Science-based Steps

Of The Cleaning Process

This is the final part of a series on the Science-based Steps of the Cleaning Process. Each step contains scientific concepts and principles explaining cleaning’s effectiveness in putting unwanted matter in its proper place.

Published with permission by the Cleaning Industry Research Institute © 2008

Containing, Removing Or Transporting Unwanted Matter

By: Michael Berry, Ph.D.

How Are Pollutants Removed?

Pollutants must be removed and transported during cleaning.

The more pollutants transported, the more effective the cleaning and the better protected our health and valuables are.

In cases of large matter simply disposing of the substance is effective.

Matter must be contained to be removed effectively.

Transport moves matter and energy within a compartment.

There are four classes of transport, each going in a specific direction.

Buoyancy moves matter upward if its density is less than that of its surrounding medium.

Carriage on currents moves matter toward the current.

Sedimentation or gravitational settling moves it toward the center of gravity while diffusion moves it randomly in all directions.

Carriage on currents moves matter toward the current.

Sedimentation or gravitational settling moves it toward the center of gravity while diffusion moves it randomly in all directions.

In cleaning most transport occurs through carriage on currents.

Flow direction for liquids and gases is predictable relative to pressure.

Fluids always flow from high to low pressure areas.

Unwanted matter or pollutants suspended in air or water — both fluids — can flow in closed systems outside the building directed for that purpose.

For example, waste water flows from modern built environments through the building’s closed plumbing system into the local sewage system.

Products of combustion, moisture, dusts and other airborne substances are transported by mechanical ventilation systems composed of air ducts, fans and filters.

Some cleaning devices create vacuums or low pressure regions where unwanted substances separated from hard surfaces, carpets, draperies and upholstered furniture can flow.

The substances are captured in canisters and bags before being disposed.

What Role Do Vacuum Cleaners Play In Cleaning?

Most vacuum cleaners possess similar dynamics.

Vacuums use the force exerted by their airflow and brushing action to pick up dirt and dust and place it into a dust bag (filter) or dirt container.

Except for central vacuuming systems with external exhausts, the same airflow circulates back in the indoor air environment after passing through the vacuum.

Proper airflow is necessary for a vacuum to effectively pick up and remove dust and other unwanted soil.
Airflow always carries small level of dusts.

Airflow is the most important aspect of vacuuming.

Air moving through the vacuum or central vacuum system is measured in cubic feet per minute (CFM).

The machine's airflow is inversely proportionate to the system's total resistance and directly proportionate to the motor's "suction" (low pressure region).

Suction — also known as vacuum — is a vacuum cleaner's ability to efficiently pick up matter.

It is the pressure difference created by the motor's spinning fans.

There are many ways airflow resistance presents itself.

When cleaning carpets, airflow is opposed by carpet fibers, air turbulence within a hose and filtering media due to flow around its fibers.

Additional opposition builds up when dirt particles partially block the filter media.

This is noticeable when a vacuum cleaner bag fills with dirt.

Airflow opposition exists even within the suction motor and vacuum case as the air turns sharply while passing through.

A vacuum cleaner takes advantage of a basic environmental science principle.

Like fluids, air always flows from a high to a low pressure region.

The flow speed depends on the pressure difference (pressure gradient) and flow resistance.

A vacuum is the absence of matter in a space.

Vacuum cleaners create a partial vacuum, or an area of reduced air pressure, as air moves outward within the fan.

Air pressure is the weight of atmospheric or compressed air (body of gas) on a specific surface area.

At sea level, atmospheric pressure is 14.69 pounds per square inch (PSI).

A vacuum's suction motor creates airflow by reducing air pressure.

Airflow is created as air with normal (high) atmospheric pressure moves toward the partial vacuum or the low air pressure.

There has been a tendency only to look at pressure (suction) when evaluating vacuum cleaners.

While an important consideration, a vacuum's collection efficiency and bag size also are important.

Filter media affects a vacuum's ability to retain unwanted matter (fine dusts and allergens) and airflow resistance.

Filter components, regardless of type, must be replaced periodically to remain effective.

A vacuum cleaner filter's total resistance is inversely proportionate to the filter media's total area.

For example, doubling the bag's surface area reduces the total airflow resistance by almost 50 percent.

Everything being equal, a larger bag makes airflow easier.

Determining a vacuum cleaner bag's filtration efficiency can be frustrating.

