TREATING FRESH AIR

Options and Uses

By
Deepak Pahwa, President – Bry-Air (Asia) Pvt. Ltd.
20, Rajpur Road, Delhi – 110054 (India)

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Engineers, and Designers, today, constantly face the challenge to conceptualise, design and specify cost-effective solution for treating conditioning large volumes of fresh air.

The uses and need of fresh air is not unknown to us. Fresh air is needed in virtually every sphere of life - whether to burn fuel, or for combustion of an engine or cleaning hazardous area of toxic or explosive gases to mention just a few. The most important need/use of fresh air is for breathing - ***breathing healthy fresh air****.*

The focus of our paper today is treating conditioning this fresh air cost effectively for man and his "machine". it is brought into our living/working space. We will discuss various technologies, equipments and methods of treating fresh air and application of treated fresh air.

An ideal 'airconditioning' equipment should sanitise cool, heat, humidify/dehumidify, evenly distribute the air through at the area; and all; cost effectively. That is the challenge, the designer faces today.

In this paper we will study the equipments/technologies available to treat fresh air.

Fresh Air Treatment Equipments

Equipments available today to treat fresh air are as varied as the uses of Fresh Air and can be categorised as-

* Fresh Air Cleaning (for filtration & V.O.C./CO/CO_2 removal)
* Fresh Air Ventilation (duly filtered) without supplementary cooling.
* "Direct" Evaporative coolers (pad based desert/swamp coolers).
* "Indirect" Evaporative Cooling Systems using rotary thermal wheel.
* Treated fresh air units *incorporating* heating/cooling coils.
* **Treated fresh air units *incorporating* energy recovery devices.**
* **Desiccant dehumidifiers for moisture/humidity control.**
* Desiccant based cooling systems.

We will take a closer look at each of these equipments, their working and their uses, especially, the Desiccant Dehumidifiers and Treated Fresh Air Units with energy recovery (incorporating the enthalpy/heat wheel).

1. AIR PURIFICATION SYSTEMS FOR FRESH AIR CLEANING

These systems are ideal for cleaning fresh air intake from areas with hazardous contaminants like CO, or other industrial gases.

They are self contained multistage units for continuous purification of toxic, odorous and corrosive industrial environment.

Air purification systems can be categorised as using:

* PIA-Potassium impregnated alumina, filter bank.
* Activated carbon filters
* or micronic filters

2. EVAPORATIVE COOLERS

The Evaporative Coolers have been used to cool from almost time immemorial.

They are the most simple and at times most cost effective system of pretreating fresh air for comfort applications.

The evaporative cooler constitutes of a pad (corrugated/khus/wood wool) kept wet by water sprayed on it continuously.

Outside (fresh air) is cooled when drawn over the wet pads.

And, cool air is supplied into the area to be "conditioned" with the help of a fan.

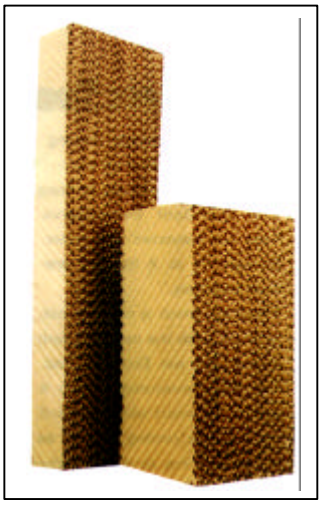

Figure-1

2.1 Large Evaporative Cooling Systems

Conventional Water spray type evaporative cooling/ventilation systems have given way to systems incorporating cellulose pads due to benefits offered. Cellulose pad based systems are efficient, less messy and takes up less space.

Cooling is achieved by saturating the ***Ecocool*** Evaporative Pads with water, sprayed on to it through prefixed channels.

