



Gas Scrubbing Plants

Process and flue gas scrubbing,
particle separation, gas cooling

Gas scrubbing plants for process and environmental technology



GEA Wiegand is a worldwide leading company for process technology.

We deliver gas cleaning plants and vacuum systems based on jet pump technology as well as evaporation, distillation and membrane plants.

In our R&D Centre, laboratory facilities and pilot plants for fermentation, evaporation and distillation are available for testing and analyses. Steam jet pumps are checked on a separate test bench.

Our scope of delivery starts with engineering and ends up with delivery and commissioning of complete plants just upon your request.

Quality and reliability are essential factors of the company. Certification according to well-established standards such as DIN ISO 9001 and ASME U Stamp are therefore a matter of course.

You may contact us through our sales network with specialized engineers in more than 80 countries on every continent worldwide.

Gas scrubbing plants for process and environmental technology

We specialize in jet and Venturi scrubbers which are used with a high success rate in the field of process and environmental technology for cleaning and de-dusting discharge air, absorbing noxious gaseous substances, separating aerosols and cooling gases.

We offer a series of standard scrubber types, which can also be combined depending on the application:

- Jet scrubbers types I and II
- Hot gas scrubbers (Quench) / flue gas scrubbers
- Packing towers
- Venturi scrubbers

Capacity ranges from 0.05 m³/h up to approx. 100,000 m³/h gas throughput with exhaust gas temperatures of up to 1,300 °C.

Jet scrubbers are particularly suitable for use with explosive gas mixtures and heavily dust-laden and highly corrosive gases.

They can also be conveniently installed into existing plants at a later date.

We have developed gas scrubbers in compact design for gas quantities of up to 2,000 m³/h:

- Laboratory gas scrubber LGW 40, LGW 50 and LGW 80
- Compact gas scrubber KGW

For more than 40 years we have been designing, constructing and supplying gas scrubbers for diverse areas of application, ranging from single components to complete exhaust gas cleaning plants with integral control systems. In our laboratory we have extensive mobile testing equipment and the necessary analysis and measuring instruments thereby enabling us to select the best plant design.

This brochure presents some of the most important applications:

Flue gas cleaning

Discharge gas from the incineration of sewage sludge, waste materials from production units and waste disposal companies, harmful substances from chemical processes: salt of heavy metals, halogen, halogen-hydrogen, halogenated hydrocarbons

Process gas cleaning

Noxious substances: halogen (F₂, Cl₂, Br₂, J₂) halogen-hydrogen (HF, HCl, HBr, HJ), sulphur compositions (SO₂, SO₃, H₂S), ammonia (NH₃), low molecular alcohols, carbon acids, amines

Dust separation with jet and Venturi scrubbers

Flare gases, lime furnace gases, flue gases, noxious substances: dust with a particle size of 0.5 µm and over

Gas cooling

Dust-laden gases from incinerators, process gas with a high carbon dust content from steel making, intermediate and pre-cooling processes in compressor units

Chloric gas absorption

In the manufacture of chlorine bleaching, in production processes, and also as safety installations for leakage, storage, filling and dosing

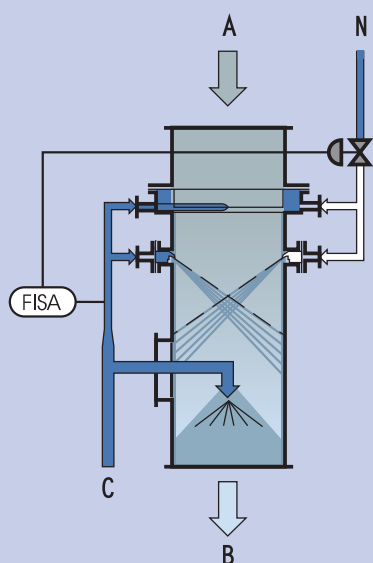
Scrubbers as emergency units

As safety installations during storage, in dosing stations, for the transportation of halogen, halogen-hydrogen and ammonia

Compact gas scrubbers for gas quantities up to 2,000 m³/h

For laboratories or pilot plants, in production processes, drainage, cleaning and filling of containers

Flue gas cleaning



Left: hot gas quench

Right: Quench with jet scrubber and packing tower arranged downstream for flue gases with an inlet temperature of 1,300 °C, capacity: 14,900 m³/h

Waste from chemical processes and production plants and also sewage sludge is often disposed of through incineration. The exhaust gases which are thereby produced with temperatures up to 1,300 °C contain, among other things, halogenated carbon-hydrogen and heavy metals. This means that exhaust gases from incineration have to be cleaned to comply with the permitted emission limits.

