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Sustainable Solutions for Air Quality

By Nick Heaton CEO, Elta Group (Asia), Perth, Australia

Introduction

In 1968, The United Nations agreed to hold its first Conference on the Human Environment. Preparations for what was billed as ‘the world’s first climate change conference’ were extensive, lasting four years. Held between June 5 and 16, 1972 in Stockholm, the conference was attended by 113 states, 400 non-government organisations, 1,500 journalists, 6,000 individuals and 19 inter-governmental agencies. The total cost of the event was over US\$30 million, which would be worth approximately US\$180m today. This major conference on global environmental issues marked a turning point in the development of international environmental politics.

The conference included a passionate speech by former Indian Prime Minister Indira Gandhi, who linked poverty and the environment for the first time, a speech which (nearly half a century on) has been referenced regularly since.

About the Author

Nick Heaton is an Electrical Engineer, qualified with the City & Guilds London Institute. Specialising in the Indoor Air Quality Markets for the last 20 years, he has been recognised by the UK Institute of Directors with an award for Director of the Year for Sustainability. He is also a member of the World Society of Sustainable Energy Technologies, which is led by the Institute of Sustainable Energy Technology at the University of Nottingham. He now lives in Perth, Western Australia with his family, where he operates as the CEO for Elta Group Asia.

Air Pollution

Following the conference, member states adopted a declaration that set out principles for the preservation and enhancement of the human environment, and an action plan containing recommendations for international environmental action (1). This declaration paved the way towards action on



Burning of fossil fuels has resulted in catastrophic air pollution (Photo credit: Steve Allen/shutterstock.com)

climate change and protecting our environment all around the world. But more significantly, Clean Air Acts have been introduced by many of the countries in attendance, resulting in a major shift in governments' roles to tackle air pollution. India implemented its first clean air act in 1981.

Despite this progress since 1972, as populations have increased along with the economic development of many countries, the burning of fossil fuels for energy, industrial processes and vehicle emissions has also increased in correlation. These activities are releasing dangerous levels of greenhouse gases into the air which is causing catastrophic air pollution. Unless more action is taken, this could cause irreversible damage to the environment.

According to the World Health Organisation, air pollution is responsible for seven million deaths per year (2). Ninety one per cent of the global population is breathing polluted air. This is being increasingly linked by scientists to a growing number of serious illnesses. *Ambient air pollution increases the risk of diseases in the heart and lung and can reduce life expectancy.*

Air pollution also causes corrosion, accelerating the breakdown of materials. This can, for example, result in damage to buildings and objects of cultural heritage. A good example of this is the Taj Mahal, which is undergoing an extensive and costly restoration to



The Taj Mahal is undergoing extensive renovation to remove marble discoloration

remove the discolouration of the marble. The main contributor of this damage has been air pollution.

Exposure to ground-level pollution can cause damage to trees and farm crops, resulting in stunted growth, lower yields and ultimately dangerous contaminants entering the food chain.

Outdoor air pollution cannot be solved overnight; it will take even more determined and combined efforts from governments and industry. The increasing popularity of clean and renewable energy sources, such as solar and wind, is already reducing air pollution in many countries, as is the move towards electric cars and public transport. However, as more scientists link air pollution to killer diseases and as public awareness grows, governments are being pressured to take more responsibility in cleaning up the air in their respective countries. They must work with industry to develop and implement forward thinking policies that progress towards the elimination of dirty power production, irresponsible pollution from factories and cleaner fuels for transport.

Indoor Air Pollution

Those who live in cities can spend up to 90% of their time indoors. When we step into a modern air conditioned building, we cannot see what is in the air; most of us would assume that the air in that building is clean and hygienic. So how is it that despite spending up to 90% of our time indoors, away from outdoor pollution, so many of us are still being affected by poor air quality?

Sick Building Syndrome is widely reported because it is a real thing. Indoor air can often not only contain whatever pollutants are in the air outside, but with the addition of other contaminants such as smoke, mould spores, paint chemicals, formaldehydes, radon, ozone, cleaning and varnishing fumes, air fresheners, personal fragrances and humidity, all of which are known to be potentially harmful to human health.

William Fisk from Lawrence Berkeley National Laboratory in California was one of the early researchers to examine the effects of indoor air quality on human health and productivity. In a 2002 ASHRAE article (3), he wrote about how they had quantified the benefits from improved indoor air quality and demonstrated the economic impacts of increased productivity. The findings showed that an improvement in Indoor Air Quality would:

- Reduce Sick Building Syndrome symptoms by 20% to 50%, with estimated savings to the US economy of \$10 to \$100 billion.
- Reduce asthma by 8% to 25%, with estimated savings of \$1 to \$4 billion; and reduce other respiratory illnesses by 23% to 76%, with estimated savings of \$6 to \$14 billion.
- Improve office worker productivity by 0.5% to 5%, with estimated savings of \$20 to \$200 billion.

