How does the natural stack effect contribute to air movement in PSV systems?

The natural stack effect, driven by temperature and density differences between indoor and outdoor air, creates a pressure differential that draws warm, moist air upwards and out through high-level Passive Stack Ventilation (PSV) terminals, simultaneously pulling fresher, cooler air into the building from lower levels to maintain a continuous, energy-free airflow cycle.

Understanding the Natural Forces at Work in Your Home

Imagine your home is like a chimney. This isn't a perfect analogy, but it captures the essence of a powerful, invisible force that architects and builders have harnessed for centuries: the stack effect. On a cold day in Manchester or a cool evening in London, the air inside your property is warmer—and therefore less dense—than the chilly air outside. This fundamental principle of physics, where warm air rises, is the very engine that drives Passive Stack Ventilation (PSV) systems.

It's a beautifully simple concept. You don't need a mechanical fan whirring away; you're leveraging nature's own HVAC system. The system comprises vertical ducts, typically running from high-moisture areas like kitchens and bathrooms, up through the building to terminals on the roof. The temperature difference creates a pressure differential. The warmer, buoyant indoor air wants to escape upwards through these ducts. As it does so, it creates a slight negative pressure indoors, which in turn pulls fresher, denser air into the building from outside through background ventilators, often located in habitable rooms like living areas and bedrooms. This establishes a continuous, gentle cycle of air exchange.

The Science Behind the Stack: Pressure and Flow

To truly appreciate this, we need to dig into the data. The driving force of the stack effect is quantified by the following formula for pressure difference (ΔP):

$\Delta P = C * h * (\rho_o - \rho_i)$

Where:

- **C** is a constant (approximately 0.043)
- **h** is the height difference between the inlet and outlet (in metres)
- **ρ_o** is the density of the outside air (kg/m³)
- **ρ_i** is the density of the inside air (kg/m³)

Crucially, air density is inversely related to temperature. Colder air is heavier. For example, air at 5°C has a density of about 1.27 kg/m³, while air at 21°C has a density of roughly 1.20 kg/m³. A typical two-storey UK home might have a height difference (h) of about 5 metres between a ground-floor kitchen extract and the roof terminal. Plugging in these values shows a tangible pressure difference is created, solely by nature.

This pressure difference directly influences the volumetric flow rate of air moving through the PSV duct. However, the system's effectiveness isn't infinite. Factors like wind speed and direction can significantly assist or hinder the stack effect. A strong wind blowing across a roof terminal can

create a negative pressure that supercharges extraction. Conversely, wind blowing from the wrong direction can cause downdraughts, disrupting the flow. Furthermore, the design of the duct itself is paramount—its length, diameter, and how many bends it has all create resistance (pressure drop) that the natural stack effect must overcome.

The UK Context: Climate, Building Regulations, and Limitations

The UK climate is actually quite well-suited to PSV systems for a significant portion of the year. Our cool-to-cold temperatures for much of the autumn, winter, and spring ensure a frequent and reliable temperature differential to drive the effect. This aligns with Part F of the Building Regulations in England and Wales, which mandates the provision of adequate ventilation for health and the prevention of condensation.

However, it's vital to understand the limitations. During the UK's increasingly warm summers, the temperature difference between inside and outside can become negligible—or even reverse if the building overheats. This can cause the stack effect to stall completely. This is a critical point of failure for relying solely on PSV in modern, highly airtight homes. While PSV can be effective in dwellings with a reasonable level of air permeability (where natural infiltration provides the necessary air supply), its performance becomes unpredictable and often inadequate in homes built to very high airtightness standards, as required by modern energy efficiency targets.

Academic sources, including research from the Building Research Establishment (BRE), suggest that while PSV can work under ideal conditions, its performance is highly variable. It lacks controllability. You can't easily 'turn it up' on a particularly humid day when you've just taken a long shower. This variability is a primary reason why the industry is moving towards more reliable Mechanical Ventilation with Heat Recovery (MVHR) and continuous Mechanical Extract Ventilation (MEV) systems.

Our Perspective at VENTI: Empowering You with Certainty

At VENTI, our purpose is to empower you to breathe freely. While we acknowledge the elegant simplicity of the natural stack effect in PSV, our experience across countless UK properties has shown us its inherent unpredictability. We believe everyone has the right to not just air, but to *clean, fresh, consistently well-ventilated* air.

This is why we proactively champion more advanced and reliable solutions. For new builds, which are exceptionally airtight, a centralised system like our **RESPIRO MVHR** is often the optimal choice. It provides total control, continuously extracting stale air and supplying filtered fresh air, all while recovering up to 90% of the heat that would otherwise be lost out of the PSV terminal.

For refurbishment projects or room-by-room solutions where ducting is impractical, our decentralised units like the **FLUXO** or **AUREN srMVHR** are transformative. They are installed directly through an external wall, offering the same heat recovery benefits without the need for extensive ductwork. For continuous, moisture-sensitive extraction in wet rooms, our **ARIA dMEV** units offer intelligent, fan-assisted performance that simply outperforms passive stacks.

We will always advise on the equipment that is *required* for your specific property. We would never specify a PSV system for a highly airtight new build because it would be setting the homeowner up for future problems with condensation and air quality. Our approach is helpful, relevant, and based on instilling confidence through easy-to-access knowledge. The natural stack effect is a fascinating force of nature, but for guaranteed healthy indoor air, a controlled mechanical system provides the certainty and performance modern homeowners need and deserve.

To ensure your property benefits from reliable, energy-efficient ventilation year-round, speak with our team today for a free, no-obligation assessment and quotation.