For many years GEA Wiegand has successfully supplied jet gas scrubbing plants with special **hot gas quenches**, which have the capacity to clean flue gases in this temperature range.

The quench head is positioned directly in front of the jet scrubber. The hot discharge gas is cooled down to substantially lower temperatures than 100 °C by spraying in scrubbing liquid before the noxious substances are absorbed in the jet scrubber and rough separation of the dust possibly takes place.

The gas and the liquid phase are separated in the centrifugal separator which is arranged downstream. Tower packing, which guarantees the cleaning of exhaust gases down to emission limits, is usually incorporated in the separator. A droplet separator prevents the entrainment of scrubbing liquid.

The plants are designed to reduce halogen and halogen-hydrogen and sulphur compositions down to the required exhaust gas limits. In the process a light alkaline scrubbing solvent is circulated.

If the hydrochloric acid concentrations in the flue gas are very high, the plant can also be designed to include HCl recovery. These plants can also be easily extended with Venturi scrubbers for fine dust or aerosol separation, catalytic plants for the removal of nitrogen and active carbon adsorbers for the separation of heavy metals.

The advantages of GEA Wiegand flue gas scrubbers in summary:

- Safe quenching of flue gases permits the use of corrosion-resistant and inexpensive materials such as rubberised materials, thermoplasts or fibre-glass reinforced plastics
- Minimum corrosion in the transition area between hot and quenched flue gas through virtual avoidance of metallic materials
- Little pressure loss in the plant (usually less than 10 mbar)
- Good response to partial load (up to less than 20 % without reducing the absorption capacity)

Cleaning of process exhaust gas

GEA Wiegand jet scrubbing plants are perfectly suited to the cleaning of exhaust air from chemical reaction processes, production buildings, container de-aeration, tank wagon emptying.

As with all wet scrubbing units, these jet scrubbing plants circulate the scrubbing liquid. However, the jet scrubber, which operates according to the ejector principle, causes **no pressure loss**; instead it generates **a pressure gain** in the gas flow so that the need to use a ventilator is often eliminated.

Additional packing or trays are installed into the scrubber's separator as counter-flow columns for fine cleaning. Depending on the particular application, jet scrubbers can also be designed with several effects or combined with Venturi scrubbers or aerosol separators.

Pure water, diluted acids or caustic solutions are used as scrubbing medium. As a result, the scrubbers are very well suited to the absorption of halogens (F_2 , Cl_2 , Br_2 , J_2), halogen-hydrogen (HF , HCl , HBr , HJ), sulphur compositions (SO_2 , SO_3 , H_2S), ammonia (NH_3) together with low molecular alcohols, carbon acids and amines).

If the exhaust gas contains a sufficient concentration of only one noxious substance, there is the possibility of recovering this from the exhaust gas:

- Hydrochloric acid recovery
- Production of ammonia solution
- Production of sodium hydrogen sulphite
- Production of chlorine bleaching

Depending on the strength of the chemicals, the plants can be supplied in metallic material, coated steel, thermo-plast or fibre-glass reinforced plastic.



*Jet scrubbing plant type II
for acid and alkaline exhaust gases*



*Jet scrubber with oxidation reactor
for the oxidation of Na_2SO_3 to
 Na_2SO_4 with atmospheric oxygen*

Dust separation with jet and Venturi scrubbers

Besides harmful gaseous substances, the exhaust gases which require treatment often contain solid particles, which have to be cleaned to meet emission limit regulations. It is necessary to know the size distribution of the particles in order to choose the most suitable equipment.

For particle sizes larger than approx. $4.0\ \mu\text{m}$, jet scrubbers can achieve a separation rate of over 98 %. In contrast to other separation systems **jet scrubbers do not only operate without pressure loss but usually also generate a pressure gain** on account of the ejector principle (compression).

