CCS®
CLOUD CHAMBER SCRUBBERS®

PRODUCT BULLETIN

Fine Particulate and Gas Removal

The Particulate Pollution Problem

The Cloud Chamber Scrubber (CCS) treats PM2.5, fine, submicron, ultrafine, and condensable particulate as well as PM10 and more coarse particles. Simultaneously, all soluble acid and caustic gases are removed at the same high levels as conventional scrubbers. The CCS is a major advance in multi-pollutant control devices.

As fine particulate regulations are tightened and pollutant gas limits are lowered, industry is looking for more effective and comprehensive solutions. Conventional scrubbers are effective on gases, but very ineffective on fine particles. Electrostatic precipitators and fabric filter baghouses – including wet ESP or hybrid FF – can remove some types of PM but are not specified for gases. These older technologies have well-known limitations in terms of particulate characteristics, particle loading, temperature, moisture content, acid gases or caustic fume restrictions, gas concentrations, etc. The CCS offers both very high removal efficiency and broad flexibility.

Using **highly charged water droplets** as collectors, the CCS is a proven solution for simultaneously treating fine particles and pollutant gases. The Cloud Chamber Scrubber sets a new performance standard as a 21st century technology.

Simultaneous Removal of Particles and Gas

- Based on new patented discoveries and innovations in electrofluidics.
- Proven submicron performance at efficiencies typically greater than 99%.
- Capability to capture particles even smaller than 0.1 micron.
- Energy efficient. Only 10 watts per 1000 cfm to charge the water droplets, plus moderate pump power for water recirculation.
- Less than 1.5" w.g. pressure drop across the system.
- Gas temperature, particle solubility, resistivity, and reactivity have little effect on performance.
- Handles heavy loadings. No particle charging, only water drops. Not sensitive to load flux.
- Also removes any gas that can be treated by a wet scrubber, including hydrogen chloride (HCl), sulfur dioxide (SO_2), ammonia (NH_3), and hydrogen sulfide (H_2S).
- Ultra-low water usage for "blowdown" discharge of captured pollutants.
- Active pilot testing program.
- Compatible with integrated NO_X system – SCR, SNCR, or Tri-NO_X.
- Energy recovery options available.

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Modular systems up to150,000 cfm.

Typical Pollutants

- Diesel emissions
- Silica, silicon dioxide
- Metal oxides
- Syn-gas contaminants
- Inorganic salts
- Heavy metals (mercury, chromium)
- Ammonium salt particles
- Condensable hydrocarbons
- Byproducts of combustion
- Carbonyl sulfide (COS)
- Acid gases such as HCl, HF, H_2SO_4, HNO_3
- Sulfur dioxide (SO_2)
- Chlorine gas (Cl_2)
- Hydrogen sulfide (H_2S)
- Ammonia
- Many other types of particulate and gas

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Benefits of Open Chamber Design

- Systems are low maintenance – standard pumps and a fan are the only moving parts
- No fouled packing to clean, no biological growth
- No clogged fibrous filters or venturi throats
- No maintaining dozens of high voltage ESP tubes that cake and corrode, no complex electrical
- No changing hundreds of fabric filter bags that blind and wear
- No high fan power requirement, CCS has less than 1.5"w.g. pressure drop

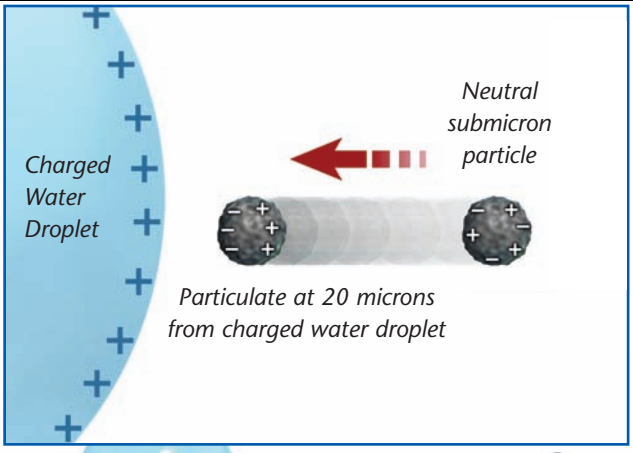
Scalable To Fit Your Application

- Modular systems from 100 to 150,000 cfm
- Treatment of high grain loads (grains/dscf)
- Simultaneous treatment of high concentrations of gas
- Incoming exhaust streams from 60°F to 2500°F
- Large scale systems in operation for 9 years
- Outdoor installations operating under harsh conditions
- High turn-down ratio of 10:1 or better

