

Energy Efficient Innovations in HVAC Ductwork



Introduction

On April 17, 2018, Spiralite – Khansaheb Industries, a corporate member of EmiratesGBC, delivered a Technical Workshop which discussed recent innovations and products in HVAC ductworks and the associated opportunities for energy savings and environmental sustainability. The workshop was facilitated by Paul Groves, who elaborated on the history of HVAC ductwork in the UAE, global case studies, recent innovations, best practices and solutions which can aid in savings.

The importance of HVAC Ductwork

Recent studies show that the associated HVAC energy costs are a substantial component of a building's life-cycle cost (expenditure over 30 years) – up to 24%. Ductwork, however, is a significant but largely ignored component, and can amount to savings of up to one quarter of the operating costs of a building. Given the use of HVAC in the region, it is essential that more focus is put on the ductwork components of HVAC systems, particularly given that energy conservation and environmental sustainability is becoming increasingly important in the UAE and GCC.

Types of Ductworks

In the 1900s, ductwork usage was largely unknown in the UAE and was mainly made from mud/clay or cement as simply a cool air conduit. Around 1935, metal ductwork was introduced and continued to be used predominately until 1993 when pre-insulated ductwork made from Polyisocyanurate (PIR) and Polyurethane (PUR) was introduced. Despite many advancements in HVAC systems, ductworks have largely remained unchanged.

Different types of ductworks include:

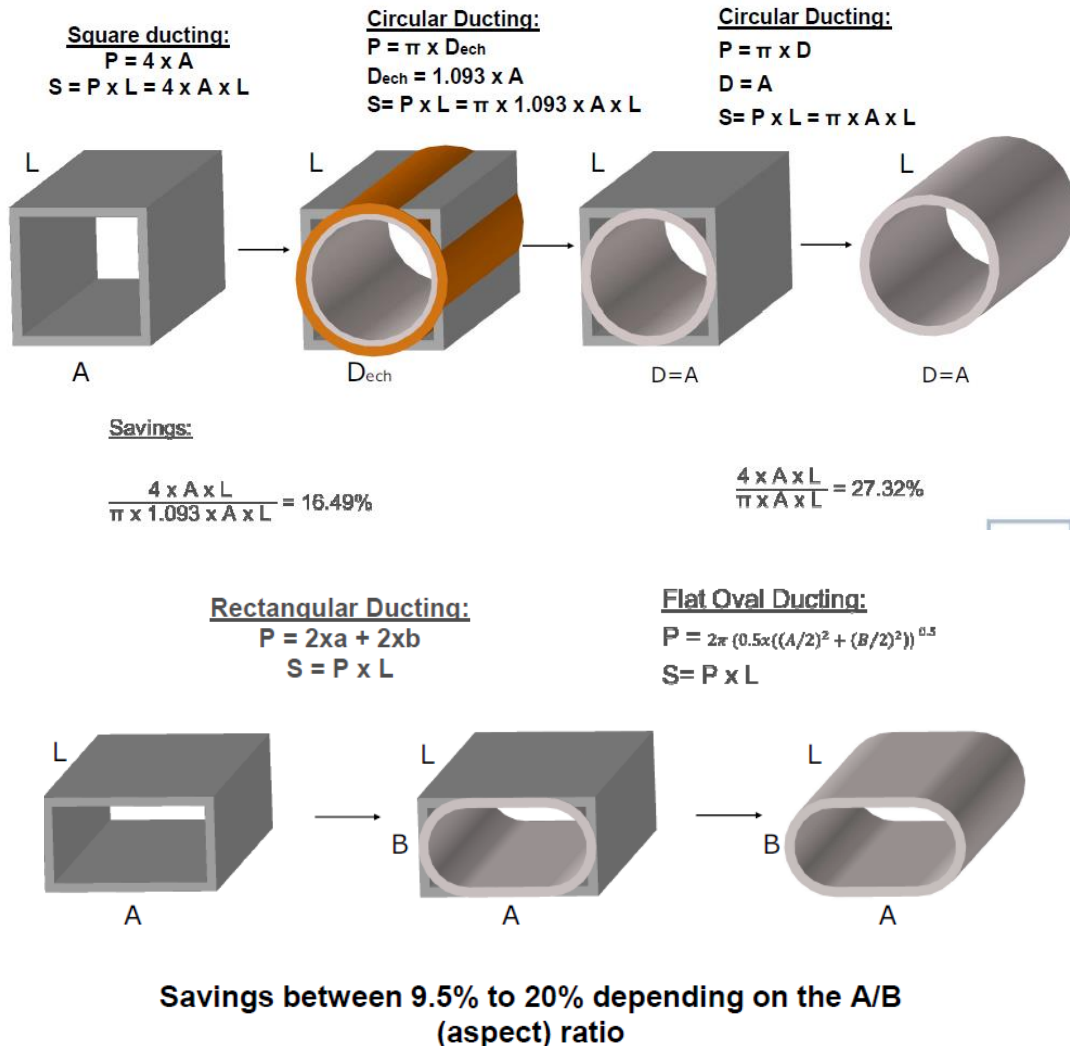
- Metal, typically galvanized iron or sheet steel
- KoolDuct phenolic pre-insulated ductwork first launched in the UK about 25 years ago
- P3/ALP/PAL made from PIR/PUR – pre-insulated square and rectangular ductwork