Some typical applications of Evaporative cooling pads based systems are for -

* Comfort cooling
* Poultry, Hatchery
* Green houses, floriculture
* Fresh air intake for Gas Turbine

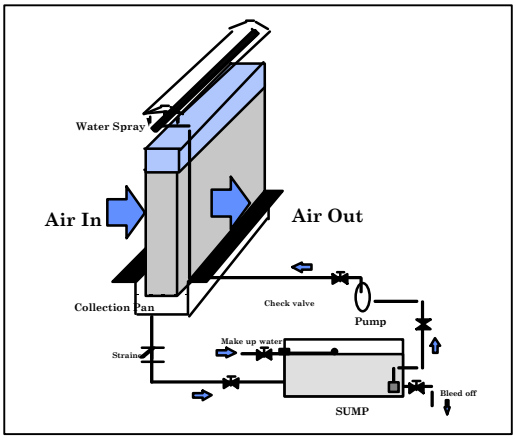

Figure-2

3. <u>CONVENTIONAL TREATED FRESH AIR UNITS</u>

Conventional **Treated Fresh Air Units incorporating Heating/Cooling Coils:** These systems are generally used where large volume of fresh is bought in. Most commercial applications need temperature and relative humidity control for comfort for which fresh air needs to be treated.

A typical TFA unit consists of:

* Double skinned AHU
* Inlet filter
* Cooling section complete with cooling coil and a drain
* Reheat section (optional)
* Blower & motor

The fresh air to be treated is drawn through the inlet over a filter and chilled down to apparatus dew point, by chilled water or refrigerant gas circulating in the coil.

This cool, saturated air is heated to desired conditions over a reheat section, (which may have steam electric heating device) or is fed directly to the return air, closed circuit, AHU, to various areas.

However, energy constraints, and ever increasing fresh air demands necessitates replacement of conventional type of TFA unit with TFA units incorporating 'energy recovery devices' as designers need to provide more fresh air at lower energy costs.

Before we discuss treated fresh air units incorporating energy recovery let us review the need for incorporating "energy recovery devices" in the airconditioning system.

3.1 Increased Ventilation Standard Vs Energy Management: The Challenge

HVAC System "Wish List" for the '90s . . . . . next millenium.

* Efficiently handle increased outdoor air percentage (20~30 cfm vs. 5 cfm/person) with humidity control.
* Minimise first cost, operating and maintenance costs.
* Decouple the outdoor air load so that conventional packaged HVAC equipment can be used effectively.
* Retrofit into existing system design.
* Maintain space humidity between 30% - 60% RH all year.
* Curtail peak electrical demand charges.
* Reduce or eliminate the use of CFCs.

As the recommended levels of outside air brought into conditioned space has been increased by 4 times (to 20~30 cfm up from 5 cfm per person), much higher latent and sensible loads are imposed on the cooling/heating equipment. This translates into two situations : (1) **an improved indoor environment,** and, (2) **significantly higher utility bills for the owners**.

Introduction of even a small quantity of air into an HVAC system raises physical plant requirements dramatically, bringing to fore a new dimension of balancing energy needs with the IAQ standard. In fact the HVAC designers are faced with several parameters which need to be incorporated in response to the regulations and guidlines laid down by market needs.

4. THE SOLUTION OPTIONS : ENERGY RECOVERY DEVICES

As market needs for control of humidity, energy, IAQ, continue to rise, it is imperative to integrate heat/energy recovery devices to airconditioning design to keep all these requirements in mind.

Types of Recovery Devices

1. Rotary Energy Exchangers/Enthalpy Wheels
2. Coil Energy Recovery Loop
3. Twin-Tower Enthalpy Recovery Loop
4. Heat Pipe Heat Exchangers
5. Fixed Plate Exchangers
6. Thermosyphon Heat Exchangers

The ability to transfer both sensible and latent heat makes the enthalpy wheel far more effective in energy recovery. It is found that the total heat recovery device typically recovers nearly three times as much energy as the sensible heat recovery device.

The adjacent (Fig 3) chart compares typical effectiveness and pressure drop data for different recovery devices.