The long-term savings identified are huge because the primary costs of sick building syndrome are initially identified and evaluated by decreases in the health and productivity of the occupants living or working inside the buildings.

In the 1980s, a five-year landmark study of 6,000 office buildings across the United States showed that people costs at that time

outweighed facility costs by a ratio of 13:1 for owner-occupied buildings (4). Salaries were shown to comprise 85% of the total costs, compared with only 8.5% for furnishing, maintaining and facilities management. If we acknowledge that even small improvements in employee productivity can be achieved from the improvement of indoor air and thermal comfort, the initial capital cost to solve these issues can offer significant pay back to landlords and employers over the long-term life of a building.

When working in an environment with poor air quality, our first line of defence is our nostrils where large particulates may get caught. Tiny particles can pass through the nerves and into our brain; the rest are inhaled into our lungs, some of which are absorbed into our arteries. In some cities, the smallest particulate matter known as PM1 and below can often make up about 80-90% of the air pollution. PM1 are absorbed into our bloodstream and arteries where they lodge themselves. When we breathe in particulate matter, it stays in our bodies and ends up in our vital organs including the brain. In the short term, this affects productivity, but long term exposure can result in much more serious health issues.

A recent study (5), carried out by the University of Cologne over 12 years, concluded that when professional footballers in Germany played their matches during periods of higher air pollution, their productivity dropped. As outdoor air pollution increased, the players covered less ground on the pitch and made fewer passes than when air pollution was at lower levels. A football match lasts for 90 minutes but imagine if, like professional footballers, we were also expected to perform to the best of our ability, to always deliver the highest productivity, whilst always being exposed to high levels of polluted air!



Air pollution reduces footballers' productivity (Photo credit: George Green/shutterstock.com)

The average working day in most countries is 8-10 hours. Including lunch breaks and other additional time, a person could be spending more than 600 minutes a day working in a building while breathing potentially unsafe levels of polluted air. That is six times longer than a football match. We walk, bicycle or use

transport to work, breathing in outdoor air pollution. We arrive at our office, clinic, classroom or wherever we work, and breath in indoor air pollution, potentially worse than outdoor. We take the same journey home, breathing in the outdoor air pollution. Then we close ourselves in at home thinking we are safe, but unless the air in our home is properly cleaned, we then spend all evening breathing in more polluted air. Not only that, we add to the indoor pollution with more humidity, cleaning products, cooking with gas or on an open fire, etc. It is no wonder the World Health Organisation reports air pollution as one of the biggest global threats to human health.

The International Journal of Occupational Hygiene has reported that sustainable development not only leads to the preservation of the resources, it also improves the productivity and welfare of the residents of the buildings (6). The report states that air quality, ventilation and thermal control (along with other factors) play an important role in the performance and health of people. It means that, amongst other factors, an energy efficient design must also consider indoor air quality and the thermal comfort of occupants.

A Poultry Farm

If thermal and humidity conditions for animals are not maintained, animals could suffer from heat stress. Poultry farms are a good example of how thermal comfort can affect productivity. Maintaining the correct temperature can mean the difference between good egg production and otherwise; if it is too hot or too cold, many chickens will not lay eggs. The same goes for high levels of humidity. Humans are no different from animals; if they are too hot, too cold, too humid or too dry, productivity suffers.

The common objective of a green building is to reduce its impact on human health and the natural environment by efficiently using water and energy, protecting the lives of people and animals, or better still, encouraging better health and increasing productivity with minimal energy usage and the lowest possible life cycle costs, reducing waste and pollution. Whether it is a residential, commercial, agricultural or industrial project, if the objective is sustainability, all these factors have to be considered by designers; so it is logical to expect that the building services products being designed into green or sustainable buildings must also meet these criteria.



A poultry farm

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Moving air and maintaining high levels of air quality inside a building cost energy. Reports have proven that focusing on saving energy but potentially compromising on air quality or thermal comfort is less sustainable, as it contributes to Sick Building Syndrome impacting negatively on health and productivity. An indoor air quality strategy for a sustainable building should, therefore, not only ensure that the systems being installed are delivering the cleanest possible air at the lowest energy costs, but also look at achieving the correct levels of thermal comfort for all occupants and the lowest long term life cycle costs for tenants and landlords.