Jet scrubber de-dusting applications are:

- Cleaning lime furnace gases upstream compressors (sugar industry, soda production)
- Cleaning flare gas and pyrolysis gases upstream compressors (petro-chemical industry)

A particular type of jet scrubber for the separation of particles is the **colour mist separator**. In paint shops they suck up the remaining colour spray (overspray), at the same time cleaning the discharge air to the prescribed limits. In most of the large paint shops the air conditioning facility is usually situated in the cellar, therefore these scrubbers are built very low and the suction channels are designed at right angles corresponding to the construction conditions. GEA Wiegand have designed plants with air throughput of $80,000\ \text{m}^3/\text{h}$ for airplane paint shops.

Venturi scrubbers are the right choice for particle sizes from approx. $1.0\ \mu\text{m}$ upwards. To achieve optimum particle separation, a loss of pressure relative to the granule size distribution must be taken into account. In order to keep the pressure loss constant, regardless of the scrubbing load, and maintain a constant separation capacity, Venturi scrubbers are equipped with **adjustable controls**. If the gas is correspondingly pre-con-

ditioned (through partial condensation of the water vapour content or water injection by means of high pressure or dual material nozzles), particles from approx. $0.5\ \mu\text{m}$ upwards can be separated.



*Single effect continuously adjustable Venturi scrubbing plant type U for washing out dusts
suction flow: $30,000\ \text{m}^3/\text{h}$
pressure loss: 20 mbar*



*Jet scrubbers for the separation of colour mist from a paint shop for commercial airplanes.
material: stainless steel 1.4571*

Gas cooling

Jet scrubbers are like spray coolers and are therefore particularly suited to applications where large quantities of hot, dust-laden gas have to be cooled.

Both units have no parts which are susceptible to rapid fouling, they operate in combination, without pressure loss and adapt very easily to large fluctuations in load.

GEA Wiegand supplies jet scrubbers as gas coolers

- For pre-cooling and inter-cooling in compression units
- For the simultaneous quenching and absorption of large quantities of harmful gases.

*2-effect gas scrubbing plant for cooling and cleaning flare gas , capacity: 7,220 Nm³/h
The plant is insulated and is delivered completely ready for connection, mounted on a base frame*

By combining jet scrubbers with spray coolers, the gas can, if necessary, be cooled down to below the temperature of the cooling liquid which is draining off.

These gas coolers offer a guarantee for long, smooth operating times and are moreover easily cleaned.

They can be extensively adapted to variable operating conditions.

Jet scrubbers can be made of many materials so that an economic solution can be found for the most diverse process conditions.

Two jet scrubbers of type II in stainless steel design for cooling 125,000 m³/h process gas with a high carbon dust content for a steelworks in Australia



Chloric gas absorption



Left hand fig.: Chloric gas absorption plant for cleaning exhaust air from chlor-alkali electrolysis and for the production of chlorine bleaching

Right hand fig.: Turn-key jet scrubbing plant made of titanium and fibre-glass reinforced epoxy resin for the absorption of 25,000 kg/h chlorine in a chlorine factory. Absorption rate: 98 %

In the production of chlorine all the resulting emissions including those from possible breakdowns must be collected together and conveyed to a gas cleaning system. Therefore, an absorption plant is an essential part of the standard equipment.

In general terms, we can distinguish **four types of emission:**

- During normal operation any constantly occurring leaks, e.g. in the filling plant, are drawn off.
- When starting up a block of cells, the entire chlorine production of these cells must be sucked up and absorbed until they produce virtually inert gas-free chlorine.
- If the chlorine compressor or the chloric gas after-treatment unit breaks down, the entire quantity of chloric gas which is produced must be fed through the absorption plant.
- In the event that there are leaks in the tanks, or the piping and fittings are not tight, the absorption plant operates as an emergency unit.

Diluted caustic soda, which occurs as a by-product in chlorine factories, is used for absorption in the scrubbing plant. The conversion follows according to the reaction equation:



An absorption plant is expected to clean the exhaust air in all four cases shown above so that it complies with legally established emission values. It must also offer a maximum level of operating safety. To this end GEA Wiegand has developed chlorine absorption plants with frequently three absorption effects. The first two effects consist of jet scrubbers, the third effect consists of a counter-flow column. Jet scrubbers have the duty of reducing high chlorine concentrations before the exhaust air for the fine cleaning process reaches the counter-flow column. In addition, jet scrubbers can suck up exhaust air through their injection effect and overcome drops in flow in the equipment and piping without any additional mechanical ventilator.

The heat that is generated through absorption is fed out of the scrubbing liquor through plate heat exchangers.

In order to combat accidents in chlorine storage areas, dosing stations and during the transportation of chlorine, GEA Wiegand offers its very own emergency scrubbing units.