Typical Applications

- Large stationary diesel
- Glass melting furnaces
- Fiber optic manufacturing
- Solar panel fabrication
- Syn-gas cleaning
- Asphalt shingle manufacturing
- Solid fuel industrial boilers
- Oil and gas fired boilers
- Waste incinerators
- Abrasive production
- Smelters and foundries
- Chemical manufacturing
- Curing ovens, dryers, rotary kilns
- Plastics manufacturing
- Sulfuric and nitric acid production
- Many more

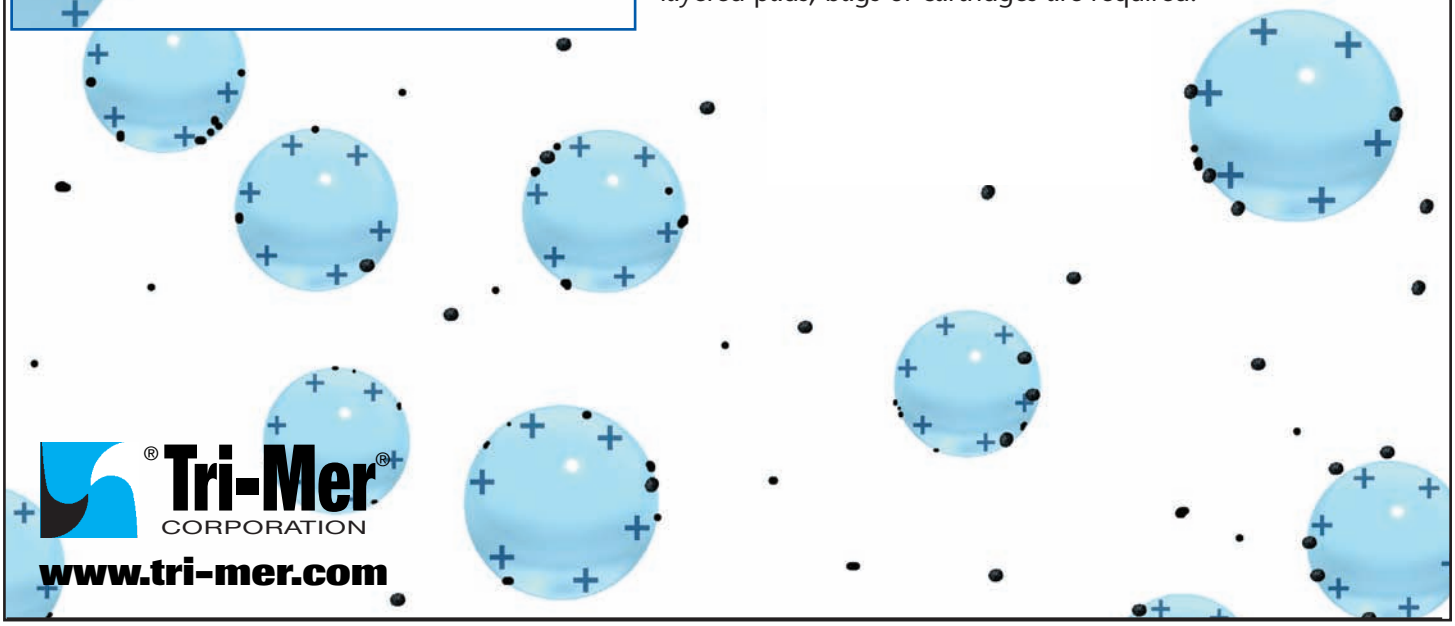
A Unique Operating Principle is Key to the Tri-Mer CCS® Process



Inside of the Cloud Chamber Scrubber . . .

