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INTRODUCTION

The information presented in this manual is intended to familiarize operating personnel with the fundamentals of dust collecting systems, operation and proper balancing to assure maximum operating efficiency.

A dust collecting system comprises a number of components, each of which must function in accordance with the original design criteria to assure maximum efficiency. A malfunction in any one part may cause the entire system to become inoperable.

The following instructions will detail these parts, describing their function in the system and the procedure to use to ensure efficient operation. The original design data and drawings prepared when the systems were installed should be available for reference. It is recommended that you study these to become familiar with the arrangement of duct work, hoods and other equipment.

The system will have been balanced after the original installation was completed and a section of this manual will describe “balancing”. It is imperative that you become familiar with this procedure and have the tools on hand to rebalance should it become necessary. Read over all the instruction manuals to become thoroughly familiar with each piece of equipment and keep recommended spare parts in stock.
SYSTEM COMPONENTS

A typical system will normally consist of the following major items:

Dust Collecting Hoods & Air Flow Control Gates.
These are installed at dust producing areas and serve to confine the outflow of dust.

Duct Work.
The ductwork collects the dust from a number of hoods and is sized to ensure proper carrying velocity.

System Fan.
The fan creates the vacuum necessary within the ductwork and hoods, which cause air to flow inward through the hood, carrying dust particles with it.

Dust Collector.
This term generally refers to cloth or cartridge filters that separate the dust from the air stream, allowing the clean air to dissipate to the atmosphere while confining the dust to a single discharge point.

Rotary Valves.
These serve as airlocks under the dust collectors to discharge collected dust and to minimize air flow either into or out of the collector depending on whether the system fan is on the dirty or clean air side.
SYSTEM TERMINOLOGY

Manometer. A Manometer is an instrument used to measure pressure. It consists of a clear “U” tube with a graduated scale between the two legs, calibrated in inches. The zero point on the scale is at the mid-point between the top and the bottom. In use, the manometer is filled with water so that the level in each leg is at the zero point. The pressure reading obtained is the difference between the two levels. The difference is expressed as inches of water column, or WC. As an example, if the water rises 1.5” in the leg connected to the hood, it will drop 1.5” from the zero point on the leg that is open to the atmosphere, resulting in a total reading of 3” WC. Each manometer is equipped with two rubber hoses, which can be of any length, usually 6” to 8” long each. However, in measuring static pressure, only one hose is normally used. Today, electronic manometers are widely available.

Velocity Pressure (Pv). Velocity Pressure is the difference between total pressure and static pressure, and is used to calculate both FPM and CFM (refer to “Basic Calculations” on page 7). Velocity pressure is measured through the use of a Pitot tube in conjunction with a manometer. A velocity pressure of 1” WC to 1.5” WC is considered normal, equivalent to about 4,000 to 5,000 feet per minute (FPM).

Static Pressure (Ps). Static pressure is measured in inches of water with a manometer, which is described above. The word “pressure” is always used even though in most cases we are talking about a dust control system under a vacuum. This is the effect created by atmospheric pressure due to movement of air created by a fan. Your vacuum cleaner is a good example of this function. The fan does not “suck” dust off the floor, it creates a vacuum inside the nozzle (or hood), which causes outside air to flow into the nozzle at such a velocity that it picks up and carries dust particles along with it.

Total Pressure (Pt). Total Pressure is the combination of static and velocity pressures, and is expressed in the same units. It is an important and useful concept to use because it is easy to determine and, although velocity pressure is not easy to measure directly, it can be determined easily by subtracting static pressure from total pressure. This subtraction need not be done mathematically. It can be done automatically in the manometer.

Pitot Tube. A Pitot tube is an instrument constructed as a tube within a tube. The inner tube is used to measure total pressure, and openings in the outer tube allow measurement of static pressure.

Feet Per Minute (FPM). Term used to indicate the velocity of air in a duct. A velocity pressure of 1” WC, as measured with a Pitot tube, results in a velocity of approximately 4,000 FPM, which is usually sufficient to keep most dust in suspension in the duct.

Cubic Feet Per Minute (CFM). A term used to indicate the air volume from an individual hood or being handled by the filter or fan. As an example, a fan may be selected to handle 10,000 cfm at 10” static pressure. The 10,000 CFM is the total air to be handled by all hoods combined and the 10” static pressure is that required to provide the desired airflow at the furthest hood.
**Anemometer.** An instrument for measuring air velocity, used in system balancing to measure face velocity for comparison to system design specifications.