Scrubbers as emergency units

In order to prevent accidents caused by escapes of chlorine from leaking storage containers or dosing plants, GEA Wiegand have developed chlorine emergency units, which operate according to the principle of the jet scrubbers. They are able, in the event of an accident, to suck up the environmental air without using a mechanical ventilator, to chemically bind the chlorine into the scrubbing liquor (usually caustic soda) and to reintroduce the cleaned air into the environment.

For the purpose of **room atmosphere suction** there are 5 ready-to-connect standard sizes with absorption capacity of 50 to 1,000 kg chlorine; in this case, the size of the plant is determined by the amount of gas to be bound and the amount of air to be conveyed. The scrubbing liquor which is kept in the storage tank of the chlorine emergency unit is individually suited to the size of the chlorine plant and is always available in case of emergency. Only the circulation pump has to be switched on in order to start up the chlorine unit.

The mobile chlorine emergency unit is unique in the world for special use when accidents occur during the transportation of chloric gas e.g. by railway tank wagons. It has the dimensions of a container and can be brought to the place of the accident by lorry, railway or helicopter in the shortest possible space of time.

The plant was developed by GEA Wiegand and is on stand-by in the National Response Centre of TUIS (Transport-Accident-Information- and Assistance System) in Ludwigshafen.

The unit consists of a 2 effect jet scrubber which can pump up to 1,000 m³/h fouled air containing up to 150 kg chlorine and can clean it to a chlorine content of less than 10 ppm.

These plants can also be used to combat leakages of other gases such as hydrogen bromide, sulphur dioxide or hydrogen chloride.



Mobile chlorine emergency unit in operation



Chlorine emergency unit DN 200 for an absorption capacity of 100 kg chlorine

Compact gas scrubbers for gas quantities up to 2,000 m³/h

Compact gas scrubbers consist of a jet scrubber and an absorption column which is arranged downstream. They operate according to the ejector principle and do not generate any pressure loss in the gas flow; instead they produce a pressure gain. Therefore, generally speaking, there is no requirement for a mechanical ventilator to draw off and convey the gas. The scrubbing liquid serves as motive medium. The mixture of gas and liquid is separated in a centrifugal separator arranged downstream. This is designed in such a way that foam formation is largely eliminated. The scrubbing liquor is fed into circulation via a circulation pump. The gas travels through a counter-flow scrubbing column arranged downstream which is provided with scrubbing liquor from the circulation pump or, if necessary, with fresh liquid.

Depending on the requirement, a packed column, a plate column or a column with structured packing can be installed. Any entrained liquid droplets are separated in a demister arranged downstream before the gas outlet.

Solvent or reaction heat which occurs during the scrubbing process is either removed by means of continuously fed fresh liquid or through an additional cooler.

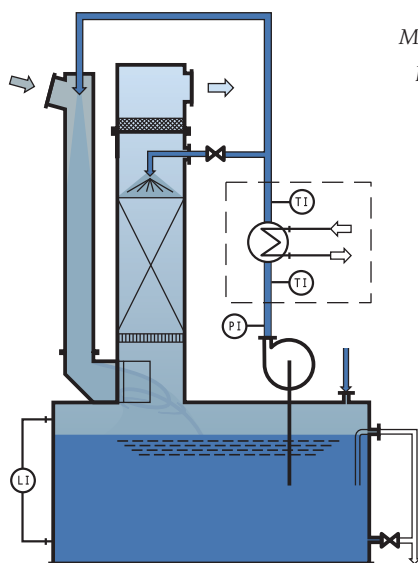
Compact gas scrubbers are supplied in four standard sizes and two designs (with or without heat exchanger):

- **Laboratory gas scrubber DN 40** for gas suction flows up to 2.3 m³/h. For gas scrubbing during tests in chemical laboratories and when filling, emptying and cleaning equipment.
- **Laboratory gas scrubber DN 50** for gas suction flows of 5-50 m³/h. For gas scrubbing during tests and in chemical laboratories and pilot plants.

- **Laboratory gas scrubber DN 80** for gas suction flows of 5-80 m³/h. For cleaning gas during tests, in the production process, when filling, emptying and cleaning equipment, during breakdowns and repairs.