It is seen that the enthalpy wheel has the highest effectiveness and least pressure drop at any face velocity, making it the most appropriate choice for energy recovery in comfort ventilation.

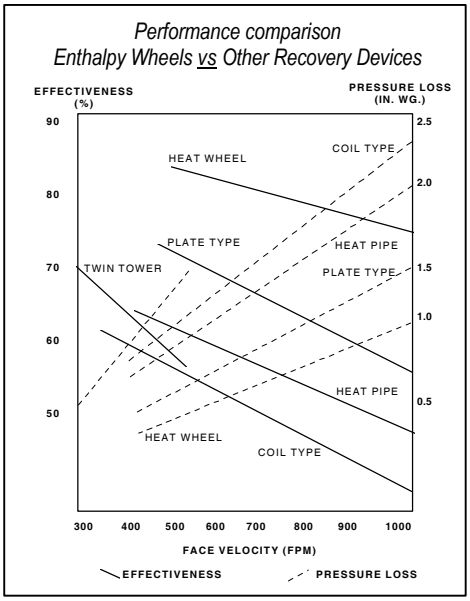

Figure-3

4.1 Enthalpy Wheels : The Best Options for IAQ Enhancement

The enthalpy wheel is a cylinder, usually 4 to 10 inches deep, packed with a heat transfer medium that has numerous small air passages, or flutes, parallel to the direction of airflow. Commonly referred to as the honeycomb matrix. The surface area exposed to airflow in a wheel lies between 300 to 3300 m^2/m^3, depending upon the configuration.

In a typical installation, the wheel is positioned in a duct system such that it is divided into two half moon sections. Stale air from the conditioned space is exhausted through one half while outdoor air is drawn through the other half in a counter flow pattern. At the same time, the wheel is rotated slowly (2 to 20 RPM). Sensible heat is transferred as the metallic substrate picks up and stores heat from the hot air stream and gives it up to the cold one. Latent heat is transferred as the medium condenses moisture from the air stream that has the higher humidity ratio through adsorption by the desiccant (with a simultaneous release of heat) and releases the moisture through evaporation (and heat pick up) into the air stream that has the lower humidity ratio.

4.1.1 Advantages of the New Generation Enthalpy Wheels . . . . . What You See! *Use of rotary heat exchangers in comfort air-conditioning dates back to mid fifties with folded wire mask pads since then the rotary heat exchangers or enthalpy wheels, as they are commonly known today how came a long way.*

The new generation of enthalpy wheels have several features which have distinct advantages over others, which need to be carefully studied before selecting the correct wheel for the application.

*Selective adsorption which eliminates cross contamination of bacteria and air borne contaminates.

In certain application areas such as hospitals, hotels, clean rooms and animal houses requiring stringent control of IAQ, where 100% fresh air is normally the requirement, designers are apprehensive of using the heat wheel for fear of cross contamination due to carryover of bacteria, germs or foul odours from the exhaust to the incoming air. The new generation wheels using 3Å/4Å (mole-cular sieve) mixtures as the desiccant; however would allow even the smallest diameter pollutants to blow over, because the pore size of the desiccant will essentially allow molecules smaller than 3Å in diameter, 5000 times smaller than the diameter of the human hair to pass into the fresh air supplies. Water molecules, 2.8Å in diameter, can enter and exit the sieve. As a result, the contamination remain in the exhaust air stream.

* In-built purge sector eliminates cross contamination. Cross contamination generally refers to a mixing of air between supply and exhaust air streams. In rotary heat exchangers, this occurs through leakage and carryover. Carryover occurs each time a portion of the matrix passes the seals dividing the supply and exhaust air stream, as the exhaust air still inside the flutes is pushed back into the room by the incoming outdoor air. To eliminate carryover, a purge sector is constructed, which flushes out the flutes before they enter the supply air side.

