

**FUNDAMENTALS**  
**of**  
**OPERATIONS and MAINTENANCE**

- \* Air Pollution Control Systems**
- \* Dust Collection Systems**
- \* Related Equipment**

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## INTRODUCTION

The information presented in this manual is intended to familiarize the reader with the various factors entering into the filtration process as it is applied to the removal of solid particulate matter encountered in industrial dust control systems and air pollution control systems.

The most versatile piece of equipment available for the removal of solid particulate matter from an air or gas stream is the fabric dust collector. These collectors are over 99% efficient in capturing particulates with a median size of one micron (one-millionth of a meter). As a layer cake of dust builds upon the exterior surface of the bag, the efficiency of the collector is actually increased. This occurs because particles that once could penetrate the bag fabric cannot find an opening in the dust cake.

## FUNDAMENTALS

The following information is presented to familiarize operating personnel with the basic fundamentals of dust collection systems so that all of the components in a system may be used to their maximum efficiency. This maximum efficiency is assured only when all of these components are functioning in accordance with their original design criteria. A malfunction of a single component could not only result in an inefficient system but also an inoperable system.

The original detailed engineering drawings prepared for system installation should be filed for future reference. The data contained on these drawings should be studied by operating and maintenance personnel until they become familiar with the general arrangement of all of the system components: hoods, ductwork, cyclones, fans, baghouses (fabric filters), airlocks (rotary valves), screw conveyors, and other related equipment. After installation and start-up, the system will be balanced by the installation contractor. This is accomplished by adjusting dampers (or blast gates). The purpose of this procedure is to adjust the flow of air in each branch in order to assure both an adequate capture velocity at every hood and an adequate conveying velocity in every line. After the initial balancing of the system has been completed and the system is performing at a maximum efficiency, the blast gates should never need adjusting. Perhaps the most common problem encountered in dust control systems today occurs when operators rush to readjust the position of blast gates as a solution for an improperly performing system. This is due most often to either a lack of knowledge concerning the design of the system or a lack of following basic troubleshooting procedures. Readjusting blast gates may alter the effect of a problem rather than addressing the source of a problem. Proper troubleshooting techniques will be discussed later in this manual.

The basic fundamentals of a system consist of the following:

- A. System Fan and Motor. A proper size and type of fan are designed for each individual system. Also, the proper motor speed and horsepower are likewise selected. The fan is the "work horse" of the system. It develops the necessary power and movement of air through the system and its components to provide the desired volumetric flow rate at each hood and pick-up point.
- B. Dust Collector. A baghouse (fabric filter) utilizes a fabric media to

entrain dust, contains an independent fabric cleaning mechanism, and discharges the collected dust to a discharge point.

C. Cyclone. A cyclone is a mechanical device fabricated in the shape of a cone, whereby through centrifugal force, heavier particles are separated from the air and are discharged at a single point on the smaller end of the cone. Since a cyclone is less efficient than a baghouse, cyclones are sometimes used prior (upstream) to the baghouse to separate the heavier particulates from the airstream. Cyclones can be used alone without an after filter; however, the efficiency of a cyclone alone is sometimes as much as twenty percent lower (in terms of the mass particulate matter collected) than that of a baghouse.

D. Airlocks. Also called rotary valves, airlocks serve as a seal between filter (or cyclone) and the discharge method used (screw conveyor, pneumatic conveying system, or a simple gravity free-falling spouting assembly). Airlocks maintain a pressure differential between filter and discharge device.

E. Ductwork. Round or rectangular pipe is used to convey air from pick-up points or hoods through a main branch into a fan, cyclone, or filter.

F. Hoods. Hoods are specially designed mechanical devices located at a ductwork inlet, creating a sufficient shape and size opening to capture a maximum amount of undesirable dust and a minimum amount of valuable product.

## OPERATIONS

The basic operation of any air pollution control or dust control system using a baghouse or fabric filter is as follows:

- A. Dust-laden gases enter into hoods by the negative (vacuum) pressure created by the system main fan.
- B. Dust-laden gas travels through all sub-main and main trunk ductwork leading into a pre-separator cyclone (upstream from filter). The cyclone separates the heavier particulates and discharges the collected dusts out the bottom through an airlock to a dust discharge system such as a screw conveyor, a pneumatic conveying system, or simply a gravity free-falling spouting pipe. All discharge techniques usually transfer collected materials according to the desired location of the user.
- C. The discharge gases travel out the top of the cyclone and are ducted into the inlet of the filter. As the lighter, dust-laden gases enter the filter, a deceleration of particles striking the inside surface of the cone section causes the heavier particulate matter to drop from the airstream into the cone discharge and through an airlock, beyond which they are conveyed away in the same manner as the cyclone described above.

The swirling cyclonic action of air in the inlet and cone sections creates a low pressure area in the center of the filter. The lighter, cleaner gasses in this area form a vortex and rise into the upper bag area. As the cleaner air is forced through each bag, the remaining airborne particles are filtered from the airstream as they contact the fabric of the bags. When the impingement on the bags has increased to a sufficient amount, a pressure drop occurs between the dirty side (usually outside) of the bag and the clean side (usually inside) of the bag. This pressure drop is required for the efficient operation of the filter, as when the pressure drop increases, the filter is capturing virtually 99.9 % of the dust. This pressure drop is natural and desirable to the extent that it does not increase to a point that the design of the system fan and motor is not overcome. Defined as differential pressure (or "delta" P), the pressure drop across the filter bags is measured by a Magnehelic gauge in units of inches on the water gauge (1.00 PSI = 27.71" WG). The differential pressure of a properly functioning fabric filter ranges from 2 1/2 inches to 6 inches.

