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WHITE PAPER

Thermal destratification in buildings: The missing piece to the HVAC puzzle

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The missing piece to the HVAC puzzle

1. What is Thermal Destratification in buildings?

Over recent years there have been many products available to reduce energy in buildings such as LED lighting, efficient HVAC (heating, ventilation and air conditioning) systems, sub metering, variable speed drive units and improved building fabrics etc. The use of any or all of these options will reduce the carbon footprint of a building resulting in lower utility costs to the owner or occupier.

However, one of the fastest growing and most simple energy reduction initiatives which can be installed into both existing and new build facilities is THERMAL DESTRATIFICATION[1], rated by the Carbon Trust[2] as one of the top carbon reducing initiatives for any type of building.

In all buildings the natural process of thermal stratification occurs, which can result in dramatic differences in temperature from floor to ceiling and wall to wall. Thermal stratification is caused by hot air rising up into the ceiling or roof space because it is lighter than the surrounding cooler air. The same applies to cool air falling to the floor as it is heavier than the surrounding warmer air. This means that HVAC systems have to constantly cycle on in order to maintain building interiors at a set and even temperature throughout.

HVAC systems are typically over delivering either heating or cooling to compensate for this stratification phenomenon in an attempt to achieve a required temperature at working/operating level, which is normally only around 1.5 metres to 2 metres from the floor. This costs a lot of money and creates a lot of carbon.

As a result large amounts of wasted heat can build up unseen in ceilings where the difference in temperature can easily rise 14°C or higher than the temperature at floor level depending on floor to ceiling height, and the higher the building the more extreme this temperature differential can be (Building Services Research and Information Association[3]). This heat is also increasing the Delta "T"[4] between inside and outside, accelerating the rate at which hot air escapes through the roof.

This heat can easily be captured and reused by the installation of an efficient destratification

fan system, which will balance internal temperatures and thus reduce the operation time and workload required of HVAC systems.

Mechanical engineers will argue that good HVAC design will ensure no stratification occurs within a space or building, however this is not the case as anyone who has worked in the roof space of a building will tell you. This can also be seen in the success of specific thermal destratification systems (such as the Airius® system, www.airius.co.uk[5]) across America, Australia, Europe and here in the United Kingdom

2. Thermal Destratification Fans

Destratification fans will always compliment the HVAC system in any building as efficient air movement is the key to making sure an HVAC system operates to its maximum potential without wasting energy. Destratification fans can also reduce the amount of HAVC equipment required for a building or space and some brands will also replace the necessity of old fashioned and very inefficient duct work.

Today, there are many different types of destratification fan available which all offer varying degrees of efficiency and energy savings. Over the past few years destratification fan technology has moved on dramatically from the traditional, ineffective paddle and box type fans to the now third generation fractional amp draw axial turbine fans.

Paddle fan

Box fan

These more efficient systems have needed to be designed as energy savings, personal comfort and indoor air quality (IAQ[6]) have become more important in order to comply with new regulations and increasing energy costs.

Axial turbine fan

3. Destratification Fan Applications

Here in the UK major retailers such as Morrisons, Tesco's, Sainsbury's and John Lewis are utilising thermal destratification systems, saving significant amounts in operational heating and cooling energy. They eliminate hot and cold spots throughout their stores whilst also improving freezer and chiller aisle comfort levels (measurably increasing dwell times and removing fogging and condensation from fridge doors, quickly drying up floor spills and issues such as condensate drainage) with no impact on fridge or open freezer cabinet performance (Morrisons[7], 2007, showed reduced temperature stratification in chiller aisles from 6-8˚C to 1-2˚C). Morrisons now specify thermal destratification in all stores.

The United States Navy also conducted its own research and found a 40 per cent reduction in energy consumption in two facilities implementing thermal destratification fans. ('Thermal Destratification Technology at West Bethesda, MD', April 2010 - International Energy Agency, www.iea.org[8])

Paradoxically, thermal destratification also provides significant savings and comfort benefits during summer months by gently and efficiently circulating conditioned cool air fully within a space, significantly increasing HVAC system efficiency and user comfort so that set points can be raised minimising system cycling times, which also means less maintenance and wear and tear on HVAC systems. In addition, as the cool air which is normally sat at ground level is being circulated up to body level and throughout means HVAC systems no longer have to over deliver to compensate for the stratification problem. The hot air sitting overhead, which impacts negatively on comfort during the summer, is also minimised by temperature equalisation with the cooler air from floor level improving comfort. (American Society of Heating, Refrigerating and Air conditioning Engineers, www.ashrae.org[9])

The Carbon Trust also recommends thermal destratification as a cost effective carbon saving solution in existing and new buildings because the leading brands are extremely simple to retrofit and/or install, resulting in affordable purchase and install prices. As simple as installing a new light fitting, destratification fans need only be wired in and hung from the roof or installed into suspended ceilings.