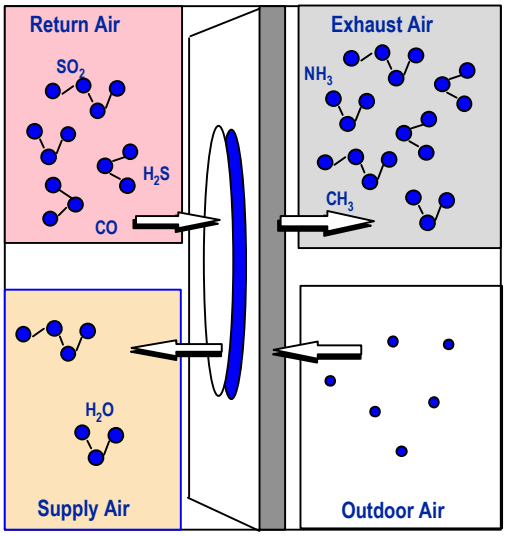

Figure-4

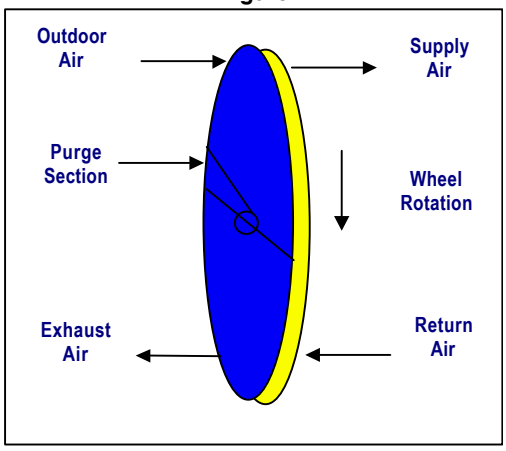

Figure-5

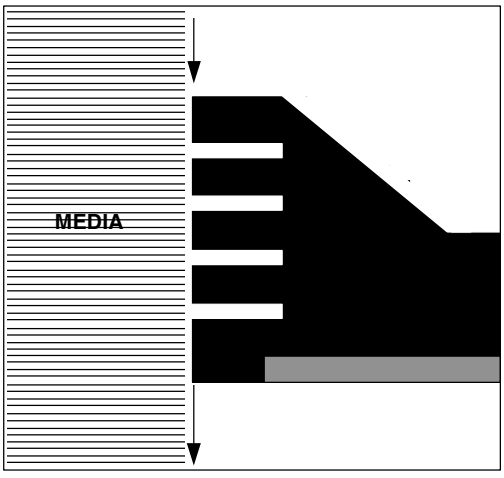

Figure-6

With effective purge arrangements some manufacturers are able to limit cross contamination to .04% of the exhaust air concentration by volume.

* Models of heat wheels using non contact seals have a distinct advantage of larger life and effective sealing due to the use of four pass labyrinth seal.

* The choice of desiccant is the key element in the enthalpy wheel technology. Silica gel, activated alumina and molecular sieves are the desiccants currently being offered on enthalpy wheels. Molecular sieves have a relatively higher sorption capacity at low concentration levels of water vapour, which does not increase significantly with increase in relative humidity. However the decrease in adsorption capacity of molecular sieve with increase of temperature is much smaller compared to the other two desiccants. Both silica gel and activated alumina have adsorption capacity twice as much as molecular sieve at 100% RH. These characteristics influence wheel design and determine moisture transfer effectiveness of the wheel at different temperature and humidity conditions of the two air streams.

While selecting the enthalpy wheels for any application, therefore, the following points should be carefully scrutinized: choice of desiccant, selectivity, flute dimension, purge sector, seal arrangement, efficiencies, pressure drops, structural strength of the rotor. Though manufacturers give detailed data on performance, which should be consulted for a given application, there are a few other characteristics of the manufacturing process which must be known to make a wiser choice.

