The secret life of the microbe

The terrifying organisms that live in our ventilation systems have perfected their methods of attack, but Martyn Love thinks he might have the answer.

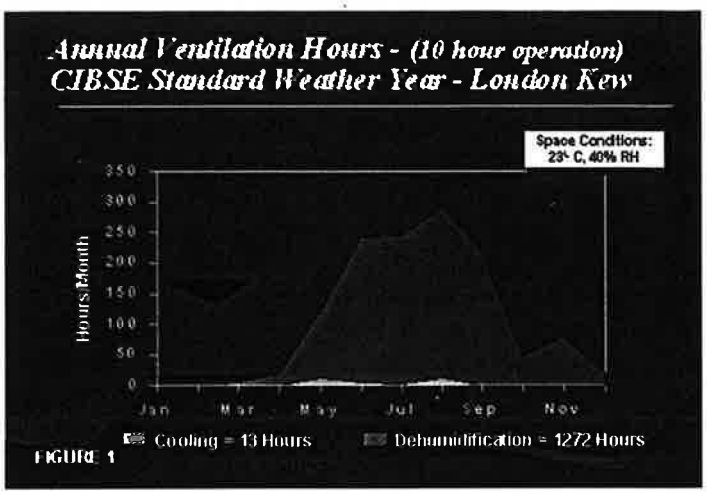


FIGURE 1

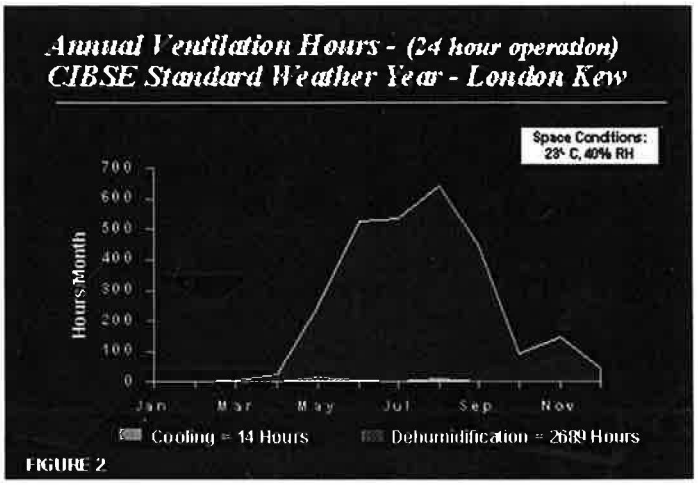


FIGURE 2

Indoor Air Quality is a wide ranging subject covering issues such as sources of contamination, the provision of ventilation air and the way in which the air is delivered and distributed.

Clearly the level of worldwide research currently in progress is a measure of the significance of IAQ in relation to the health of building occupants and its relevance to Sick Building Syndrome.

Well known sources of contamination, many of which are under continuing investigation include VOC's and pollens, of which it has been reported that just 20 grains per cubic metre of air can cause an allergy attack - around 15 million people, roughly a quarter of the UK population, are sensitive to pollen.

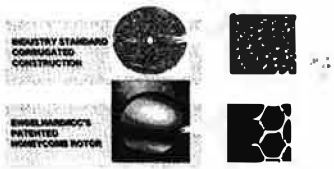
Many IAQ related problems have been connected to the growth of fungus in damp conditions. Chin S.Yang stated that certain microbes could cause allergic reactions, irritation and weaken our immune systems (*See references at the end of this article*). He also stated that microbiological elements, primarily fungi, are widespread indoor air pollutants and should not be ignored.

Additionally, some common micro organisms, particularly micro fungi can produce toxins in our ambient environment that can be carcinogenic or immunosuppressive.

Occupational or building related exposures to mycotoxins through inhalations are now recognised as a major IAQ problem.

Investigations by Montz, for example, have shown that dirty air filters when wet, stagnant and dirty condensate pans and ductwork are all potential sources of fungi.

