
+31 (0)181 419-419
pe@ravebo.nl

Scrubber for the removal of starch

The vertical scrubber is a construction in which the air is humidified directly by means of spray nozzles which pattern is counter current. The spray nozzles used are of the type of tangential hollow cone with which, in addition to humidifying the air, it is also washed efficiently. In order to be able to humidify this airflow properly, the gas flow must first be made as laminar as possible. To this end, a half pipe is provided upon entry of the scrubber to avoid turbulence in the washing section. Behind the spray nozzles there is a vane type droplet separator, which agglomerates the smallest particles and separates the coarsest parts. The purpose of this is to generate separable particles for the demister and to prevent the demister from becoming clogged or overloaded with a result of flooding. After the spray nozzles, a wire mesh demister is mounted to prevent water droplets entrained with the air flow. The spray water including the droplets collected in the wire mesh demister end up at the bottom by gravity of the scrubber. From here it can be pumped back to the spray nozzles by means of a closed loop system. It is necessary to discharge saturated liquid so that the concentrations in the washing water do not rise too high.

Gas flow rate	:	50,000 Nm3/h
Temperature	:	54 °C
Emission	:	consists of starch with 11% moisture
Emission value	:	96 mg/Nm3
Particle size	:	between 0-50 µm
Dimensions	:	ø 3,500 mm
Height	:	6,100 mm
Operating weight	:	3,500 kg

Ravebo BV
't Woud 2
3232LN Brielle
the Netherlands
+31 (0)181 419-419
pe@ravebo.nl

Scrubber for vapor recovery

The vertical scrubber is a column in which the random packings are directly moistened by means of a spray nozzle. The spray nozzle used are of the type of a full cone type with which the wetting of the packings can be realized. At the inlet of the scrubber, a half pipe is provided to avoid turbulence in the washing section. This is followed by random packings, which provide an active surface area so that the gas particles are in intensive contact with the spray water for as long as possible. Behind the spray nozzles, a wire mesh demister is mounted to prevent liquid droplets from being entrained with the gas flow. The spray water droplets collected in the demister end up at the bottom of the column by gravity. From here, the liquid can be pumped back to the spray nozzle by means of a loop system. It is necessary to discharge regularly so that the concentrations in the washing water do not rise too high.

Minimum gas flow	:	150 Nm3/h
Maximum gas flow	:	400 Nm3/h
Storage temperature:		50 °C
Vapor temperature	:	45 – 60 °CC

Three vertical scrubbers, per scrubber consisting of:

- Column
- wire mesh demister
- random packings
- support plate and hold down plate
- air driven pomp
- integrated buffer tank
- demountable spray pipe with the spray nozzle

Ravebo BV
't Woud 2
3232LN Brielle
the Netherlands
+31 (0)181 419-419
pe@ravebo.nl

Scrubber for water treatment plant

The counter current scrubber consists of a horizontal, rectangular housing which is made of stainless steel 316L. The scrubber is mounted on a AISI 316L frame including the fan.

In the event of counter current washing, the washing liquid, and the gas to be purified move in the opposite direction. The scrubber is applied with a pump system. Counter current washing is directly proportional that as the gas becomes cleaner, the concentration of the contamination in the washing liquid also decreases. In this way, the cleaning process throughout the installation remains particularly effective.

The positioning of hollow cone nozzles in the scrubber is of the utmost importance for optimal gas treatment, in connection with the capture of particles through intensive contact between washing liquid and the process gas. Optimal contact of fine liquid droplets with gas particles will lead to a large uptake of polluting gases.

The scrubber is constructed, seen in flow direction, of one spray section for the purpose of wetting the rectifier and two washing sections for capturing dust particles and water-soluble components. The washing section consists of hollow cone spray nozzles, part of which is mounted co-current and partly counter current. This wash section is equipped with several spray arms that are mounted one after the other to obtain a long spray pattern and are constructed in such a way that the spray nozzles rinse the inside of the washing section well at the same time due to their joint large flow rate. The spray nozzles are mounted with an overlapping spray pattern, creating a very intensive cleaning system. This means that the contaminated gas cannot pass through the spray sections without being moistened and cleaned. As a result, random packings (pall rings) are completely unnecessary, so that the pressure loss is very low and, above all, remains low. Both the spray and washing sections are equipped with an inspection hatch so that the rectifiers, spray nozzles and droplet separators can be checked very easily.