4.1.2 Advantages of New Generation Heat Wheels . . . . . What You Don't See!

1. Desiccant technology, in the recent years has made considerable advancements and wheels are currently available coated with desiccants with the distinguishing features, such as :
   * Desiccants with high diffusion rates
   * Desiccants with selective adsorption characteristics
   * Desiccant mixtures which combine high diffusivity with selectivity.
   * Desiccants which are adhered to substrate using water based/non masking adhesives with pollution control considerations.
2. High quality substrate webs utilising simultaneous double sided coating methods.
3. Structural rigidity of the honeycomb media/matrix by using state-of-the-art surface winding techniques in place of centre winding techniques.
4. Highly polished and finished surfaces enabling distortion free production of large diameter rotors for use with contact less seals.

These very recent 1995 developments, in manufacturing techniques, have enabled the new generation rotors to have all advantages of the previous wheels plus more to provide the best recoveries, rigidity and reliability, with minimum pressure drops.

4.1.3 Integrating The Enthalpy Wheel in HVAC Systems The most widespread application of enthalpy (heat) wheels is for *preconditioning* fresh outside air before it is introduced to a building. The system can easily be tapped into an existing ventilation system. Operating in virtually any climate zone, a single desiccant wheel operated with just a small motor to rotate the wheel can deliver fresh air on a year round basis that is generally within 3-7 degrees and 10% RH of inside conditions, regardless of what outside conditions are (without any type of

? Current ventilation standard can be met or exceeded with minimal ene cost impact.

? Incoming outside air is dehumidified by the desiccant wheel. As a resu indoorhumidities are maintainable, thus, retarding the growth of mould, mildew and other microbial contamination.

? Need for cooling capacity (30~50% of system capacity) required to dehumidify and cool outside air is eliminated.

? In the winter, wheel systems can preheat and humidify incoming cold d

? Recovers 80% of the heating or cooling energy that is exhausted from building, thus, the cost of fresh air ventilation is reduced. Annual saving range from US$1 to $2 annually for each of fresh air ventilation.

? The system has an immediate payback. In retrofit applications, where cooling capacity is already in place, payback would typically take place 1 to 3 years.

Figure-7

mechanical cooling or heating). The cost to provide high levels of fresh air ventilation becomes minimal compared to the normal heating cooling requirements of the building. The potential benefits are numerous.

Larger heat wheels are being integrated in packaged AHUs or designed in modular systems for integrating into HVAC systems to cater to larger fresh air loads for hospitals, animal laboratories and hotels.

5. THE TFA INCORPORATING ENERGY RECOVERY DEVICES

These Treated Fresh Air Units incorporating Energy devices or TFAs as they are commonly known as (also known as Energy Recovery Ventilators (ERVs) or fresh air pre-conditioners), provide many answers to the challenges faced by the designers today. They not only meet the need of the 90's but also the next millennium.

TFAs are typically used for treating/preconditioning ventilation air i.e. fresh air as well as far achieving acceptable IAQ, Humidity control, Energy conservation/efficiency, and in the process reducing the building envelope.

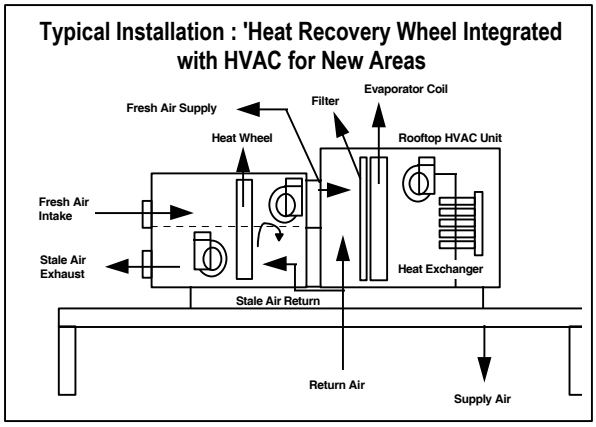

Figure-8

TFAs incorporating Energy Recovery differ in many ways from the conventional system. Some major areas of difference are listed below :

Two tier system handling exhaust and supply air stream

* Exhaust air section, Supply air section, Inlet damper section, Filter section both for exhaust and supply, Rotary Heat Exchanger section, Cooling section (optional), Supply air blower and motor section

Figure-9

The TFA incorporating Energy Recovery device exchanges the energy from the exhaust air to incoming fresh air.