- D. Although all baghouses are similar in how they clean the air

passing through the unit, they differ according to the self-cleaning method used. Compressed air filters use sequence controlled, high pressure compressed air to blast downward through the center of each bag, causing a ripple or pulsating effect on the bag. This pulsating bag is able to dislodge the cake of dust collected on its dirty (outer) surface. Reverse air filters use an internal pressure fan and motor arrangement rotating a cleaning arm mechanism over the bags. By blowing a large volume of air backwards through each bag for a brief period of time, the dusts clinging to the dirty (outer) surface can be removed. A third type of baghouse, the shaker filter, contains at least one motor, a cam, and all linkage necessary to connect the tops of all the bags. The dust cake collected on the dirty (inner) surface of the bags is loosened in this shaking process.

## MAINTENANCE

A properly operating, continuous cleaning filter is the heart of any dust collection system. When a change is noticed in the ability of the system to remove dusts from the process facility, the filter may be the best place to begin troubleshooting. The mechanical operation of the filter should be checked immediately by referring to the installation, operating, and maintenance manual of the filter. If no mechanical malfunction is found, the general appearance of the bags should be checked. The bags normally operate with a thin coating or cake of dust, but a large quantity of moisture present in the unit may cause this dust cake to become excessively thick or hard. If this occurs, the automatic cleaning mechanism will not be able to clean the bags down to the normal operating range (2 1/2" to 6" WG). The differential pressure across the bags will slowly and steadily increase, possibly resulting in a complete system failure due to the overloading of the motor on the main exhaust fan.

A. When the condition is due to excessive caking of the bags, they should be removed, properly cleaned and re-installed. The filter bags are made of a variety of materials; however, synthetics are more commonly used now which allows them to be laundered. Caution is advised that the laundry selected is familiar with this type of material and can effectively clean and dry without excessive shrinking. After re-installing the bags and re-starting the system, the pressure drop readings on the Magnehelic gauge should be checked. If the tubes have been properly cleaned, the pressure reading should be quite low, perhaps 1" to 2" WG. If the differential pressure reading is still too high (8" or above), then the entire set of bags should be replaced since they have most likely become blinded (non-porous) due to a complete saturation of all the interstices within the weave of the cloth with dust and particulates.

B. It is recommended that one individual be assigned to monitor the operation of the dust collection system. A weekly recording of the Magnehelic gauge reading on each filter will allow one operator to set up a pneumatic maintenance schedule for tube cleaning or other routine maintenance work when and if changes are noticed in these readings, or in the sound level of fans or other rotating equipment. This individual should become familiar with the maintenance manual for routine maintenance and troubleshooting. A maintenance schedule should be in accordance with the number of hours the system is in operation. Suggested maintenance intervals are recommended as follows:



Daily

1. Check pressure drop reading on Magnehelic gauge.
2. Check air exiting the clean-air plenum for the presence of dust.
3. Check filter hopper to ensure product is discharging properly.

Weekly

1. Record pressure drop across filter on Magnehelic gauge.
2. Check fan, fan motor, and bearings for excessive noise or heat.
3. Check rotary airlock, its motor, and bearings for heat and excessive noise. Check pump within the high pressure pneumatic conveying system for vibration, overheating, and lubrication level.
4. Check reading on pressure gauge and compare with previous readings. Check the air inlet to the filter and replace or clean when necessary.

Monthly

1. Check oil level on all gear reducers. (CAUTION: Do not overfill. The recommended interval for this procedure may vary according to manufacturer.)

Quarterly (every three months)

1. Check V-belt tension on all fans. Adjust as required.

## SAFETY

Only experienced personnel should be assigned to maintaining and troubleshooting the equipment. The dangers presented by high voltage, moving parts (in fans, airlocks, and screw conveyors), and air blasts (blowing open unlatched access doors) could result in severe injury or death. Please observe the following safety guidelines:

1. Turn off, disconnect, and lock out power to the piece of equipment upon which service is being performed. Also, turn off and lock out all electrical disconnects for all associated and auxiliary equipment.
2. Do not touch the outer surface of any motor housing until the motor has been turned off and allowed to cool for at least thirty minutes.
3. All access doors must be closed before starting the system.
4. If for troubleshooting or repair purposes it is necessary to run the system fan with duct work disconnected or with access doors open, clear the affected areas of unauthorized personnel and seal the area with guards or warning signs.

TROUBLESHOOTING

PROBLEM	POSSIBLE SOURCE
1. Abrupt rise in Magnehelic gauge reading.	1. Bags plugged; bag cleaning mechanism not functioning.
2. No Magnehelic gauge reading.	2. Gauge tubing plugged; fan off.
3. Dust in clean air outlet.	3. Bag bursted, torn or missing.
4. Filter hopper plugged.	4. Debris over discharge; airlock not operating.
5. No air flow.	5. Fan not running; V-belts broken.
6. Main fan motor overload.	6. Filter plugged; bags blinded; cleaning mechanism not operating.
7. Airlock motor overload.	7. Obstruction in airlock.

AIRCON CORPORATION GLOSSARY OF TERMS

abrasion, flex: An area of cloth that has worn away in a creased area due to repeated or excessive bending.

abrasion, surface: An area of a cloth surface that has worn away uniformly due to rubbing, scuffing, or erosion.

absolute zero: The temperature characterized by the complete absence of heat in the form of molecular kinetic energy, equal to  $-273.15^{\circ}\text{C}$  or  $-459.67^{\circ}\text{F}$ .

absorption: A process by which soluble gases are dissolved from an airstream into a liquid.

acfm (actual cubic feet per minute): The measurement of the volumetric flow rate of a gas, without regard to the temperature and the pressure of the gas.

