



HANDBOOK

Wet Scrubbers

Contents

Wet Scrubber Handbook

Introduction	3
Types of Wet Scrubbers.....	4
Which Wet Scrubber is Right for Me?	6
Wet Scrubbers at Work	6
Featured Product: The Impingement Plate Scrubber	7
How to Make Sure You Get the Right Wet Scrubber.....	8
Key Government Regulations	9
Key Challenges.....	10
Maintenance Checklist	11
Conclusion	12
Glossary.....	12

Introduction

If you're in the manufacturing or processing business, then you're likely polluting the air as a byproduct of your processes. That's why many manufacturers are concerned about plant air quality. Uncontrolled pollutants can lead to health problems for your workers, safety issues with your products, and even plant-wide shutdowns. To avoid these things, you must employ a means of air quality control.

Wet dust collectors, also known as wet scrubbers, are an increasingly popular type of air quality control for the industrial market. While both remove dust and particulates from your system, wet scrubbers operate quite a bit differently than their dry dust collector counterparts. Wet scrubbers filter out pollutants through the impingement process using water droplets. The smaller the droplet, the more efficient the wet scrubber. By the inherent mechanisms of their design, wet scrubbers can offer a few key benefits:

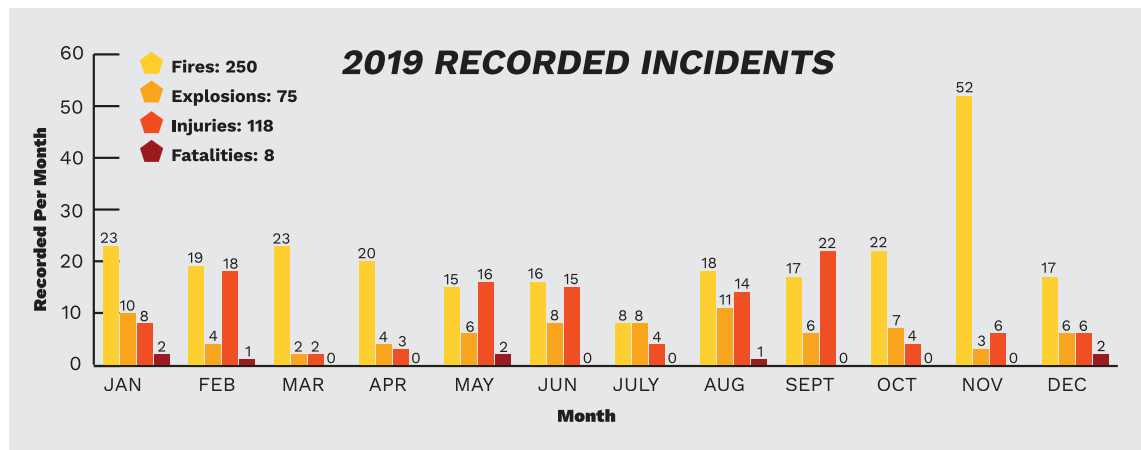
- *preventing free oxygen from directly interacting with particulate*
- *eliminating heat sources and dust clouds using water*
- *eliminating dust dispersion by aggregating dust particles within water droplets*

Together, all these features make wet scrubbers perfect for applications with light dust loading, as well as wet or sticky particulate. While the latter can easily clog or bog down baghouses and other forms of dry dust collection, wet scrubbers can keep on filtering out sticky particulate from your air streams with minimal downtime or system maintenance.

Today, the focus is on continuing to increase dust safety. By using wet scrubbers and other air quality control equipment, we're figuring out how to stop facilities from allowing dust levels to accumulate while increasing awareness and education across affected industries. Since preventing dust in the first place is practically impossible, this work boils down to better dust collection equipment.

Spotlight on Combustible Dust

By wetting your particulate, wet scrubbers effectively mitigate the risk factors for a dust explosion. Dust explosions occur when an ignition source causes the combustible dust that builds up in the air to combust rapidly. According to a Dust Safety Science report, in the US alone, a total of 175 fires and 37 explosions occurred relating to dust accumulation in 2019.



For more information, download our guide: [Using Wet Scrubbers for Combustible Dust](#).

Types of Wet Scrubbers

There are multiple types of wet scrubbers used in the modern industrial world, each with their own advantages and disadvantages inherent to their design. As the go-to source for industrial wet scrubbers, Sly offers four main designs.