Accidental occupational exposure in a non-agricultural setting had not been investigated using modern immunological laboratory tests until a "New study of Toxigenic Fungi Expo-



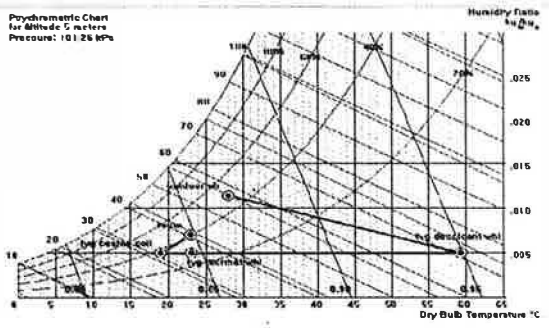
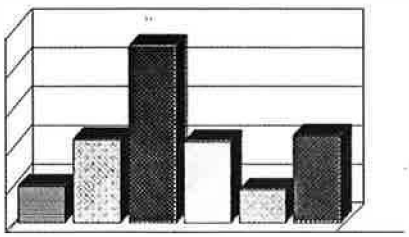
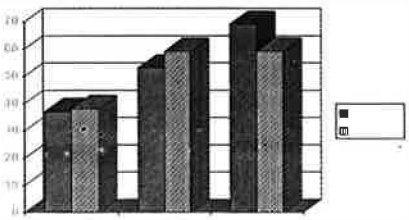


FIGURE 4





sure in an Office Building" was published in 1995.

The study, on a water damaged building, concluded "that prolonged intense exposure to toxigenic fungi was associated with reported disorders of the respiratory and central nervous system".

Research by Stirling and Associates confirmed that to avoid the propagation of bacteria viruses and fungi, relative humidities should be kept in the range of 40 - 60% and the World Health Organisation has recommended a maximum of 7g/kg specific humidity for similar reasons.

ASHRAE project 754 analysed the standard outdoor design criteria and associated design dew point over 30 years of North American weather data. The results of this study now published are in the 1997 Fundamentals suggesting a design based upon peak wet bulb.

In the US, where outdoor air ventilation rates are being increased to levels similar to those already in use in the UK, it has been recognised that this will create a significant impact on energy required for dehumidification.

The relevance of this research becomes clear when viewed alongside the UK weather data and the operating characteristics of a typical cooling plant.

An analysis of UK weather data, based upon a room humidity of 7g/kg and 23degC db/40%RH shows that for a 10 hour building operating period, the number of hours at which the external temperature meets or exceeds 23degC dB equates to 13 whereas the number of hours at which 7g/kg is met or exceeded is 1,272hrs(fig 1- refer to page 34.)

Increasing the hours of operation from 10 to 24 equates to an increase from 13 to 14 for the cooling hours, and an increase from 1272 to 2689 for dehumidification hours (fig 2).

Current System Design

In order to control room humidity levels, system design requires that the outdoor air humidity be reduced to a level that is commensurate with the room latent gains.

Typically using a chilled water or direct expansion cooling coil to remove the outdoor air latent load is a compromise, which requires lowering the dry bulb temperature beyond that necessary to meet dry bulb supply air conditions. This then results in wasteful reheating of the supply air in order to meet the desired supply dry bulb condition. The cooling coil selection will also be made at peak dry bulb and coincident wet bulb temperatures. In actual operation, higher outdoor moisture contents can lead to flooding of the evaporator coil. Also part-load performance, which reflects the majority of the operating year can realise 'overshooting' of conditions leading to further energy wastage (fig 3). There is also the potential, for example, in poorly maintained condensate pans, for gram negative bacteria to multiply and produce harmful endotoxins.

An alternative option for removing the moisture load in the outdoor air currently receiving increased attention is the application of actively regenerated desiccant materials, driven by an indirect gas fired hot water system.

This system operates by passing outdoor air through a desiccant or 'latent wheel' where the moisture is removed and the temperature increased, primarily due to the latent heat of sorption. The hot dry air is then passed through a thermal or sensible wheel where, in conjunction with an indirect evaporative humidifier, the air temperature is reduced to within 2-3 degrees K above the desired room temperature (fig 4).