Claims like "retains dust down to 0.1 μm (micron) in size," are misleading since the percentage retained at that size may be low.

Some marketing materials state a percentage without indicating the actual efficiency percentage at a stated particle size.

Vacuum cleaners with a High Efficiency Particulate Air (HEPA) filter often are recommended.

The HEPA is an efficiency specification for filters developed by the Atomic Energy Commission in 1946.

The specification effectively removed radioactive dust from plant exhausts without redistributing.

These HEPA filter machines require higher energy levels and pressure to force air through the deep, dense filter.

They have no requirements or significant risk reduction advantages when filtering out common allergens from vacuum cleaner airflow.

A HEPA filter must capture 99.97 percent of all particles as small as 0.3 μm from the air flowing through it. “As small as” means if all particles were that size the efficiency would be similar.

This is different than “down to,” which may mean a mixture of particle sizes for the stated efficiency.

Vacuums properly claiming the name HEPA provide in-depth filtration that may be useful to consumers.

There also are feasible alternatives to these vacuums.

A collection efficiency of 99 percent at >3 μm and a 95 efficiency at 1 μm is readily achievable with common vacuum cleaners.

How Does Adsorption Differ From Absorption?

Adsorption occurs when molecules of a gas, liquid or dissolved substance or particles adhere to a solid substance’s surface.

Absorption occurs when molecules assimilate into a solid or liquid.

Extraction systems are the surfaces to which things adhere, such as doormats, cleaning cloths, mops, electrostatic cleaning systems, cleaning powders or particles and sawdust.

Unwanted substances are absorbed by or adhere to the surfaces of these cleaning devices before being transported to a suitable disposal location.

Extraction devices vary in cleaning effectiveness.

Regardless of their ability to contain and remove pollutants, they share a common purpose.

Each one aids in removing unwanted substances from within the building envelope or the environment being cleaned.

What Role Does Airflow Play?

Airflow and ventilation are critical to cleaning.

Air carries suspended materials as it flows, such as gases and small particles called aerosols.

When controlled, air provides for effective cleaning so the materials it carries can be properly disposed.

Most cleaning solvents that dissolve greases and particles are liquids containing organic compounds.

When a cleaning solvent is applied or delivered to a polluted area, air flows over the solvent releasing the solution’s organic compound as a gas.

Once the solvent breaks down or dissolves — a grease spot, for example — parts of the pollutant are released into the surrounding atmosphere as small particles or gases.

Airflow must continue over the cleaning site to remove the particles and residual gas released from the solvent or pollutant.

Proper and direct ventilation minimizes pollutant and cleaning residue exposure.

Airflow is necessary for drying.
Drying only occurs when suspended moist air is displaced by dry air on, above and through an environment cleaned with a liquid solvent. Many cleaning problems occur when environments do not dry. Wet environments are reservoirs for microorganisms.

**Properly Disposing Unwanted Matter: How Is It Removed?**

Putting unwanted matter — or pollutants — in its proper place is the final step in the cleaning process. Simply placing unwanted pollutants outside is not effective. These substances must be disposed of appropriately to assure proper cleaning.

**What Is The Proper Disposal Method For Cleaning Waste?**

Where and how cleaning waste is disposed are functions of several elements.

When disposing cleaning wastes the built environment is a recognized component of a local outside environment that is part of a regional environment, which, in turn, is part of the global environment.

These environments are interconnected and whatever occurs in one affects the quality of all. The natural environment is a balance of interconnected cycles with the hydro-cycle being the most understood.

Other cycles include carbon, oxygen, nitrogen, sulfur and phosphorous. These chemical, biological and biochemical cycles are in every environmental sphere and essential for life.

Human activities alter these cycles significantly. They also are the main cause of global environmental change.

It is questionable to what extent these cycles can be disturbed without seriously affecting life.

It is not considered cleaning if wastes are disposed in ways that harm life support cycles.

Cleaning requires pollutants be put in their proper place to reduce and/or avoid exposure.

Cleaning wastes can be treated and made safe or be decomposed to return their elements to their natural cycles, especially those derived from photosynthesis.

Water is the most cleanable substance. Water-based wastes always can be treated and restored to a clean state.

Substances, such as oils and solvents, also can be cleaned and reused.

Consider the following questions when disposing of cleaning wastes. Is the disposal legal? Is it socially acceptable? Is it environmentally suitable?

If the answers are “yes,” the disposal step of cleaning has been properly executed. CM