ACGIH (American Conference of Governmental Industrial Hygienists): A professional society responsible for setting standards for the air pollution control industry.

acid deposition: Acidic compounds in the atmosphere formed from industrial emissions, especially those containing nitrogen and sulfur. These compounds may combine with moisture in the atmosphere to form acid rain.

adiabatic process: Any process in which there is no net heat gain or loss.

adsorbent: Any substance that has the ability to pull gaseous pollutants out of an airstream by the process of adsorption.

adsorption: The adhesion of a thin layer of molecules of a gaseous pollutant to the surfaces of solid or liquid bodies.

aerosol: Solid or liquid particles, with a diameter of one micron or less, suspended in air or gas.

air contaminant: Any impurity of any phase (solid, liquid, or gas) allowed to pass from a manufacturing or conveying

process into the atmosphere.

air, dry: In psychrometry, air containing no water vapor.

air horsepower: The power output of a fan or blower; the power transmitted to the airstream from a fan or blower; the theoretical power required to operate a fan if the fan is operating at 100% efficiency without any losses.

air leakage: Excess air entering into a negative pressure (suction) exhaust system through holes or loose seals.

air monitoring: The sampling of the concentration of certain air pollutants at regular intervals over a period of time.

air pollution: The presence of any substance in lower levels of the atmosphere, other than moisture, in concentrations high enough to adversely effect the health of any living organism. Air pollutants include suspended dusts, aerosols, fumes, or any gaseous compounds (usually sulfur, nitrogen, or carbon) that result from a manufacturing process.

air quality criteria: The maximum allowable concentration and time of exposure of a certain air pollutants that is considered by the Federal government to be nonhazardous to the health of exposed workers.

air, standard: Dry air at a temperature of 70°F and a barometric pressure of 29.92" Hg, corresponding to a density of approximately 0.075 lbs/ft<sup>3</sup>.

air-to-cloth ratio: The volumetric rate or capacity (cfm) of a fabric filter divided by its cloth area (square feet); corresponds to the average filtration velocity (fpm) of the filter.

air toxics: Any air pollutant for which there is no safe maximum concentration; substances for which the risk of adverse health effects of exposure are high. The health problems associated with air toxics in humans may include cancer, disfunctions of the nervous system, and hereditary gene mutations.

anemometer: An instrument for measuring the velocity of air or gas.

APC: Air Pollution Control.

aromatic: A type of hydrocarbon, characterized by the presence of at least one benzene ring, often used as an additive to gasoline to increase its octane rating.

ASTM (American Society of Testing and Materials): A professional organization responsible for establishing engineering codes and standards.

atmospheric pressure: The absolute pressure exerted by the atmosphere as measured with a barometer.

attainment area: Any area which has attained or has exceeded the government air quality standards for any given

pollutant. Such an area may be an attainment area for certain types of air pollutants but not for other types.

attrition: The creation of dust as the result of collisions among larger particles.

backwash: See reverse air cleaning.

BACM (Best Available Control Measure): The method recommended by the EPA for reducing the amount of air pollution created by a given source.

bag (also stocking or tube): A long and narrow cylindrical shaped piece of fabric used as a filtering element, collecting a dust cake either on its outside or inside.

baghouse: Any filter or bin vent that cleans air by collecting dusts on the surface of fabric bags as the air is forced to pass through the bags.

bin vent: A small filter set on top of a large containment bin that aspirates dusts and fumes created by the transport of material in or out of the bin.

blast gate: A sliding plate installed in a supply or exhaust duct at a right angle to the flow of air for the purpose of regulating the volume of air flow.

bleed: The quantity of particulates that escape through the filter media into the clean-air section of the baghouse.

blinding (or plugging): The loading, or accumulation, of a dust cake on a filter bag to the degree that the dust cake cannot be discharged by the cleaning mechanism of the filter. The efficiency of a baghouse with blinded bags is significantly diminished due to a sharp increase in the static pressure drop of the air passing through the bags.

blowpipe (or manifold): In compressed air baghouses, a pipe in the plenum section that runs horizontally several inches over the tubesheet with a hole over each bag; responsible for distributing the compressed air pulses to each bag.

brake horsepower: The input power required to operate a fan or blower; includes all internal losses within the fan but does not include losses in the drives between the motor and the fan.

bridge: A blockage of material across an opening, such as across the discharge of a holding chamber; usually results from a build-up of dusts on the chamber walls under moist conditions.

British thermal unit (Btu): The amount of heat required to raise one pound of water (at a temperature of 60°F and a pressure of one atmosphere) by one Fahrenheit degree.

CAAA (Clean Air Act Amendments): Legislation passed by the United States government in 1990 to supplement previous emissions standards.

caking: A layer of dust accumulation on the exposed surface of the filter media in a baghouse. While a thin layer of dust may be beneficial, severe caking is similar to blinding since neither condition can be corrected under the normal operation of the filter. Blinding is often caused by a high amount of humidity inside the baghouse.

can velocity: The air velocity within a baghouse, determined by dividing the baghouse air volume capacity (cfm) by the cross sectional area of the baghouse (in square feet).

capture velocity: The air velocity at a hood entrance

required to pull dust or waste products into the system.

carrying velocity (or transport velocity): The air velocity in a duct required to keep the transported material suspended, usually between 3800 and 5600 fpm, varying according to the type of material being conveyed.

cartridge filter: A filter that cleans air using removable sections or cartridges each containing hundreds of small pleats or envelopes.

