

# Metso

## Beginners guide to Metso's vent gas scrubbers





# Get to know OKTOP® vent gas scrubbers

Metso's proprietary vent gas scrubber products are offered as OKTOP® vent gas scrubbers. It is predominantly employed to scrub/wash process off-gases containing chemical residues and contaminants from the hydrometallurgical processes before releasing to the atmosphere. Fine acidic liquid droplets, emission chemicals such as H<sub>2</sub>S and SO<sub>2</sub>, and fine dust particles are among the common contaminants removed from the gases.

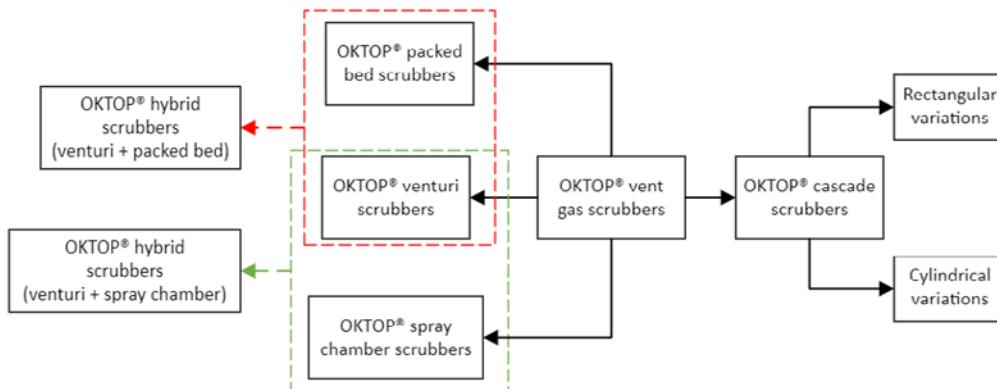


Figure 1. OKTOP® vent gas scrubber's classifications

Figure 1 represents the different types of OKTOP® vent gas scrubbers. Primarily there are four types of scrubbers: cascade, venturi, packed bed, and spray chamber. In addition to the mentioned types, Metso offers a unique combination of scrubber set-up comprehended as OKTOP® hybrid scrubbers combining OKTOP® venturi scrubber with either OKTOP® packed bed scrubber or OKTOP® spray chamber scrubber. Also, OKTOP® cascade scrubbers have two variations: rectangular and cylindrical for flexible utilization in Acid Mist Capturing System (AMCS) environments.

**Table 1. OKTOP® vent gas scrubber features**

Scrubber features	Spray chamber	Packed bed	Cascade	Venturi	Hybrid
<b>Emission source</b>	Reactor off gases	Filters, thickeners, and reactor off gases	Electrowinning and electrorifining	Autoclave off gasses	Reactor off gasses
<b>Gas amount (m<sup>3</sup>/h)</b>	500–20000	500–20000	1000–100000	5000–40000	100–1000
<b>Emission type</b>	Droplets	Gas (H <sub>2</sub> S, SO <sub>2</sub> )	Droplets / Particles	Droplets / Particles	Droplets
<b>Efficiency (%)</b>	99	99	98	98	99

The fundamental operating principle in OKTOP® vent gas scrubbers is straightforward. Where high-pressure nozzles inject cleaning solutions into the scrubber. Typically, water or alkaline solutions with high pH are employed for this purpose.

The gas to be scrubbed/cleaned penetrates through the cleaning solution creating droplets in which most of the contaminants are neutralized by the cleaning solution. The remaining chemical residues from the gas are trapped using a lamella pattern droplet separator.

The nozzle pressure, nozzle angle, and droplet size are adjusted based on the characteristics of the inlet gas to be cleaned. Amongst these, the nozzle pressure plays a vital role in controlling the droplet size, for an effective cleaning resulting in a favorable environmental impact.





Figure 2. OKTOP® cascade scrubber 2X3 (rectangular variant)



Figure 3. OKTOP® cascade scrubber C3 (cylindrical variant)

# OKTOP® cascade scrubbers

## Do you know

OKTOP® cascade scrubbers are used as part of the AMCS. It is typically used to scrub off-gases from chemical processes like pulping, electrorefining, and electrowinning. Both the cascade scrubber's rectangular and cylindrical variants are offered in two materials: stainless steel and fiber-reinforced polymer (FRP). The primary components consist of the scrubber, cascade tubes, droplet separator, water lock tank, and fans. The product sizing is based on the off-gas volume. The volume dictates the number of cascade tubes present in the scrubbers and their order of arrangement.

