United McGill™ products

a McGill AirClean™ product

Ceramic Catalytic Filter Systems

Particulate, Acid Gas, and NO_x Control

McGill AirClean LLC

An enterprise of United McGill Corporation –
Family owned and operated since 1951

McGill dry scrubber, twelve-module catalytic filter, and SCR system to control NO_x, SO_2, and particulate on a float glass furnace.

History and Capabilities

McGill AirClean has over 50 years of experience solving air pollution control problems for industrial applications such as:

- Glass Manufacturing
- Wood Products
- Pulp and Paper
- Waste Incineration
- Electrical Power and Steam Generation
- Chemical
- Pharmaceutical
- Food
- Automotive
- Metals
- Petrochemical
- And many more

Our products include:

- Catalytic Filter Systems
- Fabric Filter Systems
- Dry and Wet Electrostatic Precipitators
- Acid Gas Control Systems (SO_x, HCl, HF, and B_2O_3)
- $DeNO_x$ Reactors (for selective catalytic reduction)
- Regenerative Thermal Oxidizers

How McGill's Catalytic Filter System Works

The Process

Before entering the catalytic filter, the flue gas, laden with particulate, acid gases, and NO_x is treated with a dry alkaline reagent, for acid gas reduction, and an ammonia reagent, for NO_x reduction.

Dry alkaline reagent is pneumatically injected in the flue gas duct, up-stream of the catalytic filter, where acid gases react with the alkali to form solid particulate salts. The reacted salts and un-reacted alkali will be collected on the exterior surface of the catalytic filters and form a dust cake. The dust cake, on the filters, provides a secondary reaction site for the un-reacted alkali to react with the acid gases.

Ammonia or urea is also injected in the flue gas duct up-stream of the catalytic filter. The catalyst present in the ceramic filters drives the reaction between the ammonia or urea reagent and NO_x to form diatomic nitrogen (N_2) and water (H_2O) vapor. The following reactions take place at the catalytic filters:

Ammonia Reactions

$2NO + 2NH_3 + 1/2O_2 \Rightarrow 2N_2 + 3H_2O$

$NO_2 + 2NH_3 + 1/2O_2 \Rightarrow 3/2N_2 + 3H_2O$

Urea Reactions

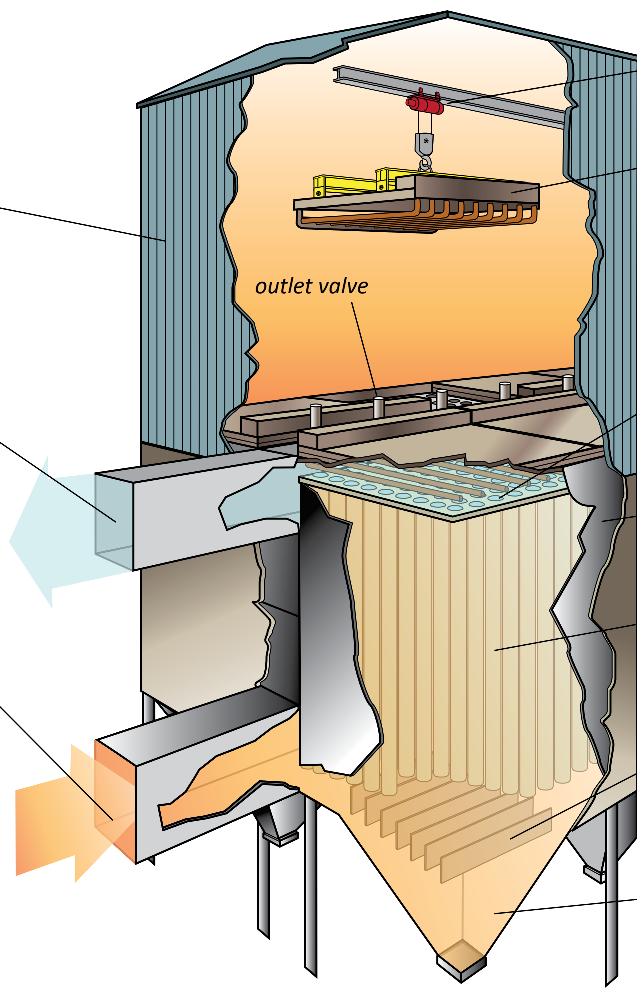
$2NO + CO(NH_2)_2 + 1/2O_2 \Rightarrow 2N_2 + 2H_2O + CO_2$