Length (LxWxH)	:	3,600 mmx 650 mm x 1000 mm
Material	:	RVS 316L

Gas flow rate minimum	:	1,650Nm3/h
Gas flow rate maximum	:	3,030Nm3/h
Gas temperature	:	150 °C
Relativ humidity	:	95 %
Dust load	:	1,500mg/Nm3
Process pressure	:	atmospheric
Acidity	:	pH 7+
Calcium containment	:	> 50 mg/l

Ravebo BV
't Woud 2
3232LN Brielle
the Netherlands
+31 (0)181 419-419
pe@ravebo.nl

Sustainability by Innovative Technology

www.raveboscrubber.com

Scrubber hydrochloric acid vapor recovery

The vertical scrubber is a column in which the air is humidified directly by means of a counter current spray system by using random packings. The vapor enters at the bottom through half a pipe to obtain a laminar airflow. The random packings (Pall rings) above it serve to increase the contact area, with the aim of creating a better and longer exchange between the gas and the washing medium. The spray nozzle that ensures the flushing of the packings is a full cone type.

The resulting droplets in the housing cannot be discharged to the environment and must therefore be captured. The removal of the droplets is extracted with a wire mesh demister.

The spray water including the droplets collect in the wire mesh demister and by gravity end up at the bottom of the column. From here it is pumped back to the spray nozzle (closed loop system).

The system is completed with chemical resistant magnet drive Iwaki pump and a Siemens S7-1500 PLC in a Rittal stainless cabinet.

Material	:	Polyethylene
Diameter column	:	ø 200 mm
Scrubber height	:	2.700 mm
Gas flow rate	:	80 – 320 Nm3/h

Package system

- Stainless steel 316 housing
- Siemens S7-1500 PLC in Rittal cabinet
- BRL accredated dosing system
- KSB centrifugal pumps
- Endress + Hauser instrumentation
- Centrifugal fan
- ECON valves
- Iwaki magnet drive dosing pumps

Ravebo BV
't Woud 2
3232LN Brielle
the Netherlands
+31 (0)181 419-419
pe@ravebo.nl

Sustainability by Innovative Technology

www.raveboscrubber.com

Scrubber installation for fluorine

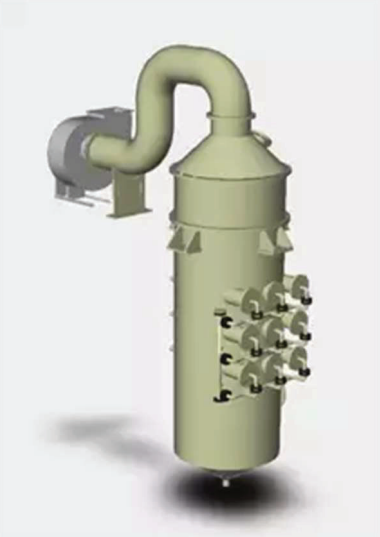
In two reactors, calcium phosphate is dosed as a powdered reagent in phosphoric acid at 90 °C. During the reaction, hydrogen fluoride is released, the emissions must meet the requirements according to Vlarem II.

Process conditions

Gas flow	:	7,500 Am3/h
Design temperature	:	58 °C
Current pressure	:	932 mbar (absolute)
Maximum load of fluorine	:	300 g/h
Maximum dust load	:	1,600 mg/m3

A countercurrent scrubber installation (vertical construction, interior arrangement), including separately installed liquid buffer, which is specially configured for a process gas flow with a maximum flow of 7,000 Am3/h. The installation is fully equipped with PLC control, instrumentation, pumps, centrifugal fan, and fittings. The scrubber housing is equipped with two flange divisions so that in case of periodic maintenance the pre-separator and final separator can be removed for maintenance or cleaning. The column is made of PP.

Scrubber pump



Scrubber installation for fluorineThe magnet drive centrifugal pump (manufactured by Iwaki, with Siemens motor) is built directly to the buffer tank of the scrubber and pumps the washing liquid around in a closed loop. The pump flow rate and the discharge pressure are constant. The pump is equipped with a blocker option by means of manually operated ball valves (manufactured GF+) and a locally readable pressure transmitter (manufactured Endress & Hauser) on the press side to assess the status of the nozzles. A higher pump pressure compared to the initial pressure may mean that nozzles may be clogged. Materials: ETFE / SIC

Level control

The washing liquid level in the buffer tank is continuously measured with an ultrasonic level meter (manufactured Endress & Hauser) for the different working and alarm levels. In addition to the conductivity measurement, the signals can be used to control the electrically driven discharge and replenishment valves. The supply of fresh replenishment water can be controlled by means of a flanged electrically operated ball valve (24 VDC, manufactured GF+). The discharge of washing water depends on the washing water quality and must take place on the basis of conductivity (make Endress & Hauser). The buffer tank is equipped with a flanged electrically operated ball valve to control the discharge.