CAS (Chemical Abstracts Service): A registry in which a number is assigned by the American Chemical Society to every common chemical compound.

cellplate: See tubesheet.

centrifugal collector: A mechanical collector. (See collector, mechanical.)

CFC (chlorofluorocarbon): Any one of a group of hydrocarbon compounds containing both chlorine and fluorine, including all compounds which fall under the tradename of freon. CFC's are easily liquified and are used widely in refrigeration, packaging, and manufacturing aerosol propellants. Although CFC's are not air toxics, the chlorine compounds released by CFC's have been suspected of destroying the ozone layer in the upper atmosphere.

cloth: A term used commonly to describe a woven textile fabric, but may be used to describe any pliable fabric that is woven, knitted, or felted from any type of fiber or wire.

COH (coefficient of haze): A measurement of the reduction in visibility due to haze, smog, or air pollution.

cold spot: A noninsulated section of an insulated baghouse, so named because this section of exposed metal is able to dissipate heat much more rapidly than the rest of the unit.

collecting efficiency: The dust collecting ability of a cyclone, filter, or baghouse, expressed in percent. This figure is obtained by determining the difference in



material concentration between the air entering a collection device and the air leaving the same device, with this difference divided by the material concentration of the inlet air.

collector, dust: Any filter, baghouse, or cyclone in a system used to capture or collect materials from the airstream.

collector, mechanical: Any device that has no moving parts and uses only the centrifugal force of the inlet gas to remove large particulate matter from the airstream. Mechanical collectors that use water to aid in this process are called scrubbers. Dry mechanical collectors are called cyclones.

concentration, dust: See dust loading.

condensation: The process of changing matter from a vapor state into a liquid state, usually by the extraction of heat.

conduction: The transfer of heat between two objects in physical contact or within one object by means of molecular activity without the movement of mass.

convection: The transfer of heat due to the mass movement of a fluid.

corrosion: Deterioration or physical degradation due to chemical action.

CTG (Control Techniques Guideline): Documents published by the EPA recommending what types of equipment and technology are best suited to deal with a source of air contamination.

damper: An adjustable plate installed in a duct for the purpose of regulating air flow.

dehumidify: To reduce by any process the quantity of water vapor.

delta P: Any pressure difference, often used to describe a static pressure drop that occurs across a piece of

equipment in a system, such as a baghouse.

density: The mass of a unit volume of a substance, usually expressed in pounds per cubic foot.

density factor: A ratio of the measured air density to the density of standard air (approximated at 0.075 lbs/ft<sup>2</sup>).

dew point: See temperature, dew point.

diaphragm valve: A pneumatically operated valve that allows a pulse of compressed air to travel from the header to the blowpipes in a compressed air baghouse.

diffusion: The scattering of a gas or an aerosol in the air in all directions due to molecular collisions rather than to the wind or the flow of the airstream.

DOP (acronym for dioctylphthalate): An aerosol (with a particle size of 0.3 microns) used to test the efficiency of a baghouse.

dry collector: Any cyclone, baghouse, filter, or electrostatic precipitator that does not use water as a means of filtration; includes any air filter that is not a scrubber.

dscfm (dry standard cubic feet per minute): The calculated flow rate of an airstream given the same mass flow rate at a temperature of 70°F and a pressure of 14.7 psia with all of the humidity in the air removed.

dust: Solid particles having a width between 1 micron and 100 microns, created by the collisions of larger particles.

dust loading: The weight of solid particulates suspended in an air or gas stream, usually expressed in terms of grains per cubic foot, grams per cubic meter, pounds per thousand pounds of gas, or parts per million.

dust permeability: A quantity describing the mass of dust (grains) per square foot of cloth filtering media divided by the resistance (pressure drop in inches wg) per unit of filtering velocity (in feet per minute). This term is not

to be confused with cloth permeability.

**effective stack height:** The elevation at which the plume (gas discharge) begins to travel in a horizontal direction; equal to the height of the smoke stack plus the vertical plume rise.

**effluent:** A general term describing any type of liquid or gas discharge or emission.

**electrostatic attraction:** The mutual affinity between particles with a negative electrical charge and particles with a positive electrical charge.

**electrostatic precipitator:** An air filter that uses electrodes (ionizer wires) to give an electrical charge to suspended particulates in the airstream so that they may be collected by another set of oppositely charged electrodes (collection plates).

**emission:** The sum total of all solid, liquid, and gaseous pollutants released into the atmosphere from a given source over a specified time period.

**emission control equipment:** Any type of equipment designed to reduce the emissions to the atmosphere from industrial exhaust systems; includes any type of cyclone, baghouse, filter, absorption equipment, or adsorption equipment.

**emission factor:** The average amount of pollutant produced from a given amount of raw material that is processed or conveyed.

**emission inventory:** The collection of data on all of the primary industrial air pollutants in a given area, includes information on the location and rate of emissions for each pollutant.

**emission standard:** The maximum legal concentration or rate at which air pollutants may be discharged from a single source; may include mandatory guidelines concerning types of emission control equipment that must be used.

**entry loss:** Loss in total pressure caused by air flowing into a duct or hood, usually expressed in inches wg.

EPA (Environmental Protection Agency): A branch of the United States government responsible for both monitoring and setting legal standards for pesticide use, air pollution, water pollution, waste disposal, radiation levels, noise levels, or any other factors that might adversely affect the health of humans.

erosion: The wearing away of a fabric or other material due to mechanical action.

exhaust gas: Any gas released from an industrial process, usually one that involves combustion or incineration.

exhaust stack temperature: The temperature of the gas exiting to the atmosphere through an exhaust stack or chimney.

exhaust volume: The flow rate of the gases exiting through the exhaust stack, usually measured in acfm.

extensibility: The stretching characteristic of fabric under specific conditions of load.

fabric: A pliable, planar structure made of interconnecting fibers, regardless of the type of fiber used or how the strands connect:

Knitted fabrics are produced by interlooping fibers.