- Climaver pre-insulated ductwork fabricated from mineral wool
- PVC/plastic ductwork – mainly small bore for residential use with no insulation qualities
- ISOL, etc – “pre-insulated circular ducting” – very heavy and prohibitively expensive
- Fabric ducts, mainly for temporary facilities
- Spiralite circular and flat oval insulated non-metallic ductwork
- Gatorduct cardboard ductwork - sustainable (made from recycled paper and board), but limited to straight rectangular sections and problematic when exposed to water and fire

Factors affecting energy savings

The main objective of achieving energy savings through ductwork is by optimizing airflow and thermal efficiency. This is done by using an appropriate ductwork shape whereby rounded shapes are more airflow efficient as compared to rectangular shapes as highlighted in Figure 1. The rounded shape

results in lower friction losses, lower pressure drops and less static pressure from the smoother inner surface (if there is an internal laminate).



Savings between 9.5% to 20% depending on the A/B (aspect) ratio

Figure 1 Rectangular vs circular and flat oval ducting

In general, one of the main barriers that can affect energy savings is the quality of the installation of the ductwork system. Poor installation leads to poor airtightness and increased pressure resistance, which increases the overall cooling demand as the chillers and air-handling units (AHUs) consume more energy to achieve the same cooling levels. This has a compounded effect of oversizing the capacity of the HVAC to ensure that cooling remains adequate for the occupants – which significantly increases the capital expenditure (CAPEX) of the project.

The material used for the ductwork is also important as they form vapor barriers and ensure there are no thermal bridges. The thermal efficiency of the HVAC ductwork is also intrinsically related to the

thermal conductivity of the material. Vapor barriers and thermal conductivity is often also overlooked, which cause both loss of cooling and condensation. Condensation within the ductwork can have very severe consequences as it can lead to the growth of moulds and microbes and greatly reduces the indoor environmental quality of the building. Furthermore, maintenance must be done more frequently and oftentimes is very difficult, which requires the use of harsh scrubbing. This can further damage the surface of the ductwork as any galvanized layer (if metal) or protective layer is effectively scraped off and results in even more rough surface area for moulds to grow - resulting in high operational expenditure (OPEX).

Case studies

A report released by Mott MacDonald indicated the cost leaky ductworks can have over a 10-year period for a building. The report highlighted that the accumulated cost due to the loss of wasted energy (through loss of cooled air) can be in the range of £850 - £24,580 (~ AED 4000 – 124,000). This is also shown in Figure 2.

Another case study in the UAE showed that using an effective ductwork material and systems can result in OPEX savings (38%) through the reduced fan power required from AHUs. This is because of the lower pressure drops between the supply and return air as a direct result of the efficient ductwork. Additionally, there was a reduction in CAPEX (7%) and it was calculated that it would take 2.13 years to pay for the AHU (from the energy savings).

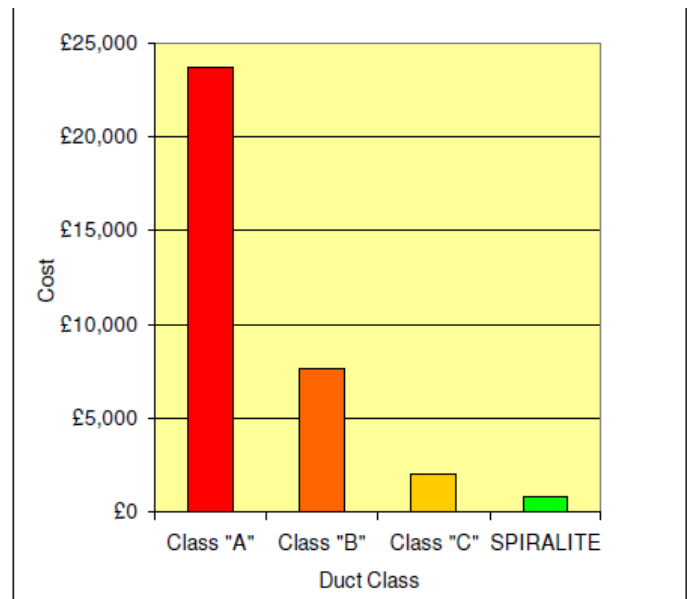


Figure 2 Cost of energy losses for different classes of ducting

Future of Ductworks

The future of ductworks lies in embracing innovation and taking an active stance on environmental considerations to ensure reductions in lower carbon emissions. Additionally, systems should be robust enough to ensure that the least amount of resources is utilized. A potential strategy in achieving this is through the use of modular constructions which results in better quality, speed, uniformity and significantly lower waste.

Conclusion

Through the UAE Vision 2021 and UAE Energy Strategy 2050, the UAE has set out clear objectives for a future sustainable economy. It is important to reduce energy demand and increase energy efficiency to support the ambitious strategies in place. In a region with high temperatures, buildings account for up to 80% of the UAE's energy consumption – dominated primarily by HVAC systems. Ductwork plays an integral role in this and can account for a significant portion of the energy consumption and therefore costs. Therefore, it is important to ensure that the ductwork system is not only appropriately designed and selected but also installed properly. Only then can meaningful, sustainable and long-term savings be achieved.