Billions of droplets and particles are continuously moving in relation to each other. As they approach 20 microns of separation, the induced electrical attraction causes the particle to enter the water droplet. There is no ESP high voltage particle charging or "distant" collector plates. ***The charged water droplets, in close proximity, are the particle collectors.***

Each water droplet therefore becomes a collector of thousands of submicron particles, constantly re-energizing with each pass through the cloud chamber. Since the charged droplets are the collectors, no fibrous filters, ESP collector plates, venturi throats, layered pads, bags or cartridges are required.



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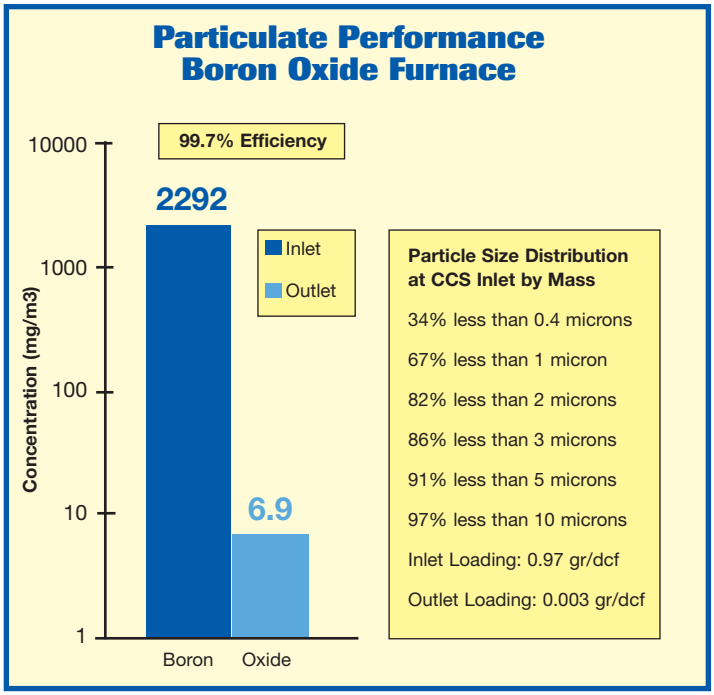
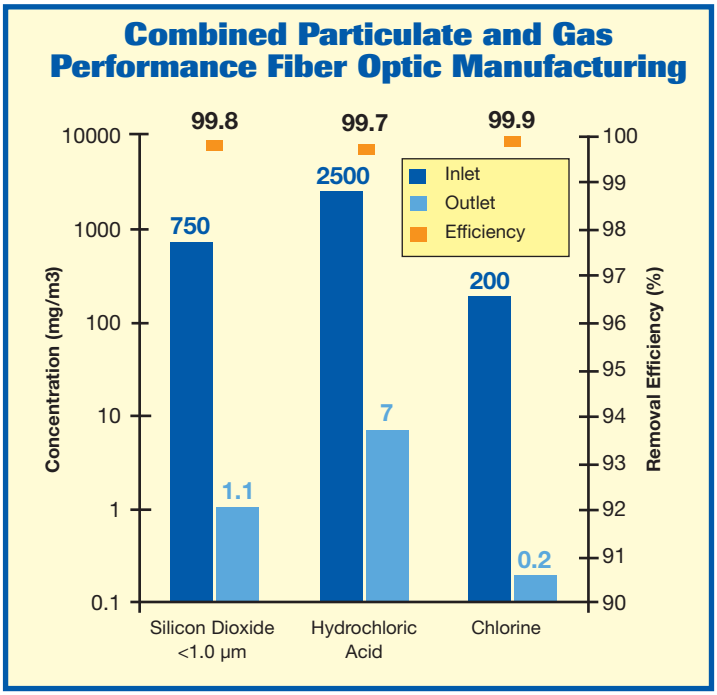
Performance Data