The rectangular variant has cascade tubes arranged as a matrix with rows and columns. E.g.: a 2X3 scrubber (see Figure 2) contains 2 rows and 3 columns with a total of 6 cascade tubes. On the other hand, the cylindrical variant has cascade tubes arranged as a revolver. E.g.: a C3 scrubber (see Figure 3) has 3 cascade tubes located circularly along the scrubber shell.

## How it works

The off-gases to be scrubbed penetrate the cascade scrubber system via the inlet ventilation duct. The fan system located opposite side from the inlet duct is used to control the flow rate of the off-gas suction. These contaminated gasses pass through the series of cascade tube arrangements which are partially submerged in the cleaning solution (water or alkaline).

As so, the entered off-gas escapes vigorously into the cleaning solution creating droplets that carry the acid particles. As the flow continues further, the washed gases along with the acidic droplets are carried along, reaching the droplet separator, within which the droplets are demisted and dropped to the bottom where it is directed into the water lock tank leaving the clean gas to flow through continuously. Finally, the scrubbed clean gas is ready for release.

# OKTOP® venturi scrubbers

## Do you know

The OKTOP® venturi scrubbers are utilized for high-pressure operations in hydrometallurgical processes. It is typically paired with the OKTOP® autoclaves to wash the exhaust gases from the pressure-leaching processes. The OKTOP® venturi scrubber possesses three primary components: venturi, washing chamber, and a demister. The venturi comprises a converging section, a throat, and a diverging section. A high-pressure nozzle is placed above the converging section providing a conical spray with 30° narrow spray angle. The demister is a crucial part of the scrubber that ensures that the emissions to the environment from the process stay at a minimal amount and ensures minimal drift loss from the scrubber. The product is sized based on the inlet exhaust gas flow rate (see Figure 6). Like other scrubber offerings both stainless steel and FRP versions are available. The scrubber operates in two stages.

## How stage 1 works

Typically, the exhaust gas enters the converging section of the venturi, as the gas flows further the area decreases which results in increasing the gas velocity. Additionally, the cleaning solution is sprayed at high-speed using a nozzle before the venturi throat which creates an under pressure providing suction to the gas line. This turbulence in the throat vigorously mixes the inlet gas and cleaning solution forcing it to form an enormous number of tiny liquid droplets. This stream further passes through the diverging section of the venturi forcing it to slow down.

## How stage 2 works

After the primary cleaning has been done in the venturi (stage 1), most of the entrained water is collected in the washing chamber. The gas then flows to the demister, where the remaining washing solution droplets are removed from the gas. Furthermore, the demister has two phases, a cyclonic separation phase and a vane demister.

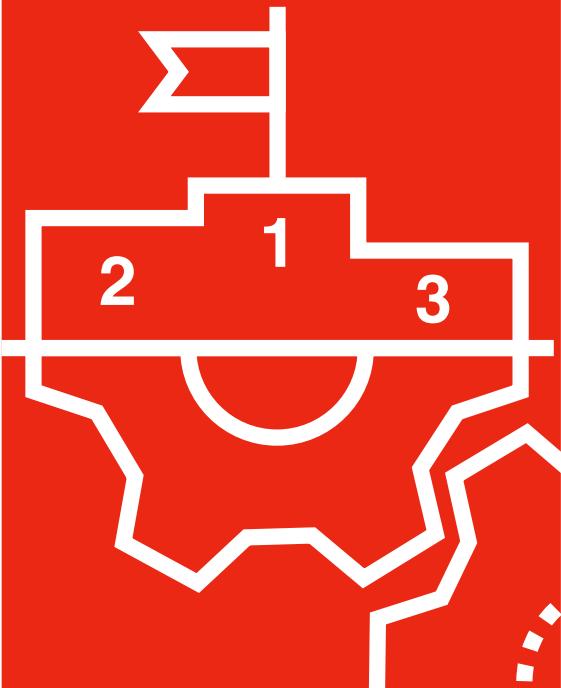
The initial cyclonic separation phase cleaning principle is that the droplets hit the demister walls and flow down while the gas moves forward. In the vane demister, which is the second phase of droplet removal, washing nozzles perform demister cleaning without stopping the scrubber. After these two phases in the demister, the gases are clean and are released from the top of the demister. The used washing solution is again directed to the internal water reservoir and is circulated back.

The water in the scrubber is used in a semi-closed circuit as there is a need to occasionally add cold water to the recycling tank to maintain the cleaning solution's temperature. The large amount of condensed water also results in constant bleeds of washing water from the scrubber reservoir. This bleed solution may need additional cleaning, which is done by leading the solution to an appropriate zone during the process.