**Face Velocity.** Air velocity measured with an anemometer at the air inlet or exhaust. Face velocity is expressed in feet per minute.

**Air to Cloth Ratio.** A term indicating the ratio of the total amount of air in a filter divided by the total cloth area. 10,000 CFM in a filter having 1,000 square feet of cloth gives a ratio of 10 to 1.

**Magnehelic Gauge.** An instrument usually furnished with a filter that provides a means of constantly monitoring the operating static pressure drop, or differential pressure (DP) across the filter bags and indicates if the filter is operating normally. A range of 0-10" WC is adequate on the dial. An increase above the desired pressure drop allowed for in the system design would result in decreased airflow and a resultant decrease in the efficiency of the entire system.

**Cross Sectional Area.** The area of the cross section of an air duct, usually expressed in square feet. Cross sectional area is used in calculating CFM.

**Traverse Readings.** Traverse readings are taken in the interest of accuracy, since the velocity of the air stream is not uniform across the cross section of a duct. Friction slows the air moving close to the walls, so the velocity is greater in the center of the duct.

To obtain the average total velocity in ducts of 4” diameter or larger, a series of velocity pressure readings must be taken at points of equal area. It is recommended that at least 20 readings be taken along two diameters in round ducts. In rectangular ducts, a minimum of 16 and a maximum of 64 readings are taken at centers of equal rectangular areas. The velocities are then averaged.

These precautions should be observed for best accuracy:

1. Duct diameter should be at least 30 times the diameter of the Pitot tube.
2. Locate the Pitot tube in a duct section providing 8½ or more duct diameters upstream and 5 or more diameters downstream of the Pitot tube. This length of duct should be free of elbows, size changes or obstructions.
3. Provide an egg-crate type of flow straightener 5 duct diameters upstream of Pitot tube.
4. Make a complete, accurate traverse.

In small ducts or where traverse operations are otherwise impossible, a fairly good degree of accuracy can be achieved by placing the Pitot tube in the center of the duct. Determine velocity from the reading and multiply by 0.9 for an approximate average.
Basic Calculations

Velocity Pressure \( (P_v) \) = Total Pressure \( (P_t) \) - Static Pressure \( (P_s) \)

\[ P_v = P_t - P_s \]

Feet Per Minute \( (FPM) \) = The square root of the Velocity Pressure \( (P_v) \) x 4004.4

\[ FPM = 4004.4 \sqrt{P_v} \]

Sq. Ft. of Cross Sectional Area \( (CSA) \) = \( \pi(3.14) \times \) Duct Radius \( (R) \div 144 * \)

\[ CSA = \pi R^2/144 \]

Cubic Feet per Minute \( (CFM) \) = Cross Sectional Area \( (CSA) \) x Feet Per Minute \( (FPM) \)

\[ CFM = CSA \times FPM \]

*Divide by 144 when duct radius is measured in inches.
FIELD TEST SHEET

FAN OWNER ____________________________
FAN MFR. ______________________________
FAN NAMEPLATE DATA __________________
DATE ______ BY ________________________
FAN RPM ______ APPX BHP________________
MOTOR NAMEPLATE DATA ________________

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<tr>
<th>READINGS</th>
<th>SP (OUTLET)</th>
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\[
\text{Density} = 0.075 \left( \frac{530}{460 + \left( \frac{\text{Barometric Pres.}}{29.92} \right)} \right) \\
= \text{lbs. per cu. ft.}
\]

\[
\text{"k"} = \frac{0.075}{\text{Density}} = \text{______}
\]

\[
\text{"k" times} \begin{cases} 
\text{SP} = \frac{\text{SP}}{\text{SP}} & \text{VP} = \frac{\text{VP}}{\text{VP}} \\
\text{BHP} = \frac{\text{BHP}}{\text{BHP}} & \text{at st'd. density}
\end{cases}
\]

\[
\text{average duct velocity} = 4000 \sqrt{\text{VP}} \\
= 4000 \sqrt{\text{_____}} \\
= \text{______ fpm.}
\]

\[
\text{CFM} = \text{velocity} \times \text{duct area} \\
\text{_____} \times \text{______} = \text{CFM}
\]

Add to the SP any loss due to duct friction between points of readings and fan due to poor inlet and outlet connections.
SYSTEM BALANCING

System balancing is very important and every operator should be aware of how it is done and be familiar with the terminology used.

Fan speed is selected to provide the required static pressure at the furthest hood; therefore the hoods nearest the fan will have a higher available pressure unless the air flow control gates are adjusted so that only the calculated static pressure is provided.