- **Compact gas scrubber KGW** for gas suction flows of 50-2,000 m³/h. For diverse applications, if a compact design is desired. Compact scrubbers can easily be extended and adapted to the prevailing operating conditions. e. g. by installing a second jet scrubber, a quench for hot gas cooling or an aerosol separator.

All compact gas scrubbers can be supplied for any duty in the most appropriate material.



Top: Laboratory gas scrubber DN 40
Middle: Compact gas scrubber
Bottom: 2-effect compact gas scrubber with packing and stripping column



Types and components

Jet scrubber type I

Jet scrubbers operate according to the ejector principle and are the only gas scrubbers which suffer no pressure loss in the gas flow, but actually generate a pressure gain. This means that, generally speaking, there is no requirement for a mechanical ventilator to draw off and convey the gases.

In its basic design, jet scrubber type I consists of the scrubbing tube with liquid distribution and motive nozzles and a separation and storage tank. All the parts can easily be adapted and are thus optimally suited to diverse duties.

Jet scrubbers type I can be supplied in the appropriate material for any requirement.

Particular characteristics: broad spectrum of application, auto-suction capacity, no pressure loss, substantial load, responds well to partial loads, flexible, can be combined and extended, resistant to fouling, high level of operational safety, little maintenance.

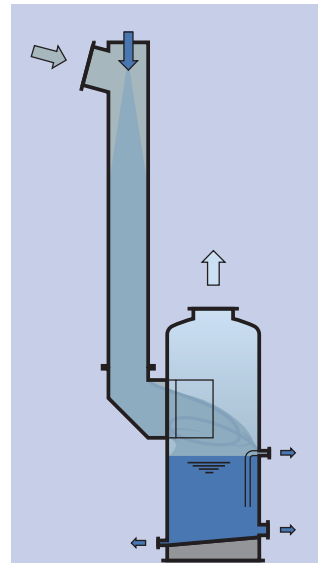
Jet scrubber type II

In constructional terms, jet scrubber type II is a variation of jet scrubber type I. In this design, the scrubbing tube is integrated into the separation tank. The high space for the gas to rise in the separation section provides both optimum flow-in conditions for the integrated droplet separator and can also be used in various ways for improving the separation capacity, e.g. through the installation of a counter spray or tower packing. In this way, jet scrubber type II combines the advantages of the jet scrubber with the possibilities of the counter-flow scrubber in one unit.

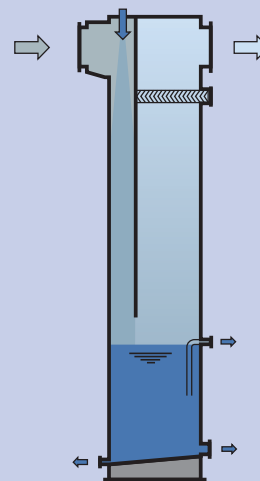
Particular characteristics: as jet scrubber type I, but further distinguishes itself through its low constructional height, minimum space requirement; large dimensions possible.

Venturi scrubbers

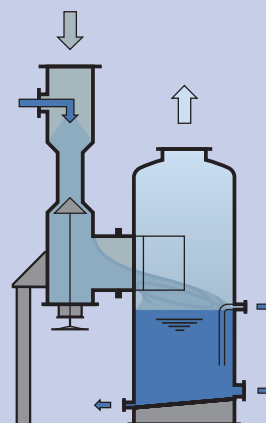
The Venturi scrubber is a high performance separator and is particularly well-suited to the separation of aerosols and fine dust from a gas flow. The good separation rate is due to the high relative velocity between the dust-laden gas flow and the scrubbing liquid in the



Jet scrubber type I



Jet scrubber type II



Venturi scrubbers

narrowest cross section of the equipment.

This cross section must be adapted to the gas flow in order to achieve the same separation rate during partial load. For this purpose we have developed Venturi scrubber type U and equipped it with a variable regulating cone. The control range lies between 10 % and 100 % load, with the same high separation rate.

Particular characteristics: can be supplied for every duty in suitable materials, adjustable pressure difference (manual or automatic), constant pressure difference during fluctuations in load, resistant to fouling, can be combined with other components.



We live our values.

Excellence • Passion • Integrity • Responsibility • GEA-versity

GEA is a global technology company with multi-billion euro sales operations in more than 50 countries. Founded in 1881 the company is one of the largest providers of innovative equipment and process technology. GEA is listed in the STOXX® Europe 600 Index. In addition, the company is included in selected MSCI Global Sustainability Indexes.

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