Black Soot Deposition…

Also referred to as "ghosting," "carbon tracking," "carbon tracing" and "dirty house syndrome," has become an increasing complaint of homeowners and apartment residents throughout the country. Since 1992, the occurrence rate of complaints received at the Florida Department of Health rose from two-a-year to, at times, two-a-week. Several factors are believed to contribute to the deposition of carbon soot in residences, but a full understanding of the cause and mechanism is still forthcoming. Several theories have been suggested by those investigating the phenomenon.

Where Does The Soot Come From?

Soot is a product of incomplete combustion of carbon-containing fuels, usually petroleum-based. Complete combustion would, in theory, produce practically no soot or carbon monoxide, and is recognized by a blue flame. This applies to all types of combustion processes including natural gas flames, wood fires and candle flames. While it is understood that soot can be generated by any combustion process, most flames that are used in homes are either vented or are carefully controlled, such as gas stoves with a notable blue flame. Through interviews with over 50 homeowners who have experienced Black Soot Deposition (BSD), it has become evident that a common source of soot is candles. Until recently, the amount of soot produced by candles had not been measured. Results from a recent experiment using a controlled chamber have revealed that certain candles, with predictable regularity, can produce up to 100 times more soot than low-soot-producing candles. In effect, burning one candle can be equivalent to burning 100 candles at once. It was also demonstrated that a candle placed in an air draft can increase its soot production by a factor of 50. The assumption by most consumers, that candles could not produce enough soot to cause the damage seen in their home, is unfounded. In fact, soot production from certain candles can be significant and may cause indoor levels of airborne soot to exceed concentrations allowed in outside air by the Environmental Protection Agency of the Federal Government.

Why Does Soot Deposit?

When soot builds up in the air of a house, it eventually deposits onto surfaces due to random collisions with surfaces. When particles collide and grow in size, they gain enough mass to deposit due to gravity. Other environmental factors may possibly shorten the time necessary for soot to deposit, but it should be understood that eventually the soot will deposit onto surfaces. Such factors as low ventilation rates of the homes and the use of ionizing electronic air cleaners may increase the rate at which soot deposits onto surfaces, but further research is necessary to establish their exact influences. Soot created by candles is .06-.1 micron (µm) in diameter. Particles of this size can penetrate almost all home air conditioning filters and can severely reduce an electronic air cleaner's ability to remove them from the air. A small percentage of the particles do impact onto air conditioning filters and appear as black, oily deposits. Soot is also attracted to cooler surfaces due to thermophoresis, a process in which particles migrate under the influence of forces created by a temperature gradient. This contributes to soiling of wall surfaces over studs and air conditioning supply vents. These particles are also attracted to electrically charged surfaces such as some injection-molded plastic items including medicine cabinets, internal surfaces of freezers, plastic vertical blinds and computers.
What are the Possible Health Concerns?

While the soot is suspended in the air, occupants are at risk of inhalation exposure. Since the particles are less than 1 micron (µm) in diameter, they potentially can penetrate the deepest areas of the lung. While some studies have looked at the health risks associated with microscopic soot generated from diesel exhaust and factory emissions, none have considered the residential exposure due to candles. The greatest exposure to soot produced by candles is expected during candle burning, so increasing ventilation by opening windows would reduce occupant exposure. Once the soot particles are deposited onto surfaces, they tend to remain attached and are unlikely to be inhaled by occupants. No evaluation on the effects of soot ingestion (swallowing) has been accomplished. Removal from surfaces is difficult, but can be accomplished with polar solvents. For hard plastic surfaces, rubbing (isopropyl) alcohol is effective at removing soot deposits. Microscopic soot particles have been recognized by the US EPA and the State of California as responsible for aggravation of respiratory illnesses in the general population. Caution is warranted until specific health impacts are studied since the soot created by candles is small enough to enter the lower respiratory tract.

What Should Be Done to Remedy the Soot Deposition?

First, cease candle burning and periodically ventilate the home by opening windows. Install an improved air conditioning filter, such as a pleated electret media filter. Consult a cleaning service experienced in fire restoration for cleaning surfaces. Not enough is known as to whether soot can be successfully removed from duct work. Candles with the following characteristics have the potential to produce excessive soot:

- Candles poured into glass jars or ceramic containers.
- Soft wax, containing unsaturated hydrocarbons.
- Aromatic (scented) wax, containing volatile aromatic hydrocarbons.
- Thick wick, or one with a wire core that keeps the wick upright.
- Soot deposits on the mouth of the jar.
- High, erratic flame when burned.
- Visible soot emitted from an erratic flame.
- Located in an air draft created by a fan or air conditioning vent.
- Pillar candle with signs of uneven burning or thick, erect wicks.
- Multiple wick candles with thick, erect wicks.
Is It Possible to Burn Candles Indoors Without Causing Soot Damage?

Candle soot has been a problem since Colonial America. All candles that emit a yellow flame produce some soot, but usually at a rate that does not cause high indoor concentrations. Consider using candles with the following characteristics:

✦ Hard wax, containing mostly saturated hydrocarbons.
✦ Thin, braided wick that curls over when burned.
✦ Low aromatic properties.
✦ Tapered and votive candles with thin wicks.
✦ Low, even flame when burned.
✦ Wick that burns down evenly with candle material.

And take these precautions when using candles:

✦ Trim wick to 1/4" each time before lighting.
✦ Extinguish candle after one hour of continuous burning and allow to cool before relighting.
✦ Keep candles out of drafts.
✦ Discontinue use of candles that leave a visible soot ring on their container.

This article was written by David Krause and modified by Ronald B. Bailey.