Impinjet® Wet Scrubbers

Sly Impinjet wet scrubbers collect particulates within incoming airstreams as well as clean, cool, and absorb vapors and gases. Our unique perforated plate design with impingement baffle strips allows the Impinjet scrubber to collect ultra-fine particulate and absorb the harshest gases. Each scrubber stage acts as a discrete fractional collector. Often called “plate scrubbers” or “tray scrubbers” by systems designers, these Impinjet units are constructed in either metal or plastic and are available in multiple stage designs to maximize efficiencies. Their high collection efficiencies of 99% for particles at 5 microns or larger are achieved through low levels of water consumption and minimum pressure drop. The Impinjet wet scrubber is highly resistant to fouling, making it the ideal scrubber for applications that require both condensing and particulate removal. Airflow capacities are 200,000+ CFM.



Key Features

- Handles combustible dusts safely, without modifications
- High condensing and cooling efficiency for gases
- Multiple stages can be added to improve efficiency
- Water recirculation as low as 3 GPM per 1000 ACFM
- Emissions warranties available
- Low maintenance
- No moving parts
- Oversized access doors to service plates and sprays

Venturi Wet Scrubbers

Sly Venturi scrubbers efficiently use an atomized scrubbing liquid to collect fine particulate and mists. Their standard adjustable throats allow for performance optimization with designs available for high temperature, highly corrosive applications. Simple, yet highly efficient Venturi designs offer a non-plugging, trouble-free way to capture particulate in a scrubbing liquid. A flooded elbow arrangement collects agglomerated particulates and provides an abrasion-resistant barrier, reducing scrubber wear. Our designs incorporate features proven to maximize collection efficiency while also minimizing operating and maintenance costs. They can be coupled with Impinjet scrubbers to achieve maximum total efficiencies throughout your system. Capacities are to 76,000+ CFM per unit.



Key Features

- Handles combustible dusts safely, without modifications
- Collects fine particles and mists
- Adjustable throat permits fine-tuning to maximize efficiency
- High collection efficiency for sub-micron particulates
- Water recirculation is typically 8 GPM per 1000 CFM
- Pressure drops from 12" w.g. to 40" w.g.
- Emission warranties available

Eductor Wet Scrubbers

Sly's Eductor scrubbers are designed to remove soluble gases and particulate from a stream by inducing a gas flow using high-pressure liquid focused into a Venturi throat. This eliminates the need for a separate exhaust fan/blower to transport the contaminated airstream to the scrubber. These scrubbers can also be used for direct-contact condensation. Their high liquid flow rate makes them particularly well-suited for collecting sticky/gummy particulate or gases that decompose when they come into contact with water. Eductor scrubbers are often used in combination with other dust collectors like packed tower scrubbers.



Key Features

- Access door in tank
- Flanged inlet and outlet
- Integral recirculation reservoir
- Anchor lugs
- Lifting lugs

Packed Tower Scrubbers

Packed tower scrubbers, also called "packed bed scrubbers" or "packed column scrubbers," are designed for the chemical scrubbing of gaseous contaminants, often used to remove sulfur dioxide, hydrogen chloride, ammonia, and hydrogen sulfide among other gases. The internal packing in the scrubber's housing provides a large wetted surface area for close contact between the contaminated gas and the scrubbing liquid. When engineered correctly, packed tower systems can neutralize toxic gas streams, exhausting clean air into the atmosphere. Sly's custom packed tower scrubbers are engineered for specific applications for optimum tower diameter, packing depth, recirculation flow rate, and the appropriate mist eliminator style. Our scrubbers can be designed to handle a wide range of airflows, with both metallic and non-metallic constructions. Typical applications range from product recovery to air pollution and odor control.



Key Features

- Stainless steel, FRP, or high alloy construction
- Instrumentation and controls
- Exhaust fan
- Recirculation pump
- Chemical feed system

Which Wet Scrubber is Right for Me?

Choosing the right type of wet scrubber for your specific application is key to getting the most out of your dust control system. Use our matrix below to help you determine which type of wet scrubber is best for you based on the operating conditions of your application.

Conditions	Impinjet	Venturi	Eductor	Packed Tower
Combustible dust	✓	✓	✓	
Fine particulate		✓	✓	
Particles 5 microns or larger	✓	✓		
High capacity applications	✓	✓		✓
Chemical scrubbing				✓

Wet Scrubbers at Work

Venturi/Impinjet Combination Scrubber Removes HCl & Particulate from Aluminum Refining Furnace Exhaust

A great example of the power of wet scrubbers is how a Venturi/Impinjet combination scrubber was able to contain stack emissions to 99.999% efficiency from two aluminum furnaces and a small refining station at an aluminum plant. The combination scrubber system removed both hydrochloric acid vapors and particulate from the nitrogen gas streams the furnaces vented.

