Using Wet Scrubbers on Highly Combustible Dust

Presented by:
John Dauber – Handte Product Manager, Americas
John Davidson – Mid-South Regional Manager
Focus of This Presentation

• When should you use a wet scrubber?
• What are the disadvantages and advantages of wet collection over dry?
• What is a Venturi wet scrubber? What other types of wet scrubbers that can be used on combustible dusts?
• Efficiency of wet scrubbers when dealing with dry metal dust applications
• Process Hazard Analysis
• NFPA requirements when capturing metal dust with dust collection
• NFPA requirements when implementing with wet scrubbers
• NFPA requirements when implementing with dry dust collectors
• Water requirements for wet scrubbers
• System design, installing and purchasing equipment
When to use a wet scrubber

Metal Industry
- Carbon Steel
- Chromium Steel
- Stainless steel

Non-Ferrus Metal Industry
- Titanium
- Aluminum/Magnesium
- Tin
- Copper

By processing with:
- Grinding (manually at grinder bench/grinding machine)
- Fettling (manual fettling)
- Brushing (manually at brushing bench/brushing machine)
- Drilling (manually/machine tools)
- Cutting (Cutting machine)
- Manual Blasting (small blasting plants)
Scrubber Installations (application examples):

Metal industry grinding stainless steel

Automotive aluminum cast fettling
Scrubber Installations (application examples):

Automotive exhausting curing caven
Scrubber Installations (application examples):

Medical grinding titanium parts

Tool polishing system

Piping company
(work table grinding, aluminum)
Wet vs. Dry Collection

- Dry collection should be your first choice
- Wet collectors require more maintenance and typically more horsepower, sometimes double
- Efficiency is much lower on wet collectors when dealing with 10 micron and smaller particles
- Wet collectors require clean water, concentration of dust particulate must be below 5% by volume
- Wet collectors can be used where dry collectors do not meet NFPA standards, such as combustible metal dusts: aluminum, titanium, magnesium (the “iums”)
- Wet collectors work well on light loadings
- Wet collectors can handle sticky dusts
- Wet collectors require less protection equipment to meet NFPA standards
Venturi Scrubber

- For fine and medium particle sizes 10 micron and larger
- Max. Load: 1 Grain Per Cubic Foot (expected loading .04 Grains Per Cubic Foot)
- Total Emissions: .002 grains cubic foot
- Pressure drop: 10“ W.C.
- Venturi Inlet Dust separation
- Venturi water supply by dedicated pump
- Water cyclone for droplet separation
- The faster the air travels through the Venturi the more efficient the collector becomes due to mist particles becoming finer as velocity increases
- Design air flow must be maintained or the efficiency will drop with air flow
Wet Scrubber Types

Vortex scrubber with built-in fan - higher collection capacity via additional impact with fan impeller

Vortex scrubber with attached fan for collection of fibers and lint

High-performance wet collector with Venturi principle for particles up to 0.3 µm and high dirty gas loads

If dust floats and does not settle in the hopper, special skimmers may be needed to provide clean water for to maintain high efficiencies.
Several Wet Collector Technologies Available

Be sure the manufacturer warranties the efficiencies of the collector based on your dust. Dust should be tested for particle size distribution which can greatly effect the efficiencies of the collection device.
Wet Scrubber Efficiencies

- Simple baffle design – 90% @ 3 micron
- Complex Baffle design – 95% to 99% @ 3-5 micron with mist after filter
  - Depending on manufacturer
- Whirl type scrubbers - 95% efficient @ 2 micron
- Centrifugal – 99% @ 3 micron mechanical
- Venturi – Up to 99% @ 1 micron and greater than 50% on submicron particles
  - Can cost you some HP greater the efficiencies
- All depends on application and constant air velocities through equipment
  - Secondary filtration can be used to maintain proper efficiencies, please refer to NFPA 484
  - A sample analysis can be determined in particle size and volume distribution to help select the proper equipment. Ensure you select a proper manufacturer that can analyze the dust and provide a report.
NFPA 484 – Metal Dust Requirements

Chapter 5 – Process Hazard Analysis

• **CAMFIL APC’s OFFICIAL POSITION ON PROCESS HAZARD ANALYSIS (PHA)**
  
  – If a customer does not want to follow the Process Hazard Analysis and Risk Assessment requirements of NFPA then we will adhere strictly to the prescribed controls in the standards.
  