Ravebo BV
't Woud 2
3232LN Brielle
the Netherlands
+31 (0)181 419-419
pe@ravebo.nl

Sustainability by Innovative Technology

www.raveboscrubber.com

Conductivity

The buffer is equipped with a Flange DN50 in which the conductivity sensor (make: Endress+Hauser) will be mounted. The sensor is supplied with a fixed cable and a transmitter which is mounted in the control cabinet. The conductivity sensor is a digital inductive conductivity sensor with high chemical resistance (PFA and PEEK).

Pressure transmitter

Compact pressure transmitter with robust ceramic oil-free measuring cell. Resistant to frequent overload and very deep vacuum. Suitable for both pressure and level applications. Display operation with LCD and push button on display. Manufactured of PVDF with Kalrez seal.

Fan

Fan to bridge the pressure loss over the scrubber installation (including connecting ductwork). The fan is fully equipped in PP.

Dimensions

Gas entry/exit	:	DN500
Diameter scrubber	:	ø 1.400 mm
Buffer dimensions	:	ø 1.200 x 1.000 mm (D x H)
Total height of column	:	ca. 3.400 mm
Materials	:	PVDF and PP

Ravebo BV
't Woud 2
3232LN Brielle
the Netherlands
+31 (0)181 419-419
pe@ravebo.nl

Scrubber of a chemical surface treatment plant

Scrubber for washing out fumes' extraction nickel baths. One PP horizontal scrubber including integrated buffer tanks. The scrubber consists of two stairs.

The contaminated gas enters the first stage via a side entry through a rectifier to obtain a laminar air flow. The gas will be guided through washing water droplets and mist with dissolved NaOH which is distributed using spray nozzles. This first stage has its own water buffer from which it must be pumped around.

The gas is then stripped of droplets by an intermediate separator. The intention is that a first separation of droplets will take place here.

After this, the gas will be guided over a second washing stage with its own water buffer. At this washing stage, fresh water is distributed without additives by spray nozzles.

Finally, the resulting droplets will be separated by a droplet separator

Flow	:	12,000 Nm3/h
Dimensions	:	3,600 x 1,500 x 1,200 mm

Ravebo BV
't Woud 2
3232LN Brielle
the Netherlands
+31 (0)181 419-419
pe@ravebo.nl

Sustainability by Innovative Technology

www.raveboscrubber.com

Scrubber system for chemical waste plant

Quench

The primary function of the quench vessel is to cool the gas flow, thereby having some washing effect. By means of two spray layers with spray nozzles with a very fine homogeneous spray pattern, the incoming gas will be further cooled back. By mounting the vessel sufficiently high, the rinsing water can flow freely to the buffer tank from the scrubber.

Diameter	:	Ø 1,500 mm
Total height	:	6,000 mm
Negative pressure	:	100 mbar
Materials	:	PP
Pressure drop	:	2 Pa

Scrubbers for SO2 removal

The scrubber is equipped with fully removable multiple spray lances that are mounted above each other to achieve a long spray pattern. The clog-free tangential hollow cone nozzles do their job with a fine drop to capture as many gas particles as possible. The section is constructed in such a way that, due to their combined large flow rate, the nozzles flush the inside of the washing section well at the same time. The nozzles are mounted with an overlapping spray pattern, creating a very intensive cleaning system. This means that the contaminated gas cannot pass through the spray section without being moistened and cleaned. As a result, random packings are completely unnecessary, so that the pressure loss is very low and remains low. The quality of the washing water is measured. Based on the measured values, it is then possible to flush automatically and then top up with fresh water;

To limit the loss of washing medium as much as possible, a final separator in the form of a very fine wire mesh demister is mounted above the pre-separator. This wire mesh demister ensures a final separation of droplets and in this configuration combines a high degree of separation with a relatively low-pressure loss.