The Process

The scrubbers received hot gases (up to 1650°F) from the furnaces, utilizing an atomized scrubbing solution in the Venturi to make contact with the gas. The Venturi removed most of the particulate and acid gases and lowered the gas stream temperature to approximately 120°F.

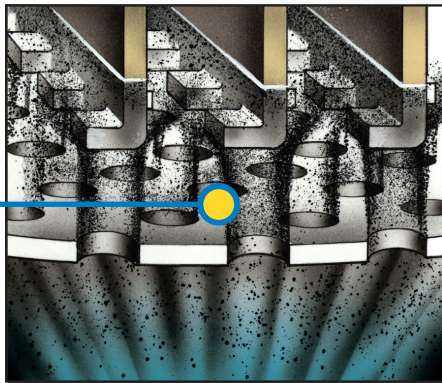
The acidic scrubbing solution then drained into tanks where it was neutralized. Most of the neutralized solution was then recirculated back to the Venturi scrubber, with only a small portion being continuously discharged to an effluent treatment plant.

The Sly Impinjet gas scrubber acted as the final polishing stage for acid gas removal. The scrubbed fluid gases are then vented back into the atmosphere using a tall stack.

Featured Product: The Impingement Plate Scrubber

Jet/Baffle Interface

Jets suck up liquid from the blanket of scrubbing fluid on the plate, creating a wetted target surface on the baffle. The constant, violent agitation of the blanket of scrubbing fluid prevents particles from settling on the plate and clogging the scrubber. Add more plates to reduce gaseous pollutants to any desired concentration.



Impingement Baffle Plates

Creates tiny water droplets that clean the contaminated gas by entrapping particles in the scrubbing liquid.

Plate Discharge and Seal Drain

Directs dirty water to bottom of scrubber for removal. A non-clogging seal prevents short-circuiting of gas.

Spray Section

Designed to cool the gas and entrap large particles. Non-clogging sprays wash the underside of plate and walls to stop material buildup.

Scrubber Outlet

When used for absorption, the scrubber's countercurrent operation helps ensure low outlet emissions.

Fixed Blade Mist Eliminator

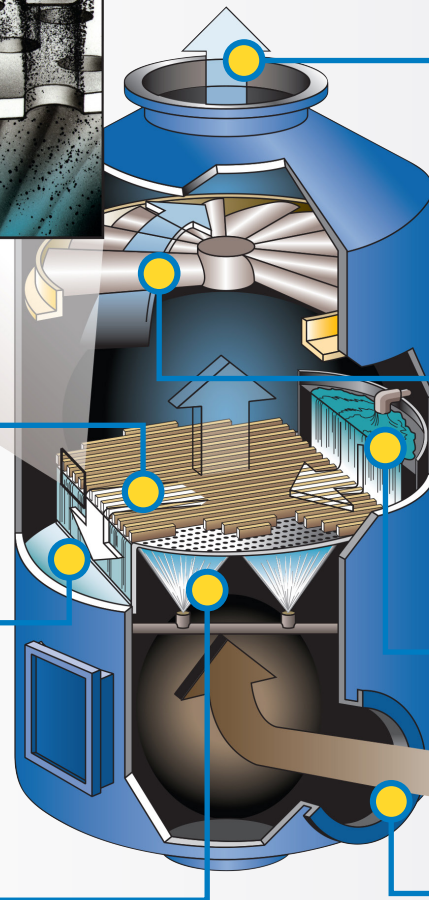
Assures droplet-free air gets sent back into the environment.

Adjustable Weir

Provides a uniform flow of liquid to keep the plate continually wet.

Gas Inlet

Contaminated gas enters through the inlet and passes through the spray section.





How to Make Sure You Get the Right Wet Scrubber

Finding the perfect scrubber is all about matching your equipment to your application and customizing it to fit your specific needs. That also means finding the right supplier. A good supplier will partner with you and continually work to make sure that your needs are met, even if the requirements of your application changes.

