Most homeowners do not realize the adverse effect candles can have on indoor air quality. Soot deposition can present hvac systems with several problems, including decreased energy efficiency, condensate drain pan overflows and soot blowout from the supply diffusers. In addition, candle soot will deposit itself on carepting, drapes and other household furnishings and items.

Before treating these conditions one must determine if a soot problem exists. Accurate contamination assessments can be performed via a thorough inspection of the air handler unit and sections of the ductwork. Once these particles are charged they can clump together with other soot particles, forming larger particles. These larger particles can adsorb more organic vapors and gases, thus growing in size and becoming attracted to surfaces that have slight electrical charges.

All three of these events will cause particles to deposit onto a surface faster than it normally would. A good indicator of turbulence in the ductwork is excessive noise that often is created when local air speed is greater than 2,300 feet per minute. Obvious constrictions and abrupt airflow direction changes especially at the main supply plenum should be avoided.

Finally, the use of certain electronic
Deposition of candle soot inside HVAC systems results from soot entering through a return vent and being transported throughout the system during normal operation. Deposits are heavily concentrated in areas of impact or airflow alteration, such as turning vanes. Coils are prime areas of deposition.

Several simultaneous events must take place for deposition to occur, so removing one factor can prevent property damage. Contributing factors are divided into three major groups. The first group is the soot source. Many sources have been proposed, but historically the most prevalent source is from combustion.

As particles are moved throughout a home they can become electrostatically charged. This can occur several ways, including high-speed transport through fiberglass-lined duct, turbulent transport in the ductwork and passage through an electrostatic air cleaner. These and possibly other charging mechanisms can charge soot particles.

Air cleaners can cause particles to become charged and to deposit onto surfaces with an opposite charge. Often these air cleaners will show signs of severe soot deposition due to the charges they possess on their surfaces.

The last group of contributing factors may be most unlikely, but can explain why two homes with seemingly similar soot concentrations and charging mechanisms have different soot deposition rates. If the materials within a home have different attractions for the electrostatically charged soot particles, deposition may differ substantially. A home without carpet, plastic appliances and with wood coverings may not experience soot deposition while an identical home built with typical materials used today may experience severe soot deposition.

Porous duct liner is a common place for candle soot to deposit itself in residential HVAC systems.
Avoiding Soot Creation

Even when soot is not visible, a candle, especially those that are aromatic, and with long, thick wicks, can generate enough soot to cause property damage in a short time. Advise your residential customers to avoid using heavy soot-producing candles.

A second factor in soot production is the airflow dynamics of a house. This includes the home’s ventilation rate, particle charging mechanisms and airflow disruption. Many new and renovated homes exchange minimal amounts of air with the outdoors, which are commonly known as "tight houses." Energy-conservation measures are a major factor in such situations.

By reducing the ventilation rate to save energy, builders have allowed pollutants generated in a home to stay inside for longer periods of time. The longer a soot particle stays in a home, the greater the chance it has of depositing itself onto a surface.

By avoiding the construction of fiberglass-lined ductwork with abrupt airflow changes and constrictions that cause air velocity to increase, hvac installers may be able to avoid the deposition of soot particles.

Another category of contributing factors involves materials onto which charged soot particles deposit themselves. Investigations of this process reveal that soot deposits onto injection-molded plastic surfaces such as garbage cans, ice trays, kitchen appliances and synthetic carpets. These items possess an electrostatic charge under many common conditions.

If soot is accumulating inside a home, then carbon monoxide and other products of combustion may also be present in sufficient concentrations to cause acute respiratory injury or even death. In these cases the most hazardous combustion pollutant is the carbon monoxide and not the soot.

Similarly, a cracked heat exchanger emitting flue gasses into a supply air stream can present conditions similar to candle soot deposition. This condition poses a much greater danger in terms of carbon monoxide poisoning and should be one of the first items checked when evaluating a soot deposition problem.

One key to distinguishing between candle soot deposition and a cracked heat exchanger is the prevalence of soot deposition beginning at the return of the system up to and including the heat exchanger area and downstream of the supply.

It also is important to determine when the onset of soot deposition began. Candle soot deposition occurs over an extended period of time, but typically is not noticed until household items suddenly look dingy. On the other hand, evidence of a cracked heat exchanger can be pinpointed to a specific point in time.

By avoiding these conditions and factors, property damage from soot deposition can be prevented or reduced. If builders and hvac installers avoid installing ductwork with high air velocity and excessive turbulence, some cases of soot deposition may not develop. In addition, ensuring adequate ventilation to outside air can prevent accumulation of soot for extended periods of time.
environmental conditions. While very weak, this charge is sufficient to attract soot particles.

All combustion appliances, another source of soot, should be vented to the outdoors as a general rule. Combustion appliances designed to vent into a home should be adjusted so complete fuel combustion occurs. If a combustion appliance is suspected, then a true emergency exists and immediate action is required.

**Cleanup Time**

Once it is determined that candle soot deposition exists, successfully removing it from most hvac component surfaces is dependent on several factors. These factors are the overall condition of the material prior to soot deposition, the amount of deposition and the accessibility of the various components.

Sheet metal surfaces typically are more easily cleaned than porous surfaces, such as duct liners. However, duct liner should be considered salvageable if the deposition is only on the top of the insulation and the insulation will recover from a thorough HEPA vacuuming. Following a cleaning of these materials, some type of resurfacing coating should be applied to fiber-lock the materials and increase the life expectancy of this portion of the air handling system.

All nonporous metal surfaces that are easily accessible should be cleaned by HEPA vacuuming and by hand wiping with a mild biodegradable cleaning

While it is good practice to clean evaporator coils while in place, the problem with candle soot deposition is it reacts when it contacts most coil cleaners. This results in the formation of hard, crystallized material that requires sufficient force to remove from the coil cleaning fins.

As a result it will be necessary to evacuate and remove the coil for proper cleaning. For best results, use a high-foaming alkaline coil cleaner accompanied with a minimum 1,500 psi pressure washer. In our experience, this method has been the most effective.

Cleaning interior surfaces of any sheet metal ductwork should be accomplished by using either a HEPA vacuum and/or aggressively brushing all these surfaces while under negative pressure. The use of compressed air or "air-brushing" alone has been ineffective at removing normal household dust and does not work when dealing with soot deposition.
solution.

The blower assembly should be removed, disassembled, thoroughly wet-cleaned and reinstalled following the cleaning of the air handling unit cabinet.

In the case of a gas furnace, hand-cleaning of the exterior walls of the heat exchanger can be challenging but can be accomplished with due diligence. If the system is a heat pump, remove the heat strips, then thoroughly clean and dry them before reinstallation.

Perhaps the most difficult portion of the hvac system from which to remove candle soot deposition is an indoor evaporator coil. Depending on the configuration and the placement within a system, accessibility to this component can range from limited to next to impossible.

Typically, most flex duct installations that have been subject to candle soot deposition lend themselves to a proper cleaning with mechanically driven brushes and negative air pressure. However, on occasion a technician must determine salvageability of these components and the cost of cleaning versus the cost of replacement.

Decontamination of a heavily contaminated hvac system can be challenging. In order to successfully remove the contaminants from the system it will require a good game plan, proper equipment and due diligence on the part of the service technician.

It is not a quick job. As such, it should not be attempted until the underlying contaminant source has successfully been addressed by the homeowner.

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