See “Industrial Ventilation, A Manual Of Recommended Practice For Design” by ACGIH for a comprehensive discussion of exhaust system design procedure.

Balancing is the procedure of directing airflow to the pickup points through the use of blast gates. This is accomplished with the aid of a manometer (either clear tube or electronic) or a 0-3" magnehelic gauge.

Start at the hood closest to the dust collector. Drill a small hole in the duct between the hood and the blast gate. Usually, a 1/8" hole will suffice, unless it is desired to install a permanent tap. Place the free end of the hose attached to the vacuum side of the manometer. Adjust the gate until the manometer shows 1" WG. If an anemometer is available, check the face velocity of the hood, and compare to the design specifications. Proceed to the next hood on this branch and repeat this procedure. Continue this process with each hood until the hood farthest from the collector has been adjusted. Start over at the first hood and check each one in order again. Some adjustments will probably be required. By adjusting the gate, the desired conditions can be established at which point the gate should either be locked or at least marked for future reference.

When determining the total differential pressure (DP) across the filter from the air inlet to the air outlet side, the same technique can be used. Drill a 1/8" hole in the inlet and outlet ducts and measure the pressure at each point. The static pressure reading on the clean air side will be higher than on the dirty air side if the filter is on vacuum. The pressure drop is the difference between these two readings.

In the following example, the procedure is outlined with the hoods numbered in the order in which they should be balanced.
SYSTEM COMPONENT MAINTENANCE

Dust Collecting Hoods & Air Flow Control Gates

Dust is generated each time a granular product is disturbed, such as being dropped out of a bin onto a moving belt, from one belt to another, from a truck or rail car into a hopper, or from an elevator leg into a bin, etc. Properly designed hoods are installed at each of these points and equipped with an airflow control gate (normally called a blast gate), which is adjusted to assure that each hood is handling the designed CFM (cubic feet per minute) of air.

Hoods positioned over a belt or a bin normally require little attention other than occasionally checking to make sure the blast gate is functional and set at the desired point to assure proper dust control as determined by the initial balancing procedure.

Hoods installed under a belt pulley, for example at the discharge end, can be more of a problem since they have to handle floating dust and carry-over that clings to the belt. These hoods should be checked more frequently to make sure that an excessive amount of dust has not accumulated which would restrict the airflow and, if allowed to continue, would cause the hood to fill up and eventually spill over. An accumulation of dust in the bottom of one of these hoods might be caused by trash such as paper, cloth, etc., or an obstruction in the branch line from this hood to the main duct. Occasionally a belt will stop while still carrying product, which would cause an abnormal flow of product into the hood. Since a dust control system is not to be considered a pneumatic conveying system, the hood will have to be cleaned out before restarting the belt. It is also possible that the air control gate may have been accidentally closed off.

Other types of hoods may be required to suit specific dust producing areas. They all serve essentially the same purpose. As long as they are kept clean and free of an accumulation of trash, and as long as unauthorized personnel are not allowed to re-adjust the blast gates, they should not cause any problem. If they are damaged in any way or if the blast gates do become inoperable, it is essential that they are repaired immediately.

Duct Work

When it is necessary to salvage the collected dust because of its value, only one type of dust can be handled per system at one time. The ductwork may cover a fairly wide area as a result. The main duct gradually becomes larger to accommodate the increased airflow and hold the air velocity to a reasonable level as each hood is added. High velocity results in increased wear on the duct work and increased fan HP. Low velocity results in settling out of larger particles which may eventually plug the line completely. Duct velocities in the range of 3,500 to 4,500 FPM are typical.

Duct cleanouts are recommended. If cleanouts are not used, it may be necessary to open up the longer horizontal runs for periodic inspection. Ductwork installed outdoors may leak and accumulate moisture, which will hasten the plugging problem in the duct as well as in the filter.

System ductwork is designed for use with a specific number of hoods. The branch line should be capped if a hood is removed. If it is unlikely that another hood will be installed in the near future in the same general location, then it may be desirable to remove the branch line all the way to the tee in the main duct and then put a metal cap over the tee. Install a slide gate in the cap to bleed in sufficient air to maintain a minimum conveying velocity. A velocity pressure reading should be taken to determine this.
If additional hoods are required at some other point in the system, a check of your ductwork drawing will determine whether this is feasible. A change in ductwork might be necessary if the hood is to be installed near the end of the system furthest from the fan. If it is to be installed near the fan, it is not so critical as long as an airflow control gate is provided and proper balancing is utilized.

