SCRUBBING

VANE-CAGE SCRUBBER

Introduction Filtration is a widely recognized technique for the removal of contaminations from air or other gaseous streams. Other available technologies for the removal of particulates are cyclones and scrubbers.

In comparison with a dust filter, a scrubber is an excellent principle for applications where the dust is sticky, abrasive or has a high explosion risk. Another application where a scrubber would be the solution is a process with a high humidity gas stream, where vapour absorption is also required or the dust could be recycled in the process as a sludge.

In general scrubbers can be divided into two groups; scrubbers for dust removal (such as venturi scrubbers, Vane-cage scrubbers etc.) and scrubbers for vapour absorption (packed columns).

Scrubbers for dust removal do not have enough contact surface to reach the efficiencies on vapour absorption such as packed columns. On the other hand, a packed column is less efficient on dust fines and very vulnerable to blockings compared with a good dust scrubber.

Royal Dahlman Vane-Cage Scrubber There are a number of dust scrubbing technologies available. The most popular is the venturi scrubber. Royal Dahlman hereby proposes the Vane-Cage Scrubber (VCS) technology as a more efficient and economical solution. Due to its excellent efficiency this technology is also applied for dust removal in combination "easy" absorption jobs such as SO_2, SO_3, NH_3, HCl etc.

Applications From origin the VCS is a commonly used technology, after dryers, in the starch industry to comply with the stringent emission requirements (in some cases <5 mg/Nm3). Nowadays the technology is more frequently applied in the Oil & Gas and (Petro-) Chemical industry.

Efficiency The counter current action of the VCS provides substantially improved contact compared to a co-current device such a Venturi . In between the liquid scrubbing media and gas actual side-by side comparison tests with a Venturi, the VCS has consistently demonstrated a much greater efficiency of particulate removal at the given pressure drop levels. This superior liquid-to-gas contact provides better "mass transfer" and improved absorption of particulates and vapour.

Operation range A single Vane-cage scrubber can be designed and built for gas flows varying from 2.500 up to 170.000 Am3/hr. Due to the feature of an adjustable internal, it is possible to design the VCS with an operating window of ± 20%. Or change the pressure drop and hereby the efficiency to meet the (new) emission requirements.

Low water rates The VCS scrubbing process provides extended "residence time" between the gas and scrubbing liquid. This important feature permits a substantial reduction in the amount of liquids required per unit volume of gas. Furthermore the VCS is able to operate with 2-5% dust concentration in the scrubbing water which results in minimum bleed streams.

Maintenance The Cyclonic inter-action of the liquid and gas exists through the entire scrubber. The flushing actions thus generated, keep the internals clean by preventing build-up. This self cleaning feature, independent of efficiency or low water rates has meant success where other wet Scrubbers have plugged up and failed.

Materials The standard VCS is supplied in Stainless Steel (304 or 316). As each scrubber is custom made it is also available in other alloy materials and even in combination with plastic shells.

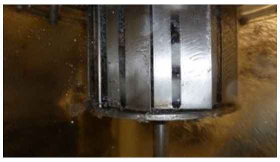
8 super duplex VCS for FCC emission reduction

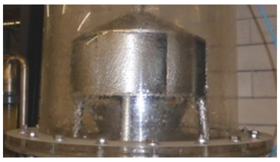
Process description Gas enters the VCS tangentially and is forced into a centrifugal motion. The washing liquid (e.g. water) is injected directly into the vane-cage through an open pipe. The contact between the washing liquid and the centrifugal gas inside the vane-cage creates a spinning cloud of very fine droplets. Part of this cloud is forced outwards through slits in the vane-cage, creating a wet cyclone and coating every part of the scrubber with a moving water film (continuously cleaning itself!).
The scrubbing liquid captures the contaminants (dust or vapour) in three distinct scrubbing steps.

Scrubbing step 1:
The gas enters the scrubber tangentially while crossing a vortex of water droplets. In this wet cyclone the gas is saturated with water and the main part of the bigger particles are captured.

Scrubbing step 2:
The stationary vane-cage acts as a number of small venturies, working parallel to wash the gas stream at a low-pressure drop.

Scrubbing step 3:
The dense cloud of very fine water droplets in the vane-cage forms the most efficient washing step. When the contaminated gas flows through this cloud it is in intense contact with the water droplets. In this process, very fine particles as well as vaporous or gaseous emissions are separated





Droplet separator:
After capturing the contaminant with water droplets, the final efficiency of the scrubber is determined by the separation of the remaining droplets from the gas stream.

After the vane-cage a stationary de-entrainer forces the gas into a quick spinning motion, which efficiently removes all droplets at a low pressure drop. Scrubbing and droplet separation in one single motion!

Additional process applications
Heat recovery
The VCS can be combined with packed bed scrubber for heat recovery and/or to remove chemical components. Commonly used after dryer to recover Megawatts of energy.

Pressurised and vacuum gasses
The scrubbing principle of VCS is based on the geometry of the internal and inlet. Therefore, this concept has also successfully been applied for pressurised and vacuum gasses.

Features	***Benefits***
Vane-cage with multiple venturies	Higher efficiency on dust emissions reduction and less energy consumption (dP) compared to a venturi scrubber
VCS allows high dust concentrations in scrubbing liquid	Lower bleed streams (reduced waste water treatment costs) and reduction of make-up water
No moving or rotating parts	Requires minimal to none maintenance
Completely self cleaning	Less maintenance costs
No demister necessary	Lower dp and less maintenance costs
No spraying nozzles applied	Minimal change on fouling