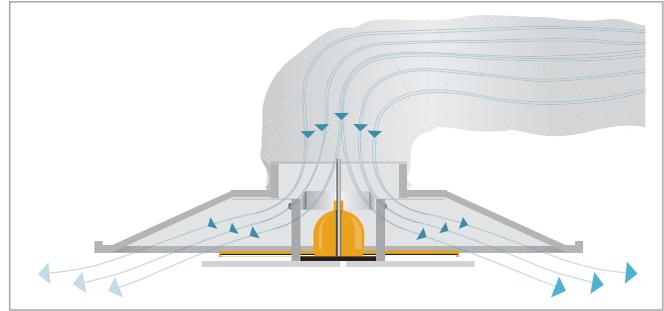
Indoor Air Quality

Filtration levels are always considered within the air handling system but how do we know if they are effective? Sensors and controls are advancing in the HVAC market. Future buildings should consider air quality monitoring systems which, incorporated within the building services design, can detect a wide array of commonly found air pollutants. Working as an integral part of the ventilation system, these sensors should be able to identify an issue before Sick Building Syndrome occurs, increasing airflows and filtration and alerting facilities maintenance teams. The initial cost of such systems can be considered high by developers or landlords, or maybe even a luxury, but if we consider the ongoing savings in improved productivity, reduced sickness, improved morale, employee retention and improved planned maintenance, the capital costs in a sustainable indoor air quality design like this can soon be recovered multiple times over.

Thermal Comfort

Green building consultants and architects across Asia, Australasia and Africa are increasingly designing electronic VAV diffusers into their sustainable building projects. There are many sustainable benefits of this new technology. At the outset, capital savings from the reduction in ductwork and BMS installations can be significant. Throughout the life of the building, electronic VAV diffusers help to maintain a consistent and comfortable temperature in zones of occupancy. This eliminates any uncomfortable thermal conditions that are proven to affect productivity in the workplace. Electronic VAV diffusers achieve this by allowing only the required amount of conditioned air to enter the space. This air volume is determined by the temperature in the space and the set-point on the diffuser's in-built temperature sensor or wall thermostat. The set-point on individual diffusers can be easily adjusted by the occupant, giving them total control over their environment during any part of the day.

Electronic VAV diffusers provide excellent supply air distribution, which ensures that uncomfortable drafts or air dumping are minimised. Air is discharged from the diffuser in a 360-degree pattern and circulated around the room and up through the centre to ensure the air within the space is thoroughly mixed and the space is kept at the desired temperature.



Electronic VAV diffuser

A key benefit of electronic VAV diffusers is their ability to potentially reduce the energy consumption of a building by reducing the demand on the air handling system. They achieve this by allowing only the required volume of hot or cold air to enter the conditioned space according to the set point. If the required air volume reduces, the diffuser's aperture size also reduces, which creates additional pressure in the ductwork. This pressure signals to the air conditioning system to slow down, which in turn saves fan energy. If the air volume required increases, the diffuser's aperture opens, allowing more conditioned air to enter the space.

The long-term life cycle cost savings achieved by the use of electronic VAV diffusers can be significant. They can also help achieve Green building credits for building management, indoor environmental quality and energy efficiency.

Energy Efficient Air Movement

According to the International Energy Agency, electric motors are the single biggest consumers of energy accounting for approximately 40% of total global electricity consumption (7). There are 300 million industrial electric motors installed worldwide, and this figure is increasing by 10% each year. Fans account for 22% of this, or 8% of the world's total electrical usage.

As we strive towards increasingly sustainable buildings, air movement companies can play a very important role with designers by continually innovating, developing increasingly effective air quality equipment that at the same time lowers energy consumption.

For example, for many decades some fan manufacturers have been continually investing in research, development and the continuous improvement of air movement technologies. Decades of research and development have gone into axial technologies, which over the years have significantly driven down energy consumption of buildings. This is because some axial impellers are now so much more efficient, the designer can opt for smaller motors than would previously have been specified. The ErP directive in Europe has played a big role in driving energy wasting fans from European markets and the demand for high efficiency axials and EC fans with demand control technologies is increasing worldwide. These fans are now being designed into many sustainable building projects across Asia and Australasia.

However, the real driver of sustainability is the investment for the long term into precision engineering, new materials and manufacturing processes by companies, which are continually

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Sustainable Solutions for Air Quality

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Decades of research in axial technologies has driven down energy consumption

improving to deliver some of the world's lowest energy, sustainably built fans, designed and built to outlast buildings with the lowest long term life cycle costs.

Summary

Since the first United Nations conference on climate change nearly fifty years ago, the world has changed. Huge progress has been made in raising global awareness on sustainability. Air pollution is now recognised as a global threat to people, animals and our environment, and over the decades this has led building designers to continuously look towards sustainably driven companies for more sustainable products to go into their buildings.

The air movement market has also progressed considerably since 1972. With the introduction of high efficiency fans, higher filtration, demand control, advanced thermal comfort technologies and air sensing technologies, our industry is playing a big role in assisting designers of sustainable buildings to provide sustainable air movement solutions. The vision is to provide high levels of indoor air quality, which ultimately will protect people and animals and help to eliminate Sick Building Syndrome altogether, taking us forward into a healthier and more productive future.

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