Here's what you need to keep in mind when choosing a wet scrubber and picking a supplier:

- **Choose a supplier with a long history in the air quality control business with experience specifically in your industry/application.** While many companies sell wet scrubbers and air pollution control equipment, only an experienced supplier can get you set up with the right scrubber. Not only must your supplier meet the requirements of your application, but they also need to have experience in designing systems that meet local emissions standards. At Sly, we have 150 years of experience helping customers across various industries find, design, and implement the most cost-effective solutions for their dust collection requirements.
- **Make sure your supplier is the OEM and not outsourcing their manufacturing.** Wet scrubbers aren't simple pieces of machinery. They require an in-depth understanding of wet scrubbing principles and an OEM that can control every step of the fabrication process.
- **Find a supplier with different types of wet scrubbers and the ability to customize equipment.** Not just any wet scrubber will do. Your supplier needs to be capable of designing, building, and customizing a variety of solutions. Here at Sly, we always make sure to fit the equipment to the customer's needs, not the customer to the equipment's capabilities. We do our own engineering, metal fabrication, painting, assembly, and quality control. That way, we have the design flexibility to control every step of the process.
- **Have your supplier understand your application's requirements and troubleshoot any problems.** Every application is different, with unique requirements and operational hurdles. Your supplier should have engineers on staff, not just to design your scrubber, but also to analyze your systems. Only with a careful, analytical eye can you find the right solution.
- **Choose a supplier that has dust analysis and particulate testing capabilities.** One of the most important parts of finding the right scrubber is to make sure that it can handle the specific contaminant in your facility. Your supplier should be able to perform a detailed particle analysis to understand the dusts and gases that your process produces. This involves measuring both bulk density and particle size distribution, each of which Sly offers.
- **Make sure that replacement parts for your scrubber are readily available and that you can perform ongoing maintenance.** Proprietary parts can keep you tied to a vendor. While Sly makes certain to customize our solutions specifically to your needs, our parts are still readily available. Your vendor should be able to get you set up with a system not only designed to stand up to your environment, but one also one where any replacement parts can be easily and quickly ordered when things inevitably need changed out or for routine maintenance.

Key Government Regulations

There are multiple agencies that work to regulate how industry goes about controlling dust. To stay compliant, and keep your plant operational, here are the top agencies and their governing regulations that you must abide by:

EPA

The biggest piece of government regulation on emission control in the US is the EPA's Clean Air Act (CAA). The Clean Air Act is a comprehensive federal law that regulates air emissions from both mobile sources, more for consumers and vehicles, and stationary sources, which directly affects industry. The CAA goes into more detail and provides emission limits for specific stationary sources. More info can be found [here](#).

To enforce these regulations, the EPA employs the CAA Stationary Source Compliance Monitoring Strategy. This provides national-level consistency in stationary source air compliance monitoring programs. In order to comply with the CAA, you must follow the regulations for your specific industry, as well as the general CAA standards.

OSHA

Like the EPA, OSHA has determined mandatory federal standards regarding dust hazards that you must follow to stay compliant and remain operational. Their general industry standards, [29 CFR 1910](#), provide a list of industry-wide and industry-specific regulations.

1910 Subpart G, Occupational health and environmental control, contains one of the most applicable standards to industry: [1910.94, Ventilation](#). Here, OSHA defines the need for dust collection equipment. They provide a thorough list of standards that you must follow regarding your air quality control equipment, as well as proper protocol for dust accumulation and timely removal.

NFPA

The National Fire Protection Association (NFPA) has issued their own Standard on the Fundamentals of Combustible Dust, referred to as NFPA 652. With a deadline of October 2020, the NFPA is set to conduct a Dust Hazard Analysis (DHA) on applicable industries. If you are creating or handling material/particulate that is combustible and/or exposable, then you need a DHA. A major focus of this analysis is to review your dust collection systems since they are a leading cause of combustible dust incidents. As such, the DHA will take a close look at the housing, hopper, inlet ducting, and outlet/return ducting of your equipment to make sure that high standards of safety are being followed.

What Happens if I Violate These Regulations?

More than just guidelines, these regulations are necessary to maintain the health and safety of your business, workers, and products. While the ramifications vary from one organization to the next, violating any of these regulations can lead to monetary fines, additional inspections, and even a shutdown of your plant. You also become more liable for operator illness/injury. Incidents can still occur no matter what you do, but failing to put your best foot forward here further risks the very life of your business.

Key Challenges

There are many challenges you'll face in your air quality control efforts. Here we detail the top challenges and how to face them head-on.