  – Recorded Webinar on PHA on BLR website (also in today’s Resource List Widget)
    
    http://w.on24.com/r.htm?e=968065&s=1&k=2EACBBBD2E2FCDD7D6796A9579A32E88&partnerref=CamfilSeptWebinar
  
• The design of the fire and explosion safety provisions shall be based on a hazard analysis of the facility, the process, and the associate fire and explosion hazards

• The results shall be documented and maintained for the life of the process with a review and update at least every 5 years

• Prior to operation:
  
  • New and/or altered operations, equipment, and/or facilities shall be reviewed for potential hazards
  
  • Written record shall be maintained of all hazard analyses conducted

• Cognizant authority at the facility signs off on PHA & Implement appropriate safe guards

• Corrective actions as a result of the hazard analysis shall be tracked and completed to ensure they have been abated or that the level of risk has been reduced to a tolerable level by a knowledgeable authority
NFPA 484 – Metal Dust Requirements

Chapter 9 – Common Items for both systems

• Implement a hazard analysis

• Machines that produce combustible metal shall have the following:
  – Hoods, capture devices, or enclosures around the equipment
  – The system shall be designed to capture and transport all the dust produced to a dust collector.

• Hoods and enclosures shall be designed and maintained
  – Fine dust goes into hood, heavy dust falls out
  – The interior of the hoods and ducts shall be regularly cleaned
  – Be aware of wax buildup, lint, metal fines, or other combustible material

• Special attention shall be given to the location of all dust producing machines with respect to the location of the dust collection system or other machinery in the area.
  – Example: Sanding or grinding area near an oven

• Dust collection systems shall not be used to collect incompatible materials
Clean air solutions

NFPA 484 – Metal Dust Requirements

Chapter 9 – Common Items for both systems

• The duct work design should maintain a minimum constant velocity. (inlet & exhaust)
  – Short, straight ducts reduce the explosion hazard and minimize the likelihood of accumulations of dry dust. (beware of material accumulations)
  – Ensure the duct design has smooth internal ledges and does not have any sheet metal screws in the construction of the duct
  – If your application requires a duct work design that has additional elbows and long straight runs to mitigate sparks, ensure the fan is designed to handle the additional resistance and ensure this is stated on the risk analysis

• Evaluation of the duct work system: (keep on file)
  – Branch ducts shall not be disconnected
  – Unused portion of the systems shall not be blanked off

• Duct systems, dust collectors, and dust producing machinery shall be bonded and grounded

• If unit is placed inside, exhaust the air outside:
  – The exhaust vent shall terminate to a safe location outside the building (wet)
  – Recirculation of exhaust air from a dry-type dust collector into the building shall be prohibited (dry)

• Common practice: fan should be on the clean side of the system
NFPA 484 – Metal Dust Requirements

Chapter 9 – Wet Scrubbers

• The clean air shall not be permitted to returned to an identified deflagration hazard area
  – The clean air can be returned, concerns hydrogen and particulate matter, you need third party testing

• The exhaust vent duct shall be inspected and cleaned frequently to prevent buildup of highly combustible deposits of metal dusts on the interior surfaces of the duct.

• The dust collector shall be arranged so that the dust-laden airstream is thoroughly scrubbed by the liquid to achieve the desired efficiency. The use of an additional dry filter medium either downstream or combined with a wet collector shall not be permitted
  – If needed please refer to NFPA 484
NFPA 484 – Metal Dust Requirements

Chapter 9 – Wet Scrubbers

• Wet-type dust collectors shall be designed so that hydrogen generated from metal contacting the water is vented out at all times
• Vents shall remain open and unobstructed when the machine is shut down
  – Review your inlet and exhaust duct work design to ensure hydrogen is not stored
• When the dust collector is not in operation, ventilation shall be permitted to be provided by an independent blower or by an unimpeded vent
• Each chamber of the collector shall be vented to dissipate hydrogen
NFPA 484 – Metal Dust Requirements

Chapter 9 – Wet Scrubbers

- Sludge level buildup in the sludge tank shall not exceed 5 percent of the tank water capacity as measured by volume.
- Sludge will be removed from container > 24 hours.
- The power supply to the equipment shall be interlocked with the airflow exhaust blower and the liquid-level controller so that improper functioning of the dust collection system will shutdown.
- A time delay switch or equivalent device shall be provided on the dust-producing equipment to prevent the start of the dust producing process until the collector is in complete operation.
NFPA 484 – Metal Dust Requirements

Chapter 9 – Wet Scrubbers

• Condensing moisture might cause material to stick to ducts and can exothermically react with most combustible metals generating hydrogen
  – Clean and inspect the exhaust duct

• The humid air of the wet-type dust collector wets the fine particulates that pass through the collector so that the particles agglomerate and tend to build up a highly combustible cake or sponge like deposit on the inner wall of the exhaust duct.
  – TSA tube mill application
NFPA 484 – Metal Dust Requirements