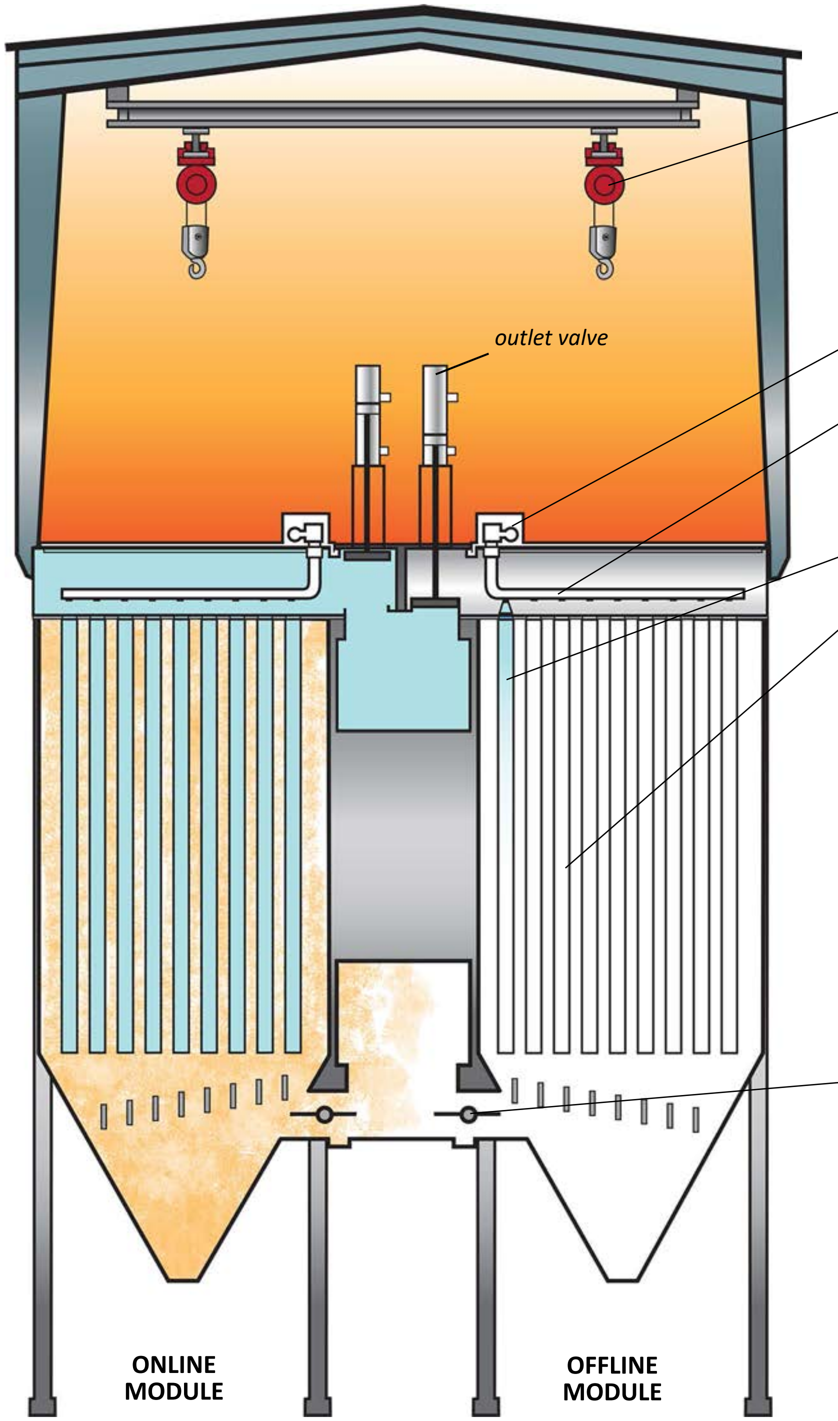
$NO_2 + CO(NH_2)_2 + 1/2O_2 \Rightarrow 3/2N_2 + 2H_2O + CO_2$

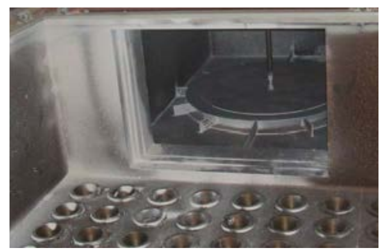
The collection process begins as dust, acid gases, and NO_x laden flue gas enters the McGill catalytic filter through an inlet manifold and is distributed to individual modules by passing through an inlet valve that remains open except during maintenance.

Once the flue gas enters the catalytic filter module the flue gas strikes ladder-vane baffles causing the largest particulate to fall into the collection hopper. The baffles then distribute the flue gas evenly throughout the cross section of the module. As the flue gas flows from the outside into the inside of the filters, particulate is collected on the outside surface of the ceramic filter. The cleaned flue gas then flows out the top of the filters through an opening in the tube sheet. Upon exiting the filters, the cleaned flue gas enters a clean air plenum and passes from the module through an outlet valve. This valve can be closed as needed to isolate modules for maintenance or filter cleaning. An outlet manifold system then directs the cleaned flue gas from the modules to a common discharge point.

Artist's rendering showing a cutaway view of a typical McGill catalytic filter.







During offline cleaning a module is isolated by closing its outlet valve.

An artist's cross-sectional view of a McGill catalytic filter system depicting on-line and off-line modules.

Cleaning Process

The catalytic filter's control system automatically begins the cleaning sequence when the buildup of particulate on the filters causes the pressure differential to reach a preset level (a timed override is also provided). For off-line cleaning, a module is isolated by closing its outlet valve. The filters in the isolated module are then pulsed one row at a time. Solenoid-piloted diaphragm valves provide bursts of compressed air that travel the length of the filters causing the particulate to dislodge from the outer surface of the filters. The particulate drops into a hopper and is collected for removal. After all the filters within the module have been cleaned, there is a null period to allow dislodged particulate to settle into the hopper. Once the null period is over, the module is brought back on-line and the next module is isolated for cleaning. Cleaning can also be performed on-line without isolating a module. This is especially beneficial in certain circumstances, such as when there is a high concentration of acid in the flue gas to be removed.

