FOCUS on FACILITIES
Diocese of Cleveland Facilities Services Corporation

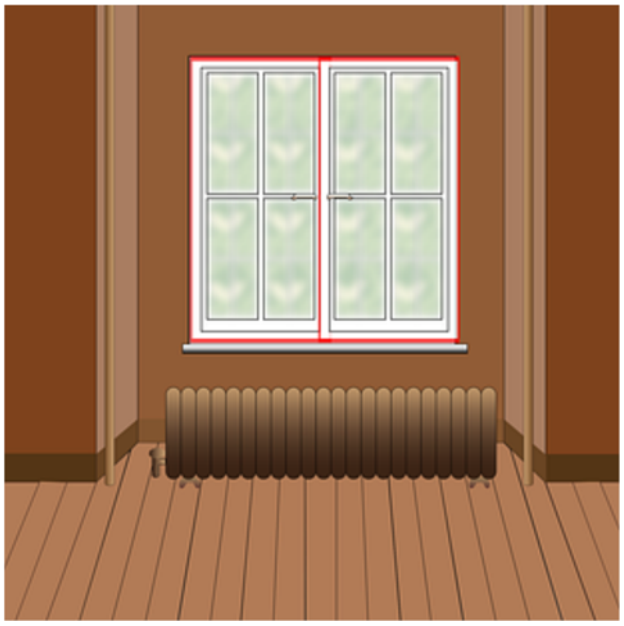
The 2nd Law of Thermodynamics and Building Space Comfort

The 2nd law of thermodynamics notes that heat flows spontaneously from hot to cold. For the layperson does that really matter when one is cold inside a building, or church? He or she just wants to be warm and comfortable and it's the person in charge of the facility who must maintain the building space comfort as part of their job during the heating season.

Now many may dispute that heat flows to cold when they are sitting by a window because he or she may feel a draft or air on them but if you were to put your hand on the window you would find it to be cold. Stepping back from the window a few feet you would feel much warmer room temperature and so this warm air is being drawn to the cold window surface. Sitting next to the window, especially a non-thermal pane glass window, an individual doesn't have to touch the cold glass to feel a cold continuous draft air flowing down the window surface. This draft is simply cold air falling along the surface of the glass because everyone knows heat rises and so cold air must drop.

This cold air creates a flow downward that is defined as creating a draft. More often than not the occupant may not notice that the heating design engineer placed a steam radiator, hot water heating element or electric heating finned radiation directly under this cold window surface to counter balance this down-flow of cold air making it more comfortable to sit or work by a window.

Interior walls, whether insulated or not, experience the same heat-to-cold but an occupant isn't going to feel the same draft of downward flowing air



simply due to the components that make up the wall structure versus a single or double pane of glass.

While a front entrance (side or rear entrances as well) experiences this same 2nd law of thermodynamics, two other potential cold scenarios often occur. The first scenario is when an individual opens an exterior door on a cold and windy day. Mother Nature may take it upon herself to send a gust of cold air through the entrance while the door is open.

To counter-balance this scenario of Mother Nature sending in a cold gust of wind into the building, the architects will usually create a set of exterior doors in series. A person walking into the building opening the first door, followed by opening a second door as the first door closes, prevents the outdoor air to simply blow on through. Revolving

exterior doors achieve a similar if not better separation of outside-to-inside environment.

In sync with this exterior foyer the heating design engineer will usually have a fan-powered unit heater incorporated into the foyer architectural design as a means of delivering a significant amount of heating input into the space to mix warm air with this cold outdoor air.

The second cold scenario is when the building is under a "negative" pressure and the building acts as a vacuum cleaner drawing in this cold air whenever the exterior door is open.

How is negative pressure created? This occurs when the facility has a ventilation system with this central air-handling unit blending a combination of recirculated room air with outdoor ventilation air to provide a heating and ventilating system while another air-handling unit(s) e.g., kitchen hood exhaust(s) fans and/or toilet exhaust(s) remove air from the building because of the quality of air and the space it serves.

It is important that the heating design engineer makes sure that the central air-handling unit introduces more outdoor heated air than the exhaust system(s) remove air from the building. For example, if the building receives 2,000 CFM (cubic feet per minute) of outdoor ventilation but the combined exhaust system(s) removes 4,000 CFM of air from the building, then the building will be under a 2,000 CFM negative pressure. Whenever someone opens an outside door, the building is going to strive to make up that additional 2,000 CFM the building exhaust system has been exhausting every minute of every hour of its operation. High-rise buildings and the known fact that heat rises can also draw in outdoor air but that's a discussion for another day.

If this second cold (negative) pressure scenario occurs, it was either initiated by mistake during the design of the heating and ventilation system (which sometime occurs), but more often than not, the problem occurs by Mother Nature simply blowing cold air into the building entrance or the heating, ventilation, and exhaust systems are not operating as designed.

The solution to the second scenario is important to continuously manage the building heating and ventilation systems to make sure the exhaust fan(s) don't create the "vacuum/suction" affect removing more air from the building than the heating and ventilation system introduces outdoor air ventilation into the building. This management burden is placed on the group or individual responsible for operating and maintaining the building. The same can be said for making sure the perimeter heating system that provides heat under windows and to those fan-powered unit heaters in entry foyers are operating as designed. Analogous to an automobile that requires routine maintenance and tune-up of the engine, the facility management is required to keep the heating and ventilation systems running on all 4 cylinders through the heating season to counter balance the 2nd law of thermodynamics!

For more information :
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