Woven fabrics are produced by interlacing crosswise and lengthwise fibers at right angles.

Bonded fabrics consist of a web of fibers held together with a cementing medium, but not a continuous sheet of adhesive material.

Felted fabrics are structures built up by the interlocking action of the fibers themselves, without spinning, weaving, or knitting. Felted fabric bags are used in compressed air baghouses.

Federal Implementation Plan (often abbreviated FIP): An EPA policy which establishes air quality standards where local or state standards are either nonexistent or inadequate.

fiberglass: A strong, nonflammable manufactured fiber in which the fiber forming substance is glass. Fiberglass is

a good insulator, and it is resistant to most corrosive chemicals with the exception of hydrofluoric acid and alkalis.

filter (or air filter): Any device, manual or automatic, whose function is the separation of air pollutants (such as dusts, suspended particulates, aerosols, fumes, or smoke) from an airstream; sometimes used to refer to only the filtering element, such as a bag.

filter cake: The accumulation of a thin layer of dust on a bag or filtering element. (See also caking.)

filter collector: Any filtration system which both filters and collects air pollutants for the purpose of future analysis and measurement.

filter drag: The static pressure drop (expressed in inches wg) across the filter divided by the filtration velocity (fpm).

filter media: The fabric support (either a bag or envelope) upon which the filter cake is built.

filter velocity (or filtration velocity): The velocity (fpm) at which air passes through the filter media, or rather the velocity that air approaches the media. The air-to-cloth ratio is equal to the average filter velocity.

finest: Small air pollutant particulates or aerosols.

flame retardant: A cloth finish designed to repel the combustibility of a fabric.

flexing: As related to compressed air filters, the quick expansion and contraction of a bag as the result of a compressed air blast traveling downward inside of the bag.

fluid: Any substance in a liquid or gaseous state, capable of flowing and altering its shape to fit its container.

fluorocarbon: A chemically inert fiber formed from a long chain of carbon molecules with all available bonds saturated with fluorine.

fly ash: Particles suspended in an exhaust from a combustion

process; these particles are larger than smoke particles and consist of both incompletely burned fuel (carbon) and other noncombustible impurities such as silica and sulfur.

fog: An aerosol of water droplets generated by either condensation or dispersion of liquid water due to splashing, foaming, or atomizing. (See also mist.)

forced draft burner: A burner which uses a low pressure fan to induce a flow of air across the top of the burner into an exhaust stack.

fume: An aerosol of solid particles, often formed as the result of oxidation of metallic gases from a volatilization process.

gas: A formless state of matter that has the ability to completely occupy the space of its enclosure. Air is a mixture of gases.

gas flow rate: The volumetric flow rate of air measured at a fixed point within an exhaust or air pollution control system, usually expressed in terms of cubic feet of air per minute. (See also acfm, dscfm, and scfm.)

grain: small unit of mass used frequently in describing air pollutant concentrations, equal to 1/7000 pound (approximately 64.8 milligrams).

grain per cubic foot: Units most often used to describe the concentration of an air pollutant.

gravity, specific: The ratio of the mass of a unit volume of a substance to the mass of the same volume of a standard substance at a standard temperature. Water is usually the standard substance. For gases, dry air at the same temperature and pressure as the gas is often taken as the standard substance.

header: A pressurized pipe on the side of a compressed air baghouse, used as a reservoir for the 90 to 110 psig compressed air required for cleaning the bags inside the unit.

HEPA (High Efficiency Particulate Filter): A classification

given to any filter capable of removing a minimum of 99.97% by quantity of 0.3 micron test particles, according to a DOP test.

high pressure cleaning air: Clean, dry, compressed air at gage pressures between 90 and 110 psig, used as the cleaning agent in compressed air baghouses.

high volume air sampler (or hi-vol): A device used to collect air pollutants as small as 0.3 microns directly from the atmosphere for the purpose of determining what types and concentrations of air pollutants are encountered in a given location.

hood suction: The entry loss plus the velocity pressure in the connecting duct, usually expressed in inches wg.

humidity, absolute: The weight of water vapor (in grains or pounds) suspended in a unit weight (pounds) of dry air or gas.

humidity, relative: The ratio of absolute humidity in a gas to the absolute humidity of a saturated gas at the same temperature and pressure.

hydrophobic fibers: Fibers not readily water absorbent.

hygroscopic fibers: Fibers which are water absorbent.

impingement: The action of bringing particulates of air pollutants into contact with another substance; this substance may be a mist of water (in wet impingement) or the fibers of a bag or envelope (in dry impingement). Impingement occurs when air is forced against the surface of a water drop or fiber. Air molecules have the ability to flow around this collecting surface, but particulates above a certain size contact and cling to this surface, due to the inertia of the moving particle.

inch of water: A unit of pressure (often abbreviated "wg") equal to the pressure exerted by a column of liquid water one inch high at a standard temperature (usually 70°F). For conversions, 1.000 psi = 27.71" wg.

inclined manometer: A manometer so constructed that the

liquid column is set at a low angle for finer measurements; used when a precision measurement of pressure is required, such as velocity pressure. (See manometer.)

inertial separators: Any unit that uses the inertia of the moving inlet gas to drop solid particulates from the airstream; term is synonymous with cyclones and mechanical collectors.

insulation: Any material used for the purpose of reducing heat transfer across a boundary; often used to prevent heat loss from ductwork or baghouses.

interception: A case similar to dry impingement in which tiny particulates cling to bag fibers. Impingement occurs due to the inertia of moving particulates, but interception describes a situation in which a mutual attraction occurs between the fiber and the particle. Such attractions are known as van der Waals forces.

interstitial velocity: The average velocity of a gas as it moves upward between the bags in a baghouse. It is found by dividing the capacity (cfm) of the baghouse by the its cross sectional area, after the cross sectional area enclosed by the bags have been subtracted from the collector cross sectional area.