The exhaust air drawn through the exhaust section is passed through half section of the rotary heat exchanger, where it give up its energy to the exchanger.

The filtered supply air passes over the other half of the rotating heat exchanger, in the supply section and exchanges the energy. This, pretreated air passes over a cooling (optional) coil, for further, before it is supplied into the area.

These TFAs incorporates the 'Eco-fresh' Rotary heat recovery wheels which gives it an overwhelming advantage over conventional systems. Some benefits of using the Eco fresh wheels are :

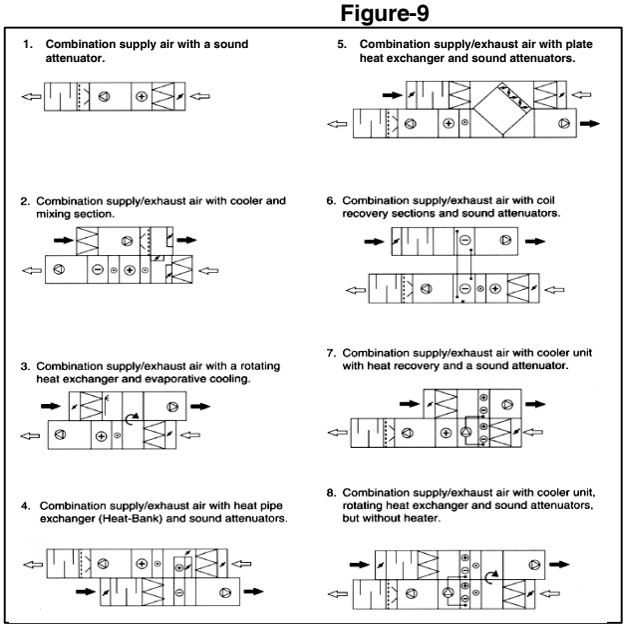

Figure-10

* Typical recovery: 71 to 81%.
* No cross contamination between exhaust and fresh air.
* Selective adsorption: special grade molecular sieve desiccant allows only water molecules to pass through it rejecting all other pollutants.
* Two tier system handling exhaust and supply air stream.
* Inlet damper section
* Filter section both for exhaust and supply, bag filters for dusty application.
* Incorporates ***Ecofresh*** Heat Wheel along with filtration, damper control, other airtreatment devices/options.
* Supply and exhaust air blower and motor.
* Double skinned, eco-friendly insulation.
* Eliminates need for complicated ducting.
* Available in range 0.3m^3/s to 6.0m^3/s.

Figure-11

5.1 Advantage of Ecoresh inside !

* Total energy recovery, recovers both latent and sensible energy.
* '***Ecofresh***' has equal recoveries unlike etched (European) wheel which are limited in latent recovery.
* For latent recoveries special grade desiccant, Ecosorb-340, ensures selectivity for moisture only; eliminating desiccant contamination totally.
* For given face velocity, recovery and pressure drops of "***Ecofresh***" is better than any internationally available rotary heat recovery wheel.
* Specially, adjustable purge section rules out cross contamination of air stream. (less than 0.04%)
* Special labyrinth sealing arrangement ensure no cross leakage of air stream between the supply and exhaust section.

6. DESICCANT BASED DEHUMIDIFIER FOR HUMIDITY CONTROL AND TREATMENT OF FRESH AIR

6.1 The Moisture menace

Although moisture is invisible, its damaging effect on almost everything around us is very evident.

Rusting of metals, lumping and decomposition of chemicals, increased microbial activity leading to growth of mould, mildew and fungi on organic substances, warping, decay, deterioration, etc. are some of the common problems due to high humidity encountered in our daily life.