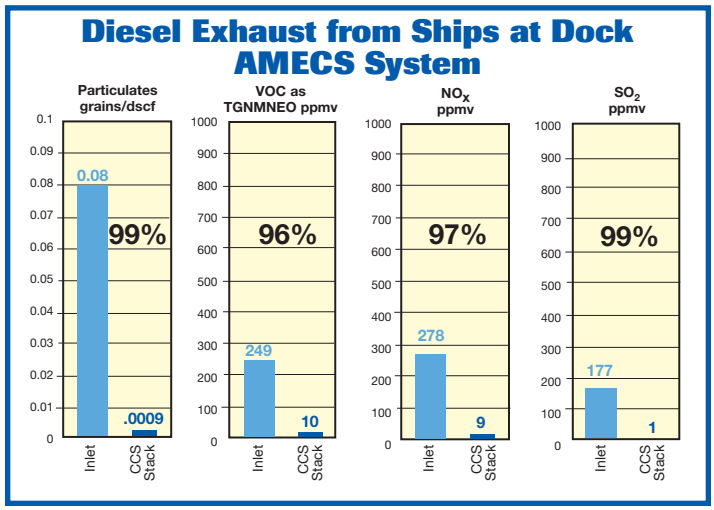
Cloud Chamber technology has been proven a highly effective and cost-efficient method of micron and submicron particulate emission control for a variety of industrial processes. More examples of CCS performance data online at **CCS Case Studies**



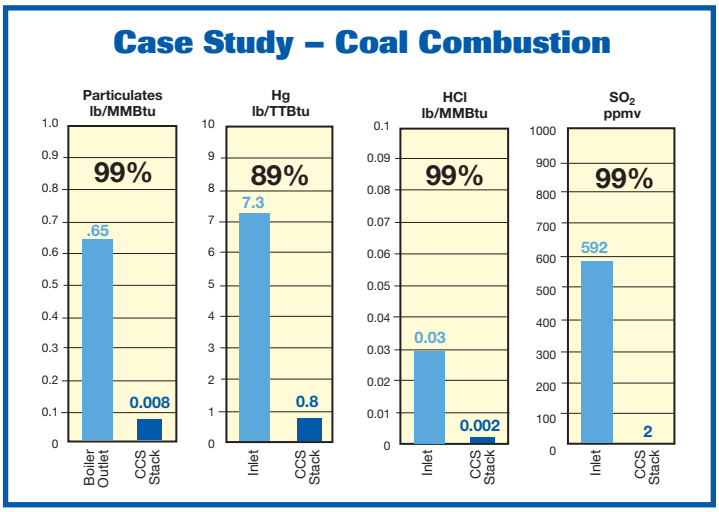
Shows typical results on exhaust with a high grain loading of submicron particles.



Indicates typical effectiveness on submicron/gas mixtures. Note the difficult pollutants being captured.



Third-party government test data on a ship at dock. The CCS – which removes the PM, SO_2, and diesel VOC – was fitted with an integrated Selective Catalytic Reduction (SCR) unit to remove NO_X.



CCS performance pilot test results for PM, Hg, HCl on a typical coal-burning industrial boiler substantially out of MACT compliance. The boiler was an older model using only multi-clone bulk removal of coarse particles. SO_2 removal was also important for this project.