K factor: The specific resistance of the dust cake as defined by the static pressure drop (wg) per pound of suspended dust per the capacity (cfm) of the filter.

low pressure cleaning air: Air supplies at gage pressures less than 30" wg, used for reverse air cleaning in baghouses.

lower explosive limit: The minimum concentration of a flammable dust or gas present in the air at ambient temperatures that will ignite when exposed to a flame.

MACT (Maximum Achievable Control Technology): Emissions standards modified to accommodate the best available air pollution control equipment.

manifold: See header.



manometer: A pressure-measuring device which consists of a U-tube partially filled with a liquid (usually water, mercury, or a light oil) so constructed that the amount of

displacement of the liquid indicates a pressure differential, or delta P, between two points.

mechanical collector: See collector, mechanical.

medium pressure cleaning air: Air supplies at gage pressures between 5 and 10 psig, used to clean a special type of reverse air baghouses, known as controlled fire baghouses.

mega: A prefix used to mean multiplied by 1,000,000 (one million), often abbreviated with the letter "M".

micro: A prefix used to mean multiplied by 1/1,000,000 (one millionth), often abbreviated with the Greek letter Mu.

micron (or micrometer): A unit of length, the thousandth part of a millimeter or the millionth of a meter, or 1/25,400 of an inch.

milli: A prefix used to mean multiplied by 1/1000 (one thousandth), often abbreviated with the letter "m".

mist: A visible assembly of tiny water droplets usually formed by condensation, with the suspended liquid particles being sufficiently large enough to fall of their own weight (as opposed to fog, which contains liquid particles small enough that no precipitation occurs).

Montreal Protocol: An international agreement made in June 1990 with a goal to eliminate the use of ozone damaging substances (CFC's, halons, and carbon tetrachloride by the year 2000, and chloroform by 2005) and to establish a fund to help developing nations meet the requirements.

MSDS (Material Safety Data Sheet): Information required by OSHA to be given by manufacturers and distributors of hazardous chemicals concerning their safe handling and use.

mullen burst: The pressure necessary to burst through a

secured fabric specimen, usually expressed in psi.

napped: A process to raise fiber or filament ends in order to produce more surface area, creating a fleecy appearance. It is accomplished by passing a cloth over a large revolving cage or drum of small power-driven rolls covered with card clothing (similar to a wire brush).

needled felt: A felt held together by interlocking adjacent fibers, manufactured by using barbed needles to push and pull loose fibers together. Needled felt is stronger than pressed felt.

NIOSH (National Institute for Occupational Safety and Health): An agency created by the United States government in 1970 for the purpose of researching ways to reduce the health risks and the number of accidental injuries created by an unsafe working environment.

OCIS (OSHA Computerized Information System): A data base compiled by OSHA that contains information on a wide variety of topics related to worker health and safety.

opacity: A term to describe the percentage of light that cannot pass through an object; may be used to describe the degree of visibility of an exhaust plume.

OSHA (Occupational Safety and Health Administration): An agency of the United States government responsible for enforcing the codes and standards set by the National Institute for Occupational Safety and Health.

particulate: Any type solid or liquid particle suspended in the air that is usually considered an undesirable air pollutant; includes all types of dusts, fly ash, pollen, smoke and fume particles, and aerosols.

PEL (Permissible Exposure Limits): A set of guidelines developed by OSHA indicating the maximum concentration of a given air pollutant to which a worker may be exposed during a given amount of time.

permeability, fabric (or cloth permeability): The ability of air to pass through the fabric, given a 0.50" wg pressure differential. Fabric permeability is expressed in units of cfm per square foot of fabric, and measured most often

with a Frazier porosity meter or a Gurley permeometer. Fabric or cloth permeability is not defined the same way as dust permeability.

**pilot valve:** A normally-closed, two-way solenoid valve which transforms an electrical signal into a pneumatic signal for the purpose of pulling air away from one side of a normally-closed diaphragm valve on the pressurized air supply line for a compressed air baghouse. This action allows the diaphragm to move away from its seal, allowing compressed air to move unobstructed from the header through the valve and into the blowpipes.

**pitot tube (or pitot-static tube):** An "L" shaped probe used to measure velocity pressure, consisting of a tube within a tube. While the outer tube measures the static pressure, the inner tube measures the total (or impact) pressure. A differential pressure measuring device can be used to find the velocity pressure (which is the difference between the total pressure and the static pressure, with respect to sign).

**plenum:** Any air compartment, connected to one or more ducts, that serves as a pressure equalizing chamber. For baghouses, it usually refers to the clean-air section above the tubesheet.

**plenum pulse cleaning:** A bag cleaning method in which the clean-air plenum is divided into several compartments. When one section is isolated from the other by means of a damper, all of the bags under that one section are cleaned at the same time (either by the compressed air method or by reverse air method).

