

# MULTI-STAGE SCRUBBING SYSTEMS

Monroe Environmental® can provide complete multi-stage air scrubbing systems for a wide variety of applications. High temperature and volatile chemical processes often require a more complex, customized air scrubbing solution than what a simple packed tower scrubber or venturi particulate scrubber can provide.

In many cases, several technologies must be integrated together to provide adequate removal and treatment efficiencies. Monroe's experience includes the engineering and fabrication of customized multi-stage scrubbers utilizing the following equipment:

- Packed Bed Scrubbers
- Venturi Particulate Scrubbers
- Wastewater Clarifiers
- Oil Recovery Units
- Carbon Adsorbers
- Quench Towers
- Cyclonic separators
- Separators and Oil Recovery Units
- Heat exchangers and temperature controls
- Sub-cooling systems
- Dry injection fabric filters (DIFF)
- Fiberglass filters
- WESP and submicron particulate filters
- Specialty ducting systems

Monroe has the experience and knowledge to evaluate your process and recommend a customized scrubbing system for your specific application. Monroe has successfully treated contaminated air streams resulting from nearly every high temperature emissions application across a variety of industries and processes.

## High Temperature Scrubbing Processes

Monroe Environmental provides gas scrubbing systems for thermal processes including incineration, oxidation, flame laminating, glass coating, dryers, boilers, and others.



*20,000 CFM Multi-Stage Scrubbing System for solid waste incineration process. (From right): Ceramic-lined inlet duct, rapid water quench, adjustable Venturi Scrubber, liquid clarification tanks, Packed Bed Scrubber, and Carbon Adsorber.*



*Two-stage wet scrubbing system with eductor venturi and packed tower for HCl and SO<sub>2</sub> reduction from pharmaceutical manufacturing process exhaust*

## Applications

- Solid waste incineration
- Boiler exhaust
- Chemical gas incineration
- Kiln exhaust scrubbing
- RTO exhaust scrubbing
- Oven/furnace exhaust scrubbing
- Flame laminating
- Dryer exhaust scrubbing
- Glass coating
- Grease and chemical production
- Textile manufacturing
- Toxic gas incineration
- And many others

## Chemical and Compound Reclamation

Contaminants formed in these processes are frequently highly corrosive, hazardous, and/or difficult to remove. Removal often requires process temperatures at 1,500°F and higher. Through proper quenching and gas conditioning techniques, Monroe can provide reclamation of costly chemicals and compounds contained within the off-gasses.



15,000 CFM Scrubbing System to condense and reclaim vaporized grease and remove hydrocarbon fumes from a chemical manufacturing process. The system includes a Dual Throat Venturi Scrubber with drag conveyor, Oil Recovery Unit, and Packed Bed Scrubber for odor control.

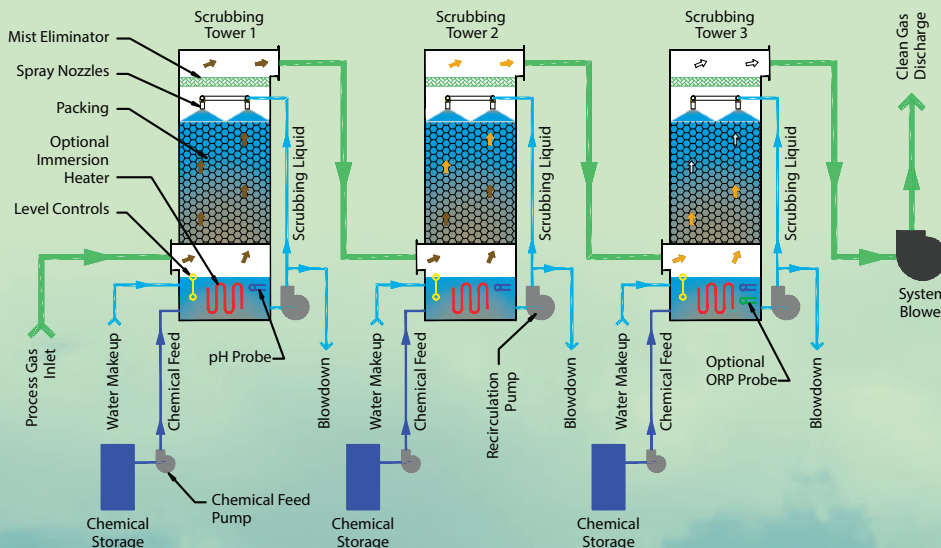


Left: 1,000 CFM Scrubbing System to remove lime dust from a chemical manufacturing process. (From left): Ejector Venturi, liquid clarification tank, high energy Venturi Scrubber, and cyclonic separator. The unit was designed to achieve 95% efficiency on 0.5 micron particles



Below: Multi-Stage Scrubbing system with inlet quench, 3-stage Packed Bed Scrubber, high energy Venturi Scrubber, liquid chiller/condenser, gas reheater, PAC injection system, baghouse, and Carbon Adsorber for toxic gas incineration

### Multiple Packed Bed Scrubbing Stages



Multiple scrubbing stages with different scrubbing solutions can be achieved by providing multiple scrubbing towers in series.

This type of system is common when there is a high pollutant loading, multiple pollutants, or when removal efficiencies greater than 99.9% are required.

The diagram to the left includes three towers in series that could be used for H<sub>2</sub>S and NH<sub>3</sub> removal, or a variety of other harmful gas combinations.