A more common problem occurs when additional hoods are added with no change in duct sizes, fan RPM or motor HP. The fan will normally handle a fixed amount of air at designed total static pressure; therefore, adding hoods merely robs other nearby hoods. This may not be serious if the resultant dust control is still adequate. However, in most cases you end up with only partial dust control at an increased number of points rather than adequate dust control on the original hoods.

The primary things to watch for are worn areas in elbows, leaking flanges, dented sections which restrict air flow and hoods no longer in use but still connected to the system. An accumulation of small leaks is the same as adding another hood with the results as outlined above. In any event, the worst possible thing to do when ductwork becomes plugged is to use a hammer to clean it out. This only aggravates the problem.

Fans

Fans are usually driven by an electric motor through a V-belt drive. Normal maintenance consists of proper use of the right bearing lubricant at the correct intervals. Be careful not to over-lubricate. Refer to the manufacturer’s maintenance manual.

Fans are subject to wear when they are installed on the dirty air side of a collector. Excessive wear on the blades will cause an unbalanced condition which will be noticeable in excessive vibration and reduced efficiency. Worn bearings will result in overheating and a change in the fan’s sound. Once an operator becomes familiar with the normal sound of a properly functioning fan, any abnormal sound will become apparent and should be checked immediately. Spare bearings and a spare wheel are good insurance against an extended down period.

Be sure the fan is operating in the correct rotation after performing any work that requires removing or disconnecting the motor. A switch in lead wires is easy to overlook.

V-belts should be periodically checked for correct tension. Belts that are too loose will result in belt slippage, causing overheating. Belts that are too tight will cause the bearings to overheat. Never replace only one belt. Always replace the entire set. Correct belt tension can typically be determined by placing a straight edge over the complete set of belts and pushing downward so that the same pressure is exerted on each belt. A deflection of approximately 1” at the midpoint between sheaves is considered normal. Refer to your belt manufacturer’s guidelines for correct tensioning procedure.
Dust Collectors

Collectors today are usually assumed to be felt cloth or cartridge filters as opposed to the older cyclonic type of collector. Filters operate at roughly 99.99% efficiency or better as compared to 80% to 90% for most cyclones. Efficiency in this case means the percentage of dust removed from the air stream in the collector. Therefore, 80% efficiency would mean that 20% of the dust is being emitted to the atmosphere.

Cyclones normally operate at a fixed pressure drop, but with varying efficiency that is dependent upon a number of factors including:

- the size and weight of the dust particles
- velocity of the air inside the cyclone
- atmospheric conditions

A cloth filter, on the other hand, operates at a fixed efficiency and a fairly constant pressure drop under normal operating conditions and when properly maintained. If any malfunction occurs in the filter that would cause added resistance to the air flow, less air will be handled by the individual hoods thus causing more internal dusting.

It is apparent, therefore, that a properly operating, self-cleaning filter is the heart of any dust collecting system, and the filter is usually the first piece of equipment to check when a change is noticed in internal dust control. Selection of a filter with the proper cloth area is based upon the air volume to be handled, the type of dust and atmospheric conditions. The filter pressure drop, or differential pressure, will level off after the initial startup period. Differential pressure readings will fall within a relatively small range unless trouble occurs. Filters are normally equipped with a magnehelic gauge, which indicates the pressure drop across the filter bags. 2" to 5" is considered normal.

When a change in internal dust control is apparent by the appearance of more float dust in the atmosphere, the mechanical operation of the filter should be checked immediately by referring to the instruction manual. If there is no mechanical malfunction, then check the appearance of the filter tubes themselves. Filter bags normally operate with a coating of dust. If the dust becomes caked due to moisture or for any other reason, the automatic cleaning mechanism will not be able to clean down the tubes as effectively. Caking will cause a rise in the differential pressure, which in turn causes a drop in the total air flow with a resultant increase in float dust inside the plant.

Excessively caked bags should be removed and replaced with new bags. The operating manual will give you instructions on the proper method to use for replacing the bags. Filter bags are made of a variety of materials, with synthetics most commonly used now. It is important to rebalance the system after a complete set of filter bags is replaced. Check the magnehelic gauge after bag replacement. The initial differential pressure should be quite low, perhaps under 1" of water. Never replace only one bag. Always replace the entire set of bags.

If you have any questions regarding the material in this manual, please contact your AIRLANCO representative at 800-500-9777 or www.airlanco.com.