In most cases, controlling the relative humidity to below 35% helps to keep this moisture menace under check.

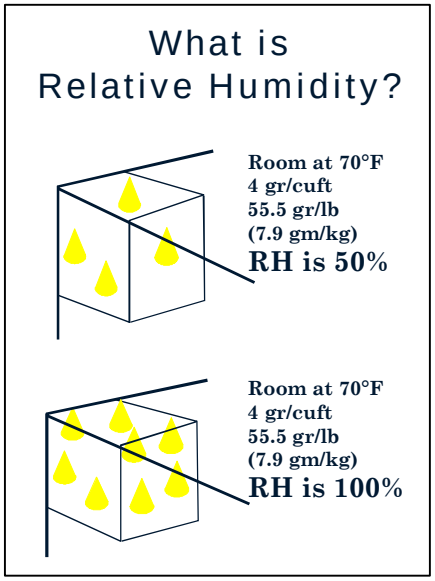

Figure-12

6.2 What is Relative Humidity?

Relative humidity is the actual amount of moisture in the air compared to the total or maximum moisture the air can hold at a given temperature.

6.3 Methods of Dehumidification

Principally there are three methods of dehumidification:-

... Over compression

... Refrigeration Dehumidification

... Sorption Dehumidification

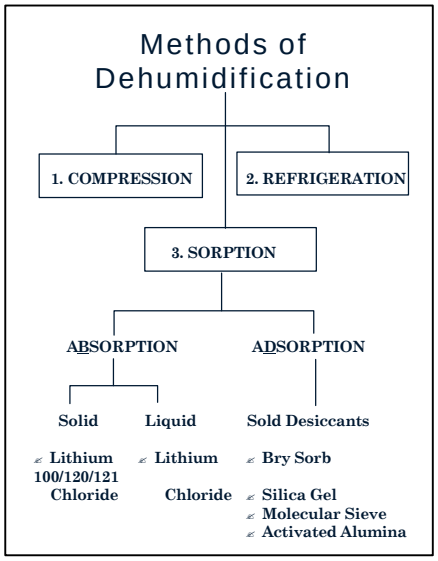

Figure-13

6.3.1 Using Compression to Dry Air *Air compression suggests a method of reducing moisture content in air*. This approach is some times quite practical for very small volumes of air but the cost of compressed equipment, BHP requirement and the amount of cooling water required for after-cooling make it very impractical for large volumes of air.

6.3.2 Reducing Temperature to Dry Air Another method most commonly employed is the reduction of moisture in the air by means of reducing the temperature. But cooling to very low temperature makes the refrigeration process impractical, as it requires a great deal of subsequent re-heating. The reduction in air temperature is also limited by the freezing point of water condensing on the cooling coil.

6.3.3. Using Sorbents to Dry Air Sorbents are solid or liquid materials which have the property of extracting and holding other substances (usually water vapour) brought into contact with them.

Sorbents can be classified into two general categories.

* A**b**sorbents
* A**d**sorbents

Absorbent: Absorbents are generally liquids or solids which become liquid as they absorb moisture, i.e. they undergo a physical or chemical change as they collect moisture. Lithium Chloride (LiCi) and Sodium Chloride (NiCi) are typical examples.

Adsorbent: Adsorbent do not under go any physical or chemical change when they come in contact with moisture. Water is adsorbed or held on the surface of the material and in the pores, Adsorbents are mostly solids. Typical examples of Adsorbents used for dehumidification are silica gel, molecular sieve and activation alumina.

7. DEHUMIDIFIERS

Bry-Air engineers and manufactures a large range of solid as well as fluted media based Dehumidifiers which work on the principle of physical adsorption. Water Vapour is removed from the air stream by exposing it to solid desiccant and retained by it without undergoing any physical or chemical change. This principle is combined with revolutionary mechanical engineering design whereby moisture is removed on a continuous basis.