Figure 6. OKTOP® venturi scrubber flow rate 10000 Nm<sup>3</sup>

# Increasing sustainability and safe plant operation



## OKTOP® packed bed scrubbers

### Do you know

The OKTOP® packed bed scrubbers are compact products with scrubbing stages arranged on top of each stage within a hollow tube-like setup. It is utilized to remove chemical contaminants such as H<sub>2</sub>S, SO<sub>2</sub> and other generic absorptions from the exhaust gas.

The primary components are the scrubber hull (hollow tube), spray pipe, nozzles, packed bed material, and the demister (droplet separator). The product sizing is done according to the off-gas volume flow and the volume flow is determining the scrubber's hull diameter. As an example, the packed bed scrubber shown in Figure 4, has the diameter of 1000 mm. Plus, the scrubbers are offered in both stainless steel and FRP material variants.

### How it works

The packed bed is the primary location where the gas scrubbing occurs. The packed bed consists of random packing material. This is to ensure maximum surface contact area between the gas flow and the washing solution.

On top of the packed bed a cleaning solution is distributed via one or a few nozzles as a built-in spray nozzle system. The washing solution is recycled via an internal solution reservoir located at the bottom (like a water lock tank) of the scrubber hull. In the scrubber the off gas is flowing from the bottom of the scrubber hull, which is the opposite direction from the cleaning solution.

When the gas reaches the top of the hull, there is a demister (droplet separator) located that removes any remainder droplets from the gas. This ensures that the material coming out of the scrubber is entirely in gas form. The vane demisters operating principle is that the air flow hits the vane and collects the droplets to the walls of the demister and deviates from the gas flow path.



Figure 4. OKTOP® packed bed scrubber D1000 steel

# OKTOP® spray chamber scrubbers

## Do you know

The OKTOP® spray chamber scrubbers are also compact products with scrubbing stages arranged within a hollow tube-like setup. It is utilized to clean processed gases for example from direct leaching. The primary components are the scrubber hull (hollow tube), spray nozzle system, and demister (droplet separator). The product sizing is done according to off-gas volume flow and the volume flow is determining the scrubber's hull diameter.

As an example, the spray chamber scrubber shown in Figure 4 has the diameter of 1000 mm. Plus, the scrubbers are offered in both stainless steel and FRP material variants.

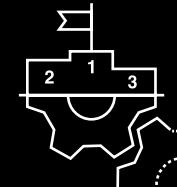
## How it works

The operating principle is based on the typical counter-current flow system, where the gas to be cleaned flows bottom up and the cleaning solution is sprayed from the top. When the exhaust gas to be cleaned enters the scrubber it passes through the spray nozzle system. Where a series of nozzles spray cleaning solution.

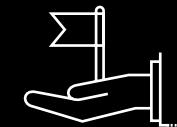
The contaminants carried by the gas are washed and fall to the scrubber's bottom, where the reservoir (water tank) is located. The washed gas further passes through the demister (droplet separator) to the remaining droplets from the gas. The water from the reservoir is further processed and recirculated to the rubber to minimize water consumption.



