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THE MECHANICS OF HOME BUILDING

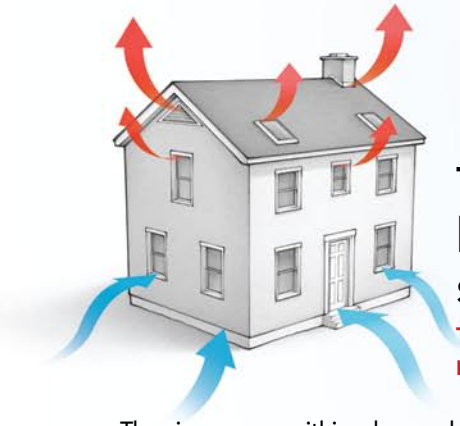
BY ROB YAGID

The stack effect

It's August, the dog days of summer, when your air conditioner hums endlessly and your electric bill skyrockets. Due to the stack effect, keeping the heat at bay can feel like a losing battle. The stack effect is a cyclical flow of air driven by differences between indoor- and outdoor-air densities and temperatures.

There are three forces that move air through a house: HVAC equipment, wind, and the stack effect. Of these, the stack effect is the least understood and at times the most powerful. By understanding this effect, you can increase the comfort, energy efficiency, and healthfulness of your home. Here's how it works.

Rob Yagid is an associate editor. James Lyons, PE, contributed to this article.



The heating season

THE STACK EFFECT IS STRONGEST

The air pressure within a house decreases with height, so the air pressure on the ground floor is higher than the air pressure on the top floor. Air always flows from areas of high pressure to areas of low pressure. During the winter, the difference in air pressure between the ground level and the top floor of a three-story house will be a lot more severe outside than inside, where the air is warmer and less dense. Cracks and openings throughout the building shell allow the pressure difference between indoor and outdoor spaces to drive air out of the top floor and to suck air in through the first floor. The greater the difference between the indoor and outdoor temperatures, the more significant this airflow becomes.

Drawings: Christopher Mills

Hot air is drawn in through the top of the house through air leaks and open windows to replace escaping cool air, which results in an uncomfortably hot top floor. The upper floors of the house are depressurized relative to outdoors.

Air-conditioning units cool hot air, causing it to sink, which helps to start the cycle of flowing air over again, leading to excessive cooling costs.

In the summer, there is the potential for condensation when hot, humid air contacts interior surfaces that have been chilled by air-conditioning. That can result in mold growth or rot.

Cool, conditioned air escapes through leaky first-floor wall assemblies. The lower levels of the house are pressurized relative to outdoors.

The cooling season

THE REVERSE OCCURS

During the summer, when indoor air is cooled, the stack effect occurs in reverse. The outdoor temperature is often warmer than the indoor temperature, so the top floors of the house will have a lower air pressure relative to the outdoors. This creates air infiltration higher in the house as air moves from high pressure to low pressure and causes exfiltration on the lower floors. The temperature difference between indoors and outdoors may only be 20°F, so the stack effect—and the airflow through the building shell—isn't as great as in winter.

SOLUTIONS

On cool summer nights, the stack effect can be used to your advantage. If the outdoor temperature dips below the indoor temperature and it's not too humid, you can open the upstairs windows to cool the house because the stack effect will reverse itself.

To mitigate the stack effect, you can install a mechanical antistratification system (see p. 57 in *FHB* #195). But the best way to remedy the stack effect in most houses is by air-sealing the house to minimize gaps between indoor and outdoor spaces, including the attic hatch, window rough openings, and any recessed lights in the ceiling. Tightening the house reduces the air leakage that the stack effect causes while saving energy and improving comfort.

Integrating balanced whole-house ventilation and quality HVAC duct design that prevents temperature and pressure imbalances in the house also helps to solve the stack-effect problem. Energy use caused by whole-house ventilation can be reduced with a heat-recovery ventilator. See "How It Works" in *FHB* #205 and online at Fine Homebuilding.com for more information.