**plume:** The path taken by the gas discharge from a smoke stack or chimney.

**PM10:** The concentration of suspended air particulates that are 10 microns in diameter or smaller; the class of air pollutants that are the most harmful to the respiratory system of humans.

**polyester:** A manufactured fiber in which the fiber-forming substance is any long-chain synthetic polymer composed of at least 85% by weight of an ester of dihydric alcohol and

terephthalic acid (C<sub>8</sub>H<sub>6</sub>O<sub>2</sub>).

polymerization: A chemical process whereby two or more molecules bind themselves together to form large molecules.

porosity, fabric: Percentage of voids per unit volume of fabric, not to be confused with fabric permeability.

pounds per 100 pounds of gas: A unit often used to describe the concentration of solid particulates in the air.

PPM (parts per million): A mass ratio often used to describe small concentration of toxic air pollutants; gives pounds of pollutant per million pounds of air.

preshrunk: A condition in which a cloth or fabric is immersed in a hot, aqueous solution in order to eliminate its tendency to shrink during laundering or under wet operating conditions.

pressure, atmospheric: The pressure due to the weight of the atmosphere, as measured by a barometer. Atmospheric pressure will vary according to elevation and temperature. (See also standard atmosphere.)

pressure drop: See delta P.

pressure, gage: Pressure measured relative to atmospheric pressure, may be either positive or negative. Static

pressure measurements taken within a dust control system are always expressed in terms of gage pressure.

pressure jet cleaning: See pulse jet cleaning.

pressure, resistance: The static pressure required to push air through the system or any component of the system (including straight runs of pipe, hoods, elbows, cyclones, and/or filters).

pressure, static: The pressure exerted by a fluid in a direction in which there is no net velocity. This is the pressure measured in any direction by a fluid at rest. For a fluid in motion, it is measured in direction normal

to the direction of flow.

pressure, total: The algebraic sum of the velocity pressure and the static pressure (with due regard to sign).

pressure, velocity: The pressure in the direction of flow necessary to cause a fluid at rest to flow at a given velocity.

process weight: The mass flow rate (in pounds or tons per hour) of a raw material that is conveyed through some process; often used as a basis for setting an emission standard.

psychrometer: An arrangement that consists of a dry bulb thermometer, a wet bulb thermometer, and a device to create an air flow across the thermometers (either a fan to move the air or a sling to move the thermometers). The nearness of the wet bulb temperature to the dry bulb temperature is related to the amount of moisture of the air.

psychrometry: The study of the behavior of air and how it is affected by heat and moisture.

pulse cycle: In compressed air baghouses, the interval between the time a pitot valve allows a pulse of compressed air to enter through a diaphragm valve into a blowpipe and the time the next pitot valve in the sequence performs the same operation. Pulse cycles generally range from 5 to 30 seconds but may be much higher.

pulse duration: In compressed air baghouses, the interval of time that the electrical signal necessary to open a pitot valve remains active. The duration of this electric signal most often ranges between 50 and 500 milliseconds; but because of a slow response time, the diaphragm valve may remain open for up to four or five times longer.

pulse interval: The time of the pulse cycle minus the time of the pulse duration. Because the pulse duration is of such a relatively small amount of time, the pulse interval is often considered the same as the pulse cycle.

pulse jet cleaning (also compressed air cleaning): A bag cleaning method in which a short duration (in milliseconds) blast of 90 to 110 psig compressed air is introduced from a blowpipe into the top of a bag. A burst of air explodes down into the bag causing the bag walls behind it to collapse against the cage.

re-entrainment: The occurrence where dust is collected from the airstream but then returned to the airstream from the same device. This term is used to refer to the situation in baghouses where dust particles on the surface of the filter media are forced back into the air when the bags are cleaned.

resistance: The total pressure drop across the filter media and dust cake in a baghouse, expressed in inches water gage.

reverse air cleaning: A method of fabric cleaning in a filter in which the direction of air flow is reversed in order to flex the fabric and break the dust cake. This type of cleaning was also once known as backwash, backpressure, repressure, or collapse-clean.

reverse jet cleaning (or Hersey cleaning): A term once used to describe a cleaning method in which a traveling ring traverses the exterior of each filter bag. This method used high pressure air originating from small holes in the inside of the ring in contact with the cloth to blow through the fabric. However, in recent years, the term reverse jet has been used to describe pulse jet or compressed air filters.

Ringelman chart: A numeric scale from 0 to 5, used to measure the degree of blackness of smoke emissions. "0" represents a transparent plume, and "5" indicates a completely opaque plume.

sanforized: A patented process in which the cloth becomes constricted in the warp direction to eliminate shrinkage in laundering.

SCFM (standard cubic feet per minute): The calculated flow rate of a gas based on what that rate would be given the same mass flow rate at a temperature of 70°F and a

pressure of 14.7 psia.

scrubber (or gas scrubber): A device which uses a liquid (often a water spray) to precipitate dusts or aerosols from an airstream by the process of absorption.

settling chamber: A device that allows heavy particulates to drop from an airstream by reducing the air velocity. It is often located next to an incinerator for the purpose of collecting fly ash.

shaking, mechanical: A method of bag cleaning involving linkages that accelerate woven bags from side to side to loosen the dust cake (often on the inside of the bags); may be manual or automatic.

shaking, air: A bag cleaning method in which bags are shaken in a random fashion by a high velocity airstream rather than by mechanical devices.

singeing (or singed finish): The removal of protruding hairs from the warp and filling yarns of the fabric by burning.