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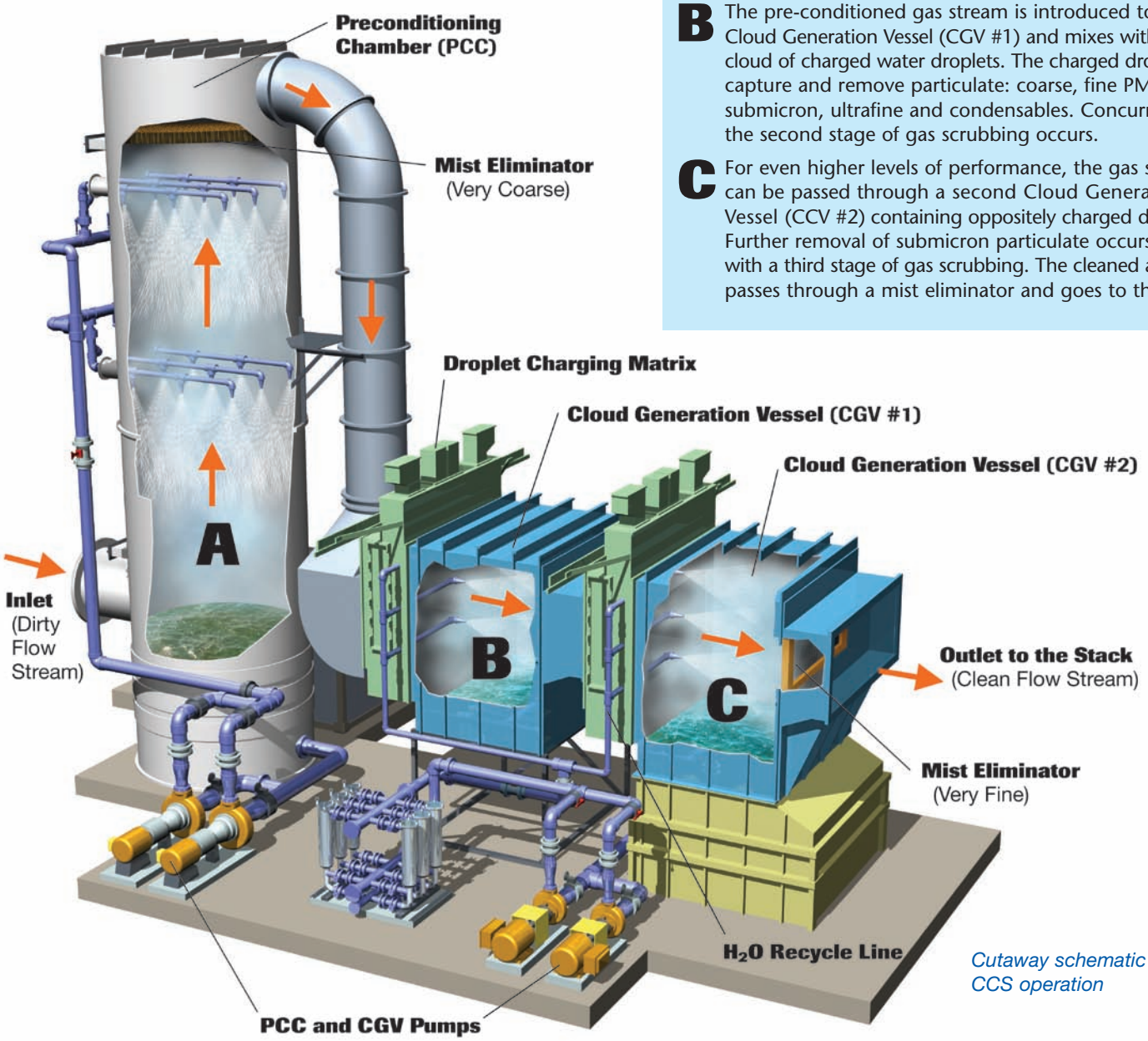
Patented Charged Droplet Technology

System Operation

A Process gas enters the Pre-Conditioning Chamber (PCC) where cooling takes place, larger coarse particles are removed, and the primary stage of gas scrubbing occurs. Within the controlled conditions of the PCC, ultrafine particles and condensables are grown to a few tenths of a micron in preparation for removal.

B The pre-conditioned gas stream is introduced to the Cloud Generation Vessel (CGV #1) and mixes with a cloud of charged water droplets. The charged droplets capture and remove particulate: coarse, fine PM2.5, submicron, ultrafine and condensables. Concurrently, the second stage of gas scrubbing occurs.

C For even higher levels of performance, the gas stream can be passed through a second Cloud Generation Vessel (CCV #2) containing oppositely charged droplets. Further removal of submicron particulate occurs, along with a third stage of gas scrubbing. The cleaned air then passes through a mist eliminator and goes to the stack.



Cutaway schematic of CCS operation

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