Worker Safety

If there are problems with your air quality control system, the operators in your facility are going to be the first ones affected. Workers who are exposed to certain respirable dusts are at an increased risk of developing serious dust-related diseases. For instance, respirable crystalline silica particles can travel deep into a worker's lungs which can cause silicosis, an incurable and deadly lung disease.

Preventing Explosions

Dust explosions and dust-related fires are going to be your biggest immediate concerns when dealing with a dust collection system. The five risk factors for an explosion are fuel (combustible dust), an ignition source, oxygen, a dispersion of dust particles, and the confinement of dust clouds. While dust collection systems are going to work to make your products and work environment safer, the dust collectors themselves are a likely place for an explosion to occur due to their inherent prevalence of these risk factors.

As such, your risk of an incident is directly influenced by the type of dust collection equipment that you have, along with the Kst value (the dust deflagration index) of your dust. Wet scrubbers typically have a lower risk of an explosion than dry dust collectors. The larger the Kst value of your dust, the more severe the explosion.

Testing Your System

To make sure your equipment is continually operating efficiently, it's best to run regular tests on your wet scrubbing system. This involves testing your equipment itself as well as analyzing the particulate that you're collecting.

Before selecting your wet scrubber, you need to analyze the dust you're going to collect. Understanding the characteristics of the dust that you're filtering starts with measuring bulk density and particle size distribution.

These measurements can be used to enhance the performance of your equipment. It's good practice to also perform a particle analysis whenever something changes with your process.

Sly offers particle analysis services to help you reach the most efficient and cost-effective pollution control solutions for your specific needs.

Sustainability

No matter how effective a dust collection system is, it must be sustainable for you to consistently make your plant a safer environment. To that end, you'll need to choose high-quality equipment and maintain it as best as possible, replacing any parts as soon as they break or become ineffective. You'll also need to design an energy-efficient system that can operate effectively in any condition you'll encounter.

Maintenance Checklist

Maintenance of your wet scrubber is critical for the safety of your workers and air pollution control. For optimal system reliability and performance, Sly recommends a consistent schedule of inspections and the timely repair of damaged or malfunctioning equipment. This checklist provides a sample periodic maintenance program for all styles of scrubbers that you can use as a guide to help tailor your own programs.

- 1. Structural Integrity:** Beyond affecting system performance, the structural integrity of your equipment can cause health concerns and reduce equipment life. A comprehensive inspection should be done annually, including welds, joints, and flange seals.
- 2. Auxiliary Equipment:** In addition to the scrubber itself, thorough system inspections include a check of all miscellaneous complementary equipment, including exhaust fans, rotary airlock valves, inlet/outlet dampers, etc.
- 3. Ductwork:** Ductwork allows particulate to reach the scrubber. Standard practices suggest a minimum airstream velocity within any duct of 3500 feet per minute (fpm), and between 4000-4500 fpm for heavier dusts like sand. If these velocities aren't reached, dust tends to accumulate in the ducts, choking the system. This increases the pressure drop in the system and its energy requirements, resulting in reduced air ventilation at the pick-up points. To prevent this, periodically inspect the entire length of your ductwork for accumulated dust and clean it out before it becomes a problem.

Key Issues to Monitor

No matter if you're checking the scrubber itself or any pretreatment or auxiliary equipment, common issues to look out for include:

- Duct or joint warpage
- Misaligned equipment
- Corrosion or abrasion
- Solids buildup or clogging
- Sump sludge
- Scaling
- Tears or leakage
- Abnormal pressure drops
- Unusual sounds during operation

Once you identify any of the above issues, you can work with the experts at Sly to find a quick and long-term solution. That way, you can ensure stable operations and a long product life for your scrubber.

Conclusion

To succeed in industry, you must maintain high levels of air quality control throughout your plants and facilities. Wet scrubbers can take advantage of the anti-explosion properties of a scrubbing liquid while still capturing and removing industrial particulate from your system, increasing safety and worker health. With the right scrubber, you'll be able to keep your operations running efficiently, effectively, and with minimal downtime. Our expert team at Sly is here and ready to help you select the right wet scrubber for your operation and customize it to best fit your needs.

Glossary

Collection Efficiency: The measure of a wet scrubber's ability to remove particulate from the inlet gas, typically expressed in percent or emission rate (grains per cubic foot).

Deflagration: Rapid burning through subsonic combustion.

Kst Value: The dust deflagration index, which measures relative explosion severity compared to other dusts. The larger the value, the more severe the explosion.

Particulate: Any airborne solid material.