SIP (State Implementation Plan): The programs proposed by a state government in order to comply with the EPA's enforcement of the Clean Air Act.

smoke: An air suspension (aerosol) of solid carbon particles, 0.1 microns or smaller in diameter, originating from an incomplete combustion process of carbon-based materials such as coal, oil, tar, and tobacco.

sonic (or sound): A fabric cleaning method using acoustic energy to vibrate bags. It may be used alone or as supplement to shaking or backwash cleaning.

stack: Any open-end vertical pipe or chimney for the purpose of releasing exhaust gases into the atmosphere.

standard atmosphere: The standard pressure exerted by the Earth's atmosphere at sea level at 70°F, equal to 29.92" Hg, 14.696 psi, or 407.2" wg.

static pressure (cold): The calculated resistance to the airflow in an exhaust system if the gas temperature

remained at a constant 70°F, given the same mass flow rate of the gas.

static pressure (hot): The measured resistance to the airflow in an exhaust system at its measured temperature.

system gas volume: The volumetric flow rate of gas or air exhausted from an air pollution control system.

tape sampler: An automatic air sampling device that gathers data at preset times.

temperature, absolute: Temperature expressed in degrees above absolute zero. (See absolute zero.)

temperature, dew point: The temperature at which the condensation of water vapor occurs due to saturation (100 percent relative humidity) at a given state of constant absolute humidity and constant pressure.

temperature, dry bulb: The actual temperature of a gas measured by a conventional, non-insulated thermometer.

temperature scales: The temperature scales, Celsius (°C) and Fahrenheit (°F), differ according to how the degree values are divided between the freezing and boiling points of water. At atmospheric pressure, the freezing point of water is 32°F or 0°C, while the boiling point of water is 212°F or 100°C. Because a temperature difference of 100 Celsius degrees corresponds to 180 Fahrenheit degrees, the value of one Fahrenheit degree is 5/9 that of one Celsius degree. The size of the temperature increments of the absolute temperature scales of Rankine (°R) and Kelvin (K) correspond to those of the Fahrenheit and Celsius scales, respectively. Absolute zero is 0°R or -459.67°F as well as 0 K or -273.15°C. The Rankine temperature is the Fahrenheit temperature plus 459.67°F, and the Kelvin temperature is the Celsius temperature plus 273.15°C.

temperature, wet bulb: The temperature measured by a conventional mercury thermometer wrapped in a cotton wick saturated with water. The dryness of the air affects the rate of evaporation of water from the wick, which lowers the temperature registered by the wet bulb thermometer. The wet bulb temperature is either equal to or lower than



the dry bulb temperature.

tensile strength: The maximum amount of stress (defined as the stretching force divided by the cross sectional area perpendicular to the direction of the force) that a material can tolerate without pulling apart.

textile: Any kind of fabric that is woven or may be woven.

Threshold Limit Value (TLV): The maximum concentration of an air pollutant set by the ACGIH to which a worker may be exposed over a specified time period without developing any adverse health problems.

TLV-TWA (Threshold Limit Value-Time Weighted Average): The average TLV set for an eight-hour work day and a forty-hour work week over a period of several years of exposure.

TLV-STEL (Threshold Limit Value-Short Term Exposure Limit): The average TLV set for no more than fifteen minutes of exposure (with at least 60 minutes between exposures and no more than four exposures per day).

TLV-C (Threshold Limit Value-Ceiling): The maximum TLV concentration never to be exceeded for any length of time.

tubesheet (or cellplate): A horizontal metal plate placed across the entire width of a baghouse, with holes through which the open ends of the filter bags are supported.

turning vanes: Plates positioned inside an air duct to reduce turbulence and straighten the air flow.

TWA: Time weighted average. (See Threshold Limit Value.)

vapor: The gaseous form of substances which are normally in a liquid or solid phase at standard atmospheric conditions. This change of state is accomplished by either raising the temperature or lowering the pressure.

variance: Permission granted by the government for a business or industry to operate outside the bounds of one or more EPA or OSHA guidelines for the amount of time

required for a system to be designed or constructed that would meet the necessary legal requirements.

velocity head: See velocity pressure.

velocity of approach: The velocity of air or a gas in feet per minute, normal (perpendicular) to the face of the fiber media in a baghouse.

velocity traverse: A method of determining the average air velocity in a duct. A rectangular duct is divided into rectangles of equal area, and a circular duct is divided into concentric circular rings. An average velocity is taken from an average of all the velocities measured at a point in each area.

velometer: An inclined manometer that determines air velocity by measuring velocity pressure.

venturi: A device shaped like a converging-diverging nozzle inserted through the top of the bag openings in the tubesheet in some compressed air baghouses and used to increase the effectiveness of the compressed air blasts.

volume, specific: The volume of a substance per unit mass; the reciprocal of density, usually given in cubic feet per pound.

water gage: See inch of water.

GLOSSARY OF ABBREVIATIONS

Btu British thermal units (unit of heat or energy)

°C degrees Celsius or degrees Centigrade

cfm cubic feet per minute (volumetric flow rate)

°F degrees Fahrenheit

' (ft) feet

fpm feet per minute (velocity)

Hg height of a mercury column in a barometer (unit of pressure)

" (in) inches

K degrees Kelvin

lbs pounds (unit of mass or weight)

lbs/ft<sup>3</sup> pounds (mass) per cubic foot (unit of density)

psi (lbs/in<sup>2</sup>) pounds (force) per square inch (unit of pressure)

psia pounds per square inch of absolute pressure

psig pounds per square inch of gage pressure

°R degrees Rankine

rpm revolutions per minute

wg (water gage) height of a water column in a barometer (unit of pressure)

vac volts of alternating current