This allows the treated air to be supplied to the space at the correct moisture level for the room ratio line leaving the specified system type, e.g. chilled ceiling, chilled beam, to manage the room sensible requirements.

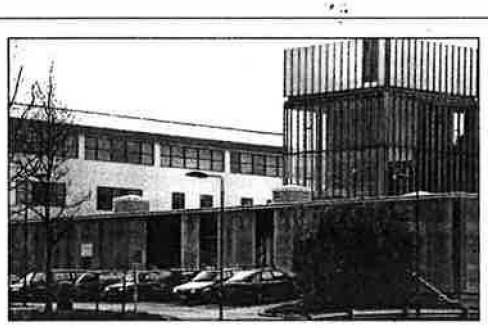
This separation of the latent and sensible loads ensures effective control across the full range of outdoor air conditions.

Desiccant technology is not a new concept; however, a breakthrough in technology by E/ICC (fig 5) has enabled the production of a honeycomb construction wheel which, when combined with a new desiccant material ETSÆ (Engelhard Titanium Silicate), allows lower regeneration temperatures for the material and hence improved energy efficiency.

The same honeycomb structure, but minus the desiccant material, provides a highly efficient heat exchanger that not only provides indirect cooling in the summer, but also operates as a heat recovery device in winter.

The application of desiccant technology has also been shown to give significant improvements in Indoor Air Quality. A study by the Allegheny University School of Medicine's Department of Microbiology and Immunology has shown that ETSÆ based desiccant systems reduce microbial contamination in the key areas of bacteria and fungi (fig 6).

In three instances where desiccant technology has been retrofitted to existing systems, reductions in fungus and bacteria counts were in excess of 60% (fig 7).



Hertfordshire University has installed Monodraught's Windcatcher natural ventilation in two lecture halls in an attempt to reduce energy costs.

Enquiry No 215

System applications

Desiccant based Air Conditioning Technology can be applied most effectively to the outdoor air requirements for chilled ceilings displacement ventilation, chilled beams and fan coil systems together with a variation of the VAV system.

The system can also be applied as an additional enhanced ventilation system, with or without part cooling, increasing comfort levels by virtue of the ability to control the space humidity levels.

In summary, the application of desiccant technology offers the opportunity for improved Indoor Air Quality, whilst reducing the requirement for mechanical refrigeration so cutting CO_2 emissions.

● **Martyn Love is director of sales and marketing at LTI Advanced Systems Technology.**

REFERENCES

Dr. Jean Emberlin - Pollen Research Unit - *Hay Fever Times*

Dr. John Mullins - Sally Hospital, Cardiff

Chin S. Yang, PH.D., P & K Microbiology Services - Indoor Environment 97

Edward Montz, JR, PhD - Enviro Village Library

Eckard Johanning, Ray Biagini, DeLon Hull, Philip Morey, Bruce Jarvis, Paul Landisbergis, Int. Arch Occup Environ Health (1996) No 4 Vol 68, p. 207-218

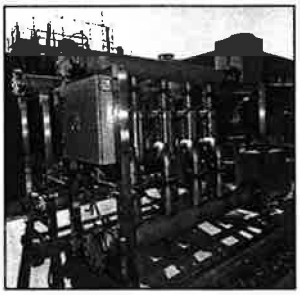
A.V. Arundel, E.M. Sterling, J.H. Biggin, and T.D. Sterling - Indirect Health Effects of Relative Humidity in Indoor Environments – ASHRAE Desiccant Cooling and Dehumidification

P. R. Heimann, B. Kovak, Dr. J. Hammel. *ASHRAE Journal April 1997*

Enquiry No 216

VES Andover's 'Ecovent' heat recovery air handler is providing ventilation for the La Frigate restaurant in Jersey. VES has also provided an 'Esopower' automatic control panel.

Enquiry No 213



Following a plant optimisation survey by Power Plan Services at the Eli Lilly manufacturing facility at Basingstoke, a changeover to direct free-cooling was recommended to reduce energy costs. Cross variable geometry coil filters were installed to provide automatic full-flow filtration for the system.

Enquiry No 214