Gas Velocity and Distribution

Many catalytic filter manufacturers size their systems strictly on the basis of the “air-to-cloth” ratio, overlooking the importance of the system’s flue gas distribution and “can” velocity (see Figure 1). When gas distribution is uneven or internal velocities are too high, frequent filter cleaning, high abrasion, and high particulate re-entrainment can cause premature filter failure.

McGill considers both flue gas distribution and can velocity when designing a catalytic filter system. We equip each module with ladder-vane baffles rather than the conventional strike plates or diffusers that many manufacturers use. In addition to removing large particulate, the baffles distribute the flue gas evenly throughout the module. By spacing the filters far enough apart (3 inches or more), we reduce the gas velocity around the filters to an acceptable level. These design features prolong filter life making the system less expensive and simpler to maintain.

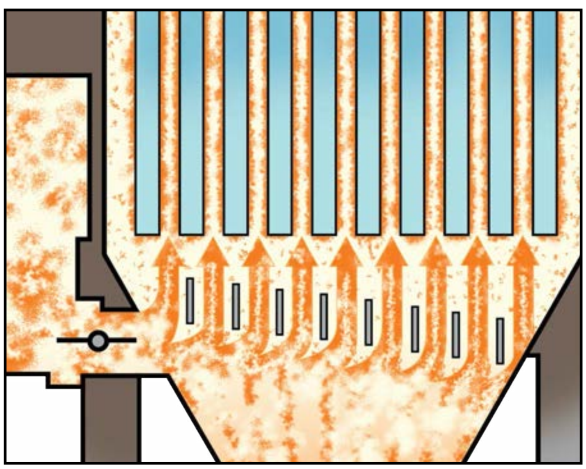


Figure 1 — Can Velocity

Can velocity is the velocity of the flue gas as it passes the bottom of the filters (maximum abrasive velocity), as shown in this illustration. It can be determined by using the following equation.

$$\text{Can Velocity} = \frac{\text{Gas Volume Flow per Module (net conditions)}}{\text{(Module Cross-Section Area)} - \text{(Filter Bottom Area)}}$$

Easy Maintenance

Filter inspection and replacement are the most critical and time-consuming maintenance operations perormed on a catalytic filter system. To inspect and service the filters properly, the module design must provide easy access to the filters and a safe work environment for maintenance personnel. McGill catalytic filters are designed so maintenance work can be done from the outside of the module, free from exposure to particulate and flue gas. Maintenance personnel have easy access to the filters from atop a roomy platform the size of the width and length of the module rather than from a confining walk-in plenum that most other designs have. For large systems, a 3-ton crane is provided to remove the top lid of each module. Pulse piping and valves are removed with this lid, allowing safe and immediate access to the filters. Piping and valves can be electrically isolated and disconnected quickly and easily.

A view from inside the penthouse atop the catalytic filter system.

An overhead crane is used to remove the top lids from the catalytic filter’s modules to provide easy access to the collection filters.

With the top lid removed, filter maintenance can be performed in a safe, ambient air environment.

Modular Construction

McGill's use of modular components simplifies and reduces erection time resulting in lower construction costs. It can also speed up major repairs or rebuilds by having to replace only the affected components. The photo sequence below depicts McGill's modular concept.

1) A catalytic filter module delivered to the jobsite and ready to be rigged for lifting.

2) With the foundation work completed, and the structural steel erected, the last of the modules for this catalytic filter system is lifted into place

3) Once the modules, hoppers, scrubbing tower, and manifolds have been erected, insulation is applied prior to the installation of the exterior siding.

4) The completed system.

Design Process and Considerations

McGill's sales and design engineers will review your specific process conditions and recommend the optimal catalytic filter system to meet your emission control requirements. Their critical design analysis will include such considerations as:

- Particulate removal requirements
- NO_x removal requirements
- Acid gas removal requirements
- Dust characteristics
- Flue gas chemistry
- Operating temperature

With our turnkey capabilities we are able to offer a single-source performance guarantee and equipment warranty for all of our systems. In addition to designing and manufacturing our own equipment, we also provide all auxiliary equipment for your complete installed solution. We offer maintenance services that include off-site monitoring, inspection, repair, rebuilds, and parts. Our product and service offering allows us to provide our customers with the best possible control technology in a cost-effective and turnkey manner.

McGill 5 Module Catalytic Filter System, controlling particulate, SO_x and NO_x on a container glass furnace.

McGill 4 Module Catalytic Filter System, controlling particulate and NO_x on a container glass furnace.

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Products depicted in this brochure were current at the time of publication. As a quality-conscious manufacturer, McGill AirClean is continually seeking ways to improve its products to better serve its customers. Therefore all designs, specifications, and product features are subject to change without notice.

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