Chapter 9 – Dry Media

• Media collectors shall not be permitted unless the combustible dust Kst is less than 150bar-m/s and the following requirements are met:
  – Media collectors shall not be used for dust being collected in air for metals covered by chapters on niobium, tantalum, titanium, zirconium, and hafnium unless their use is supported by a risk assessment that is acceptable to the AHJ
  – Media dust collectors shall be provided with all the following ignition prevention measures:
    • MIE of the dust is less than 1000mJ, static draining filters
    • Accumulations of on filter media are limited to the levels below the thresholds for any oxidative self-heating ignition and any possible ignition due to the exothermic reaction with humid air. These thresholds shall be determined as part of the dust collection risk analysis conducted in accordance with section NFPA 484-5.2
    • Filter differential pressure to be monitored, if the accumulation of dust exceeds the predetermined limits, a controlled shutdown of the collector and dust generating equipment shall be implemented
    • Periodic inspections and replacement of media shall be based on intervals determined by the pressure drop across the filter media or by indication of self-heating detection equipment based on moisture reactivity
NFPA 484 – Metal Dust Requirements

Chapter 9 – Dry Media

• Install spark detection and either extinguishing methods or methods of diversion away from the collector

• The collector design shall prevent the accumulation of hydrogen due to a metal-moisture reaction

• Indoor dry-type dust collectors shall be permitted for the following metals:
  – Aluminum, magnesium, steels, and misc.

• Indoor dry media:
  – Self-contained, dry down draft benches shall be prohibited
  – Dry-type dust collectors shall be permitted to be located indoors where the following requirements are met:
    • A hazard analysis shall be conducted in accordance with section 5.2 to ensure that the risk to personnel and operations is minimized for both new and existing equipment
    • The Pmax < 8 bar-g & the Kst <150 bar-m/s
    • The minimum ignition energy (MIE) is greater than the 100mJ
    • The material is not a UN Class 4.2 solid
NFPA 484 – Metal Dust Requirements

Chapter 9 – Dry Media

• Indoor dry media:
  • Enclosure-less collectors shall be prohibited
  • Fire Protection - The requirements for fire protection for indoor dry-type dust collection systems shall apply retroactively
  • An automatic fixed fire suppression system shall be provided with a fire extinguishing agent that has been shown to be effective with the material collected for indoor collectors
  • An Automatic fixed fire suppression system shall not be required where the amount of material collected is less than 1lb combustible metal and the dust collector is emptied after each day or operation
  • Collected material shall not be stored in the collector, but shall be continually emptied from the collector into a sealed metal container through an isolation device in accordance with NFPA
NFPA 484 – Metal Dust Requirements

Chapter 9 – Dry Media

- Indoor dry media:
  - Media collectors shall contain a filter break detection system that automatically shuts down the collector and connected equipment if a filter break is detected.
  - The collector exhaust duct shall exit the building using as straight and short a path as possible.
  - The collector inlet duct, exhaust duct, and blower shall be inspected at least every 6 months to ensure that the material is not accumulating.
  - The collector exhaust duct located inside the building shall use one of the following deflagration protection methods:
    - Deflagration pressure containment in accordance with NFPA 69
    - Deflagration isolation in accordance with NFPA 69
NFPA 484 – Metal Dust Requirements

Chapter 9 – Dry Media

• Indoor dry media:
  • The collector shall include a data plate listing the type of combustible metal dust that the collector is designed to collect the following:
    – Metal collected by the collector, Pmax & Kst, the minimum MIE of dust
    – A visible warning label that collecting other materials can create a fire or explosion hazard
    – The collection of any metal other than metal for which the system was designed to collect shall be prohibited
    – If other materials are to be collected, the modified process shall first be reviewed under management of change to ensure the requirements of this chapter are maintained
  • If the material does not meet both of the following criteria, the additional requirements will apply:
    – The material is not a UN Class 4.3 solid as tested using UN 4.3 water reactivity test methods
    – Water has been shown to be an effective extinguishing agent

Media collectors should include automatic cleaning of filters, and the pressure drop across the filter shall be continuously monitored and alarms activate if the pressure
Dry Cartridge Dust Collector

- Particle sizes sub micron
- Max. Load: 50 Grains Cubic Foot
- Total Emisions: .001 grains cubic foot
- Pressure drop: 4“ W.C.
- Channel baffle pre cleaner
- Pulse jet cleaning system
- Efficiencies are not effected by variable airflows
Passive vs. Active Controls on Dry Collectors
Water Level Control

- Mechanical water level control (WR)
- Electro-magnetic level control (FRM) (Preferred for Combustible dusts)
Design, Installing and Purchasing of Equipment

Compare manufacturing brands
• Efficiency guarantee
• Manufacturer’s warranty
• Local service
• Quality of product
• Knowledge of NFPA
• Hood, capture device, or enclosure design
  – A bad hood or duct work design can ruin the whole project
• Research lab to test the dust sample
Thank you for your attention!

Any questions?
Disclaimers

*This webinar is designed to provide accurate and authoritative information about the subject matter covered. It is sold with the understanding that the publisher is not engaged in rendering legal, accounting, or other professional services.

*This webinar provides general information only and does not constitute legal advice. No attorney-client relationship has been created. If legal advice or other expert assistance is required, the services of a competent professional should be sought. We recommend that you consult with qualified local counsel familiar with your specific situation before taking any action.