Figure 5. OKTOP® spray chamber scrubber D1000 steel



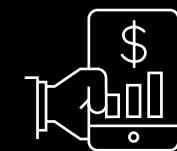
Optimized  
gas cleaning



Provides a safe  
working environment



Minimized atmospheric  
environment impact

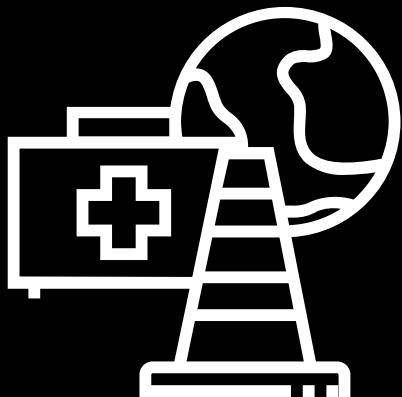


Reduced  
process losses

# OKTOP® hybrid scrubbers

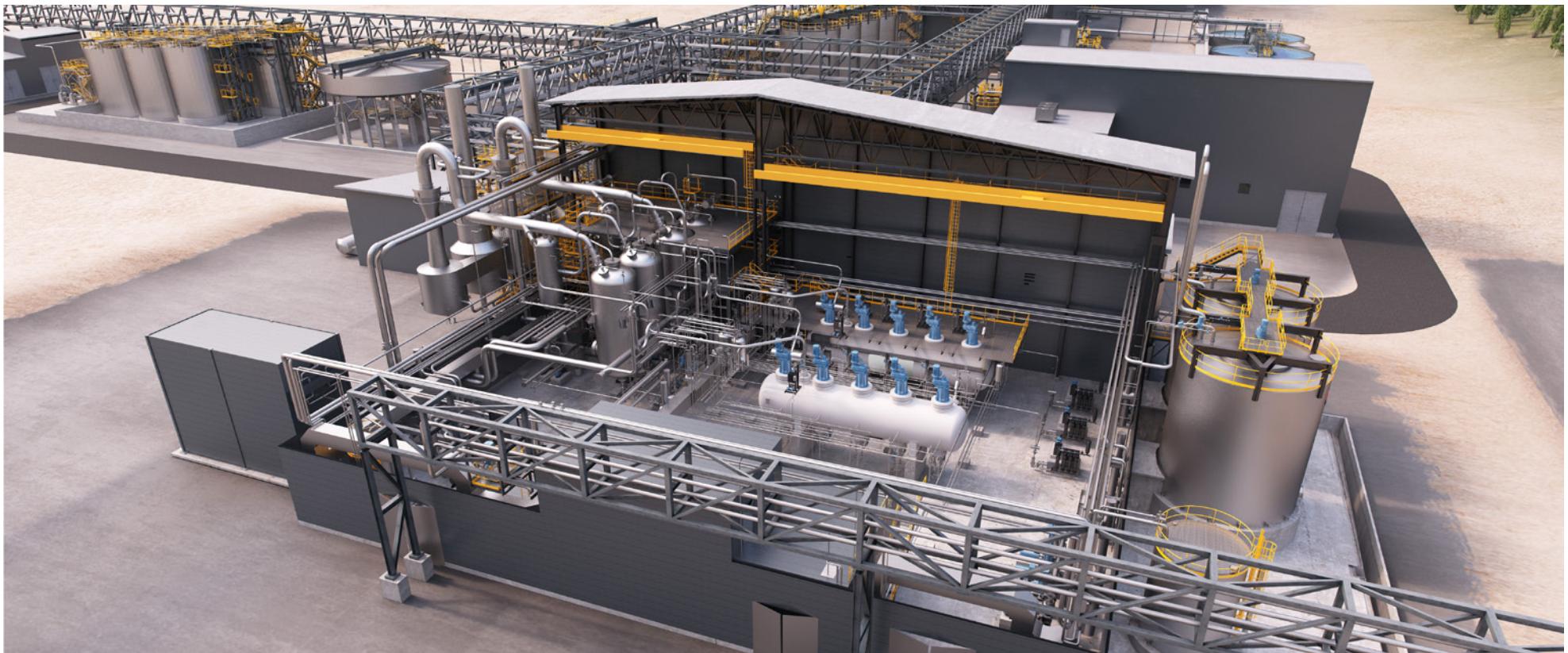
As mentioned earlier (see Figure 1), the OKTOP® hybrid scrubbers are a combination of venturi scrubber + packed bed scrubber or spray chamber scrubber. Overall constructing it into a three-stage scrubbing process, which makes it the most efficient scrubber from Hydrometallurgy.

It is typically used for small amounts of gases that need to be cleaned after the venturi operation in heavy-duty exhaust gas cleaning. Hybrid scrubbers with a venturi involved substitutes the need for a blower in the system. The venturi can provide a steadier flow of small gas amounts than a blower, hence providing more efficient cleaning.



## Safety

The general purpose of Metso's OKTOP® scrubbers is to minimize the amount of emission that is released into the atmosphere. OKTOP® scrubbers provides maximum efficiency in removing all the emissions from the processes. In some processes there is a large amount of vapor released. It is important to note that this is not emission as vapor consists mostly of water.



## Sustainability

The OKTOP® vent gas scrubbers are all designed and developed to satisfy the legislative criteria, providing world-class solutions to industries to handle emissions and worker safety. Additionally, the residual chemicals and other debris from the processes are cleaned promptly, preventing other subsequent equipment in the plant from scaling, corroding, and malfunctioning. Valuable components / chemicals are also recycled back to the process.

Metso is capable of providing a complete package for scrubbing needs. This includes auxiliary equipment, such as fans, pumps, instruments, electrical equipment and complete automation. From designing the scrubbing process to deliver and startup the actual product, Metso is your right supplier.

Metso is a frontrunner in sustainable technologies, end-to-end solutions and services for the aggregates, minerals processing and metals refining industries globally. We improve our customers' energy and water efficiency, increase their productivity, and reduce environmental risks with our product and service expertise. We are the **partner for positive change**.

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