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Air distribution duct before cleaning.

The same duct after cleaning.

Duct Cleaning

Putting all the pieces together

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More technological changes have occurred in the last 100 years than in the previous 1000 years. Modern automobiles, aircraft, communications, industry, power plants and air conditioning have changed the way most of mankind lives today. But all this progress has also polluted our natural resources, most notably the air around us. While the outdoor air in our major cities is now being cleaned by government intervention in the quality of fuel consumed by automobiles and their engine exhaust, as well as by industry being compelled

to move out of city limits, indoor air within our offices, hotels, hospitals, theatres and shopping malls can only be cleaned by the building maintenance staff.

Concern for Indoor Air Quality

IAQ became one of the leading environmental issues in the USA during the early 90s. In India the awareness came many years later and today in our major cities it is fairly common to come across persons suffering from allergic bronchitis (asthma), allergic rhinitis (stuffy nose) and other breathing problems caused both by the polluted outdoor air as well as the air inside our carpeted homes and sealed offices with central air conditioning, over which the individual has no control. Newspaper articles on the subject and reports by doctors in government as well as private hospitals about the increasing incidences of pollution-caused allergies now appear frequently.

Studies abroad have shown that 70% or more of all IAQ problems involve the HVAC system and that most are due to inadequate care and maintenance of the system. The air ducts, which are the "lungs" of a building can accumulate deposits of construction dirt, dust, cigarette tar, smoke, insects and other air borne pollutants. Dirty air ducts can also become an ideal breeding ground for mold spores, mildew, pollen, bacterial colonies and other health - threatening microorganisms. The air that occupants of such buildings constantly breathe is exposed to all this dirt inside the duct as well as growths of fungus and mold inside the coils and drain pans of the air handling units.

Gradual Realisation that Ducts Must be Cleaned

Most ductwork is concealed above false ceilings and the term "out of sight, out of mind" applies very well to these ducts. A few years ago, a well respected hospital in Mumbai decided to revamp their air conditioning system for a suite of operation theatres. False ceilings were torn down, ductwork dismantled but before they were disposed of, the consulting engineer for the new AC system decided to look inside these ducts and was horrified to see all the dirt stuck to the walls of the ducts. He had all the dirt removed and weighed and found that there was 17kgs of it, including construction debris and greencoloured lint, which could only have come from the green cotton garments worn by the team of surgeons and their assistants inside the operation theatres.

A 5-star hotel discovers a bag full of dust & waste inside their ducts.

Surprising but true! A gunny bag full of dust and waste material such as pieces of insulation and metal scrap left behind during the construction period. The maintenance team was shocked and wondered why they had never thought of cleaning the ducts earlier.

Foreign hotel chains such as Marriott and Hyatt and fast food restaurants such as McDonald have introduced their standard maintenance routines followed in the USA for years, into their Indian operations with duct cleaning as a normal procedure.

Such news travels fast among the engineer's fraternity who handle maintenance in large centrally air conditioned buildings and today there is a greater realisation among maintenance engineers that cleaning ducts is serious work and must be done.

Availability of Duct Cleaning Services

About five to six years ago a few companies in India imported duct cleaning equipment from the USA and added this facility to their Service Department's activities as a diversification measure. The American and Canadian embassies in New Delhi also imported such machines and pretty soon we have today about half a dozen companies offering their cleaning expertise to clients in all the major cities of India. Still a very small number by American standards where there are hundreds of companies doing such work. Of course the market there is vast since most homes install all-air ducted systems for heating and cooling in addition to the commercial, office and institutional establishments.

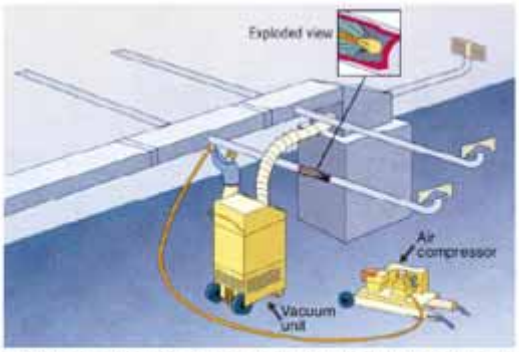


Figure 1 : The forward air sweeping tool is manually inserted and pushed down the duct run, using blasts of compressed air to dislodge any caked-on debris.