These features account for some of the remarkable returns on investment noted by existing users. Some users advise around three months' payback (Impress Metal Packaging[10], UK, 2009 quoted saving £62,251 in three months for an outlay of £21,268) and energy savings on heating and cooling costs by up to 50 per cent.

Destratification is also effective in non-conditioned spaces such as warehouses and factory's where internal environments can be very cold during winter months, even though at times vast amounts of heat generated by machinery, processes and people can be sitting up in the roof space. This heat can be recirculated to cost effectively improve temperatures at floor level.

These non-conditioned applications can also benefit during summer months. The simple process of air movement across skin as a result of efficient and continuous air circulation creates a natural evaporative cooling[11] effect on people, reducing body temperature through the evaporation of perspiration. Furthermore, the equalisation of internal air temperature also improves thermal comfort.

In addition to warehouses, factory's and retail outlets thermal destratification has many other applications such as in swimming pools, greenhouses and churches[12] for example. In these types of applications thermal destratification fans have shown to measurably reduce pool heating costs as well as eliminate condensation on surfaces, whilst also removing toxic chlorine gas from the water surface in chlorine based pools. This can be seen in a testimonial by James Dunn at Newtownabbey Borough Council's in relation to a destratification system installed at their Sixmile Leisure Centre.

> *"The heating systems come on much less often and complaints from swimmers about the warmth in the swimming pool area have reduced by 90%. We have found the destratification units have reduced our heating costs by an impressive 25% in the sports halls and swimming pool area; the thermostat in the swimming pool building has also been turned down 2°C!"*

In greenhouses it has a great impact on plant growth and flowering, improving air circulation throughout the planting benches eliminating non-productive cold corners, whilst also reducing heating costs. It can also be used to change the cycle of flowering in greenhouses, resulting in produce being offered outside normal supply seasons.

> *"The destratification system reduced our energy costs by 26% and paid for itself in one winter season. The units increased the air circulation throughout the planting benches, eliminated non-productive cold corners and increased our winter plant growth. Our concrete floors and walkways also became a heat storage bank, supplying free heat during the night. As a result the consistent temperature increased our winter plant growth in ways we had never seen before. Calla Lilies bloomed 25% more than in previous winter months and our*

philodendron showed exceptional growth. We've now installed the system throughout our greenhouses." - Kelly Grummons - Chief Horticulturalist, Timberline Gardens.

In churches, with their typical high architecture and building materials, recirculating high level heat and achieving temperature equalisation can make vast improvements to comfort levels for congregations at floor level.

The key to efficient destratification is delivering continuous, direct, non-turbulent air flow with maximised throw distance so that high and low level temperatures are fully mixed in a controlled fashion, using low energy motors. The leading brands begin operating on only 12 Watts and can be angled up to 90° off vertical. This also means you can direct the flow of air to where you need it, which standard off the shelf fans cannot provide. Generally standard fans use far more energy and cannot push air in a single direction for any distance beyond 3 metres, turbulently mixing the air where it is turning but very little else. To be effective you need to consider a true destratification fan system.

Historically destratification fans could only be installed into buildings with ceiling heights from approximately 4 metres to 10 metres, however today they are being fitted into offices, retail stores, factories, swimming pools, schools and many more applications. Depending on the manufacturer destratification fans are now available which can be installed into buildings with both open and suspended ceilings from 2.5 metres to 31 metres, covering applications ranging from offices to aircraft hangars.

4. Conclusion

Thermal destratification is a simple concept that makes a lot of sense. In any building or space which is heated or cooled, or any building or space which requires environmental control for staff, stock or equipment thermal destratification fans will be worth looking into. They offer significant energy and monetary savings, optimise HVAC system output, improve environmental control and comfort levels and act as a cost effective solution to reducing a buildings carbon footprint.

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