Diameter	:	Ø 1,500 mm
Height	:	6,000 mm
Material	:	PP

Ravebo BV
't Woud 2
3232LN Brielle
the Netherlands
+31 (0)181 419-419
pe@ravebo.nl

Sustainability by Innovative Technology

www.raveboscrubber.com

Oxidation columns

The primary function of the oxidizer is to oxidize MgSO3 to MgSO4, this oxidation takes place through an intensive contact of MgSO3 and air. By means of nozzles, the liquid will be finely distributed, and the blown air will come into contact with the liquid and oxidation will take place. To limit the loss of washing medium as much as possible, a final separator in the form of a very fine wire mesh demister is mounted above the pre-separator. This wire mesh demister ensures a final separation of droplets and in this configuration combines a high degree of separation with a relatively low-pressure loss. Fresh water is used to compensate the evaporation loss.

Liquid composition	:	MgSO3 + MgSO4 dissolved in water
Liquid flow rate minimum	:	36 m3/h
Liquid flow rate maximum	:	120 m3/h
Liquid temperature	:	30 - 40 °C
Air flow maximum	:	20,000 Nm3/h
Diameter	:	Ø 1,750 mm
Height	:	8,000 mm

Ravebo BV
't Woud 2
3232LN Brielle
the Netherlands
+31 (0)181 419-419
pe@ravebo.nl

Scrubbers for food industry (fine particle removal)

Process description

The scrubbing operation is based on a wash water recirculation by a centrifugal pump, which pumps the washing water out of the integrated buffer.

- The washing section consists of hollow cone nozzles, part of which is mounted co-current and part of which is mounted counter current. The positioning of these hollow cone nozzles in the scrubber is of the utmost importance for optimum gas treatment, in relation with the capture of particles due to intensive contact between washing liquid and the process gas. Optimal contact of fine liquid droplets with gas and dust particles will lead to a large uptake of polluting particles / gases. This type of scrubber is particularly suitable for irregular concentrations (peak discharges), which will largely be absorbed by the counter current washing principle;
- The washing section is equipped with fully removable multiple spray lances that are mounted above each other to achieve a long(er) spray path. The clog-free tangential hollow cone nozzles do their job with a fine drop to capture as many dust / gas particles as possible. The section is constructed in such a way that, due to their combined large flow rate, the nozzles flush the inside of the washing section well at the same time. The nozzles are mounted with an overlapping spray pattern, creating a very intensive cleaning system. This means that the contaminated gas cannot pass through the spray section without being moistened and cleaned. As a result, random packings are completely unnecessary, so that the pressure loss is very low and remains low. The water quality of the washing water is measured by means of a conductivity measurement. Based on this measured value, it is then possible to flush automatically and then top up with fresh water;
- A pre-separator is mounted above the washing section. This can be a lamella separator or a wire mesh demister. For optimum operation, this pre-separator is sprayed at with tangential full cone spraying nozzles. The pre-separator is intended to separate the coarse drops and to reduce the liquid loading of the gas. In addition, this separator also functions as an agglomerator, which means that the fine droplets that cannot normally be separated are agglomerated. This means that the small droplets grow together into larger; this relieves the final separator and allows it to function optimally;
- To limit the loss of washing medium as much as possible, a final separator in the form of a very fine wire mesh demister is mounted above the pre-separator. This wire mesh demister ensures a final separation of droplets and in this configuration combines a high degree of separation with a relatively low-pressure loss;

Ravebo BV
't Woud 2
3232LN Brielle
the Netherlands
+31 (0)181 419-419
pe@ravebo.nl

- After the final separator, the gas flow is routed to the centrifugal fan to compensate for the pressure loss over the scrubber installation. The gas flow can then be emitted.

Specification's scrubber 1

Total height	:	3,550 mm
Diameter buffer	:	1,000 mm
Diameter column	:	600 mm

Specification's scrubber 2

Total height	:	3,400 mm
Diameter buffer	:	800 mm
Diameter column	:	450 mm

Package systems

- Stainless steel 316 housing
- Siemens S7-1500 PLC in Rittal cabinet
- BRL accredated dosing system
- KSB centrifugal pumps
- Endress + Hauser instrumentation
- Centrifugal fan
- ECON valves
- Iwaki magnet drive dosing pumps

Ravebo BV
't Woud 2
3232LN Brielle
the Netherlands
+31 (0)181 419-419
pe@ravebo.nl