How Do You Clean Ducts

The only acceptable method today is "source removal" which involves the physical removal of contaminants from inside the ducts. To achieve proper cleaning, the duct work must be put under a vacuum, after which the contaminants are dislodged from the inner walls of the duct work using high pressure compressed air. See **Figure 1**.

Equipment Used for Duct Cleaning

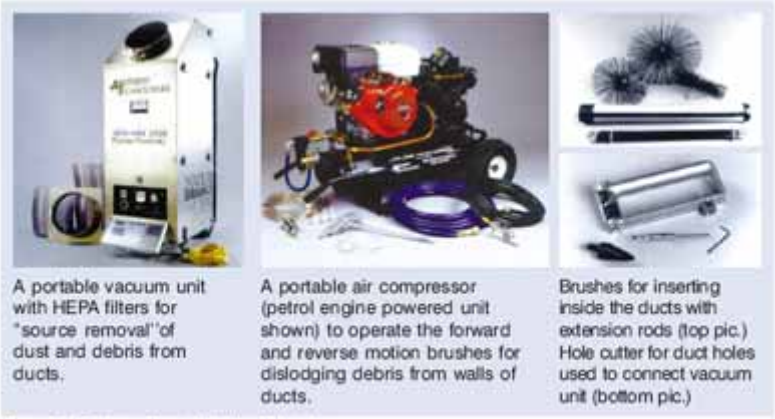
The portable power vacuum unit, see **Figure 2**, is the single most important piece of equipment required. It should be highly portable, lightweight and have a small "footprint" so that it can be easily loaded and unloaded from transport vehicles, moved up or down narrow stairways and fit into small places. The blower inside the unit should be capable of delivering 1800 to 2500 cfm for light commercial work and 6000 cfm or more for large commercial projects.

The static head, which is a measure of the vacuum unit's ability to overcome the internal static resistance from filters and external static resistance of the ductwork should be a minimum of 100 to 150 mm. This should enable the unit to maintain adequate airflow even with dirty filters. The best blower type for this application is a backward-curved aerofoil followed by backward - inclined or radial fans. Forward - curved blowers are not well suited for the high level of static resistance encountered in duct cleaning.

Vacuum units should have three progressive filtration stages to ensure that the air is almost perfectly clean before discharge into the air conditioned space. The firststage coarse prefilter should be cleanable and reusable. The second-stage intermediate filter should be 65 to 85% efficiency to capture most of the remaining visible contaminants. The final-stage HEPA filter will have a minimum efficiency of 99.97 percent at 0.3 microns.

Duct Cleaning - Step by Step

Let's walk through the steps of typical duct cleaning from set up to clean up. Always remember, safety first. Turn the thermostat to the off position, and shut off the electrical power to the air handling unit and any other electrical installations such as duct heaters, humidifiers etc. This is your protection while cleaning the blower wheel and housing in the air handler.



A portable vacuum unit with HEPA filters for "source removal" of dust and debris from ducts.

A portable air compressor (petrol engine powered unit shown) to operate the forward and reverse motion brushes for dislodging debris from walls of ducts.

Brushes for inserting inside the ducts with extension rods (top pic.) Hole cutter for duct holes used to connect vacuum unit (bottom pic.)

Figure 2 : Equipment used for duct cleaning.

1. Separate the supply and return air sides of the duct system by providing blank off at the air handling unit fan outlet connection and at the filter section. The air handling unit including the coil, filters and the drain pan should be cleaned seperately.

2. Cutting into the duct system requires use of a hole cutter or snips to cut the metal duct. An access hole is made in the main trunk line or plenum of the duct work system. A 12-inch access hole is the optimal size for maximum air flow, but a smaller hole is sometimes necessary when size and space restrictions occur.

3. A quick connection collar is used to attach the portable power vacuum to the ductwork. This collar is a flat plate with a collar attachment. The flat plate is attached to the plenum using screws. The plate is sealed to the duct with a gasket to prevent loss of air flow. This collar and locking clamps allow the portable power vacuum to be connected to the duct system with 12-inch diameter flex duct. The portability of the vacuum allows it to be taken to the air handler and get as close as possible. The shortest length of flex hose yields the greatest air flow to the vacuum unit. The hose should always be stretched taut to eliminate any bends and curves that restrict air flow.

   After the supply and return have been separated and the vacuum has been attached, turn the vacuum on. Air will be drawn in through each supply grille and exhausted through the portable power vacuum. All the dirt and debris will be contained in one of the three levels of filtration. The exhausted air has been filtered down to 99.97 percent at 0.3 micron size. Air circulated into the conditioned space is considered hospital grade clean.

4. The next step is to cover each of the grilles. (Lightweight kitchen bags cut into the appropriate sizes work nicely). Using plastic to cover each grille, with the exception of one or two of the grilles farthest away from the air handler and the run you are cleaning, allows you to maximize the airflow through the duct system.

5. Any loose contaminate or dirt will be taken immediately into the power vacuum unit. But what about the year's of cakedon buildup adhering to the ducts? This buildup needs to be loosened and dislodged for the ductwork to be effectively cleaned. Compressed air is the best method for dislodging and moving loosened contaminant in the duct system. Using a portable air compressor that's been designed for duct cleaning will give you better cleaning results and reduce time on the job.

   Air compressors designed for duct cleaning deliver a very high pressure and output of 16 cfm at 185 psi. This power is necessary to properly drive the specially designed cleaning tools in the duct work. Compressors are available in gasoline or electric models.

6. The tools for cleaning inside the duct work are nozzles with air holes - or air whips - designed to move air in one of two directions. The forward air sweep is designed to deliver air forward. It consists of a rigid hose usually 20 feet in length that's inserted in the duct and pushed away from the operator, thus pushing dirt in the forward direction. The airflow in a forward air sweep is controlled by a hand valve and the operator utilizes short blasts of air while moving the hose down the duct. This procedure loosens any caked-on debris or heavier contaminate not initially taken by the vacuum's air flow.

   The reverse air sweep delivers air in the reverse direction. It utilizes flexible and lightweight tubing that is 25 to 35 feet in length with the nozzle securely threaded to the end. This nozzle is drilled to direct the air back toward the flexible hose and the operator. This design allows the power of the compressor to drive the nozzle and drag the hose with it away from the operator. The force of the air loosens any dirt and debris in the duct, allowing the vacuum's air flow to draw it away.

The reverse air sweep has a lot of "action" inside the duct. The flexible hose and power of the compressor cause the nozzle head to move around the wall surfaces, even climbing the sides of the ducts. The reverse sweep also is operated by a hand valve. The operator usually allows the nozzle to carry itself to the end of the duct run, then pulling back on the hose while blasting air in a sweeping action.

Sometimes a robotic vehicle with a video camera is used for inspection. By using a video camera one can see the amount of dirt inside the ducts on a TV monitor before cleaning as well as after cleaning is completed.

Getting Down to Business

7. Now it's time for the elbow grease. We need to begin cleaning each duct run. Starting at a run farthest away, uncover the grille if it has been covered with the plastic. Using a compressed air pistol with a venturi designed to increase the air volume, air wash the grille before removing it. After it has been removed clean out the collar area.

   Again use the booster gun, or in cases of heavy dirt, vacuum it out by using a HEPA filtered shop vacuum cleaner. Attach the forward sweep to the compressed air line hose and insert the sweep into the duct, using blasts of air while moving the sweep down the duct run toward the main trunk line.

   Repeat this process several times to thoroughly clean the duct. In cases where there is heavy caked-on contaminate, loosen it by using a brush or power whip to scour the surface clean. Then repeat the forward sweeping procedure to push the contaminate into the main trunk. Be sure to replace the plastic sheet over the cleaned grille when you have finished cleaning that run.

8. It's now time to clean the main trunk line. Each grille, collar and duct run has been thoroughly cleaned. The dirt and contaminate has been pushed into the main trunk line or in the filters of the vacuum unit. The main trunk will be cleaned with the reverse sweep.

The 1-inch access holes should be drilled every 25 feet to insert the sweep. Pull the dirt from the farthest point back toward the air handler and vacuum source. Securely seal the 1-inch holes with a cap plug when you are finished.

Repeat these same procedures to clean the return air ducts. You will cut another access hole to attach the portable power vacuum to the return side of the system. Return ducts are usually dirtier than the supply ducts. They are downstream from the filter and have a lower velocity that causes a greater dirt buildup. Returns will require more air sweeping and probably brushing as well to remove all the debris.

9. When both the supply and return ducts have been cleaned, the air handler must be cleaned as well. Many contractors lay a plastic sheet over the coil when cleaning the supply for protection and to make the coil cleaning easier. The blower wheel should be cleaned and greased.

10. Cleanup is the next step. The 1-inch holes have been sealed with cap plugs. The 12-inch holes need to be sealed with a sheet metal plate. Remove the quick connect collar for use on the next job and secure a plate over the 12-inch hole. Screw this in place and then seal the edges with foil duct tape. This prevents any duct leakage caused by the duct cleaning procedure. Remove all the plastic covers from the grilles and you have completed the job. The main trunk, ducts, and grilles are all thoroughly cleaned and the dirt is contained in the vacuum unit for disposal.

Site Preparations Before Starting the Work

1. Duct cleaning should be scheduled during periods when the area is unoccupied to prevent exposure to loosened particles of dust and dirt.
2. The duct layout drawing should be studied so that the routing, size and number of bends, dampers etc is clearly understood. In case a drawing is not available, a sketch showing the routing and size should be prepared.
3. If the duct is very long, an inspection door should be provided in the main duct, if not already provided
4. In case of long ducts having a number of branches, cleaning should be done by isolating a section at a time.

5. Place dust protection covers on furnishings, work stations etc to prevent damage.

Occupant Safety and Protection from Contaminants

During the duct cleaning procedure, the most important concern should be the safety and well being of the facility's occupants, the facility itself and the workers performing the cleaning service. Considering that one of the most commonly cited reasons for having air conditioning systems cleaned is to safeguard the health and safety of building occupants, both the cleaning contractor and the client have the responsibility to ensure that the cleaning process does not expose occupants to new hazards.

Kitchen Exhaust Duct Cleaning

The kitchen is the main source of fire in a restaurant, hotel or canteen and the exhaust hood with connected exhaust ducts is where the fire commonly starts because both the hood and duct are covered with oil from the cooking process. Grease filters provided at the intake of the hood do not capture all the oil and a substantial part of it gets past and must be cleaned very regularly from inside the duct hood and fans. A different cleaning process is required for such ducts.

Laundry Duct Cleaning

Laundry exhaust ducts are also prone to fire because of the cotton fluff and dust which accumulate inside the ducts over a period of time. Regular duct cleaning in such areas is a necessity to prevent fires and damage to clothes as well as equipment.

National Air Duct Cleaners Association (NADCA)

In February 1989, a group of air duct cleaning professionals in the USA joined together to help educate the public about the need for properly performed HVAC system cleaning services. They formed the National Air Duct Cleaners Association (NADCA) and made it their goal to promote Source Removal methods of duct cleaning. They have since developed duct cleaning "standards" as well as training material for new entrants in this growing service field.

Conclusion

In India, duct cleaning is in its infancy right now but is slowly being recognised as an essential maintenance tool wherever air distribution ducts are installed. The cleaning equipment itself is fairly simple to manufacture and it's merely a matter of time before

some entrepreneur sets up shop to produce this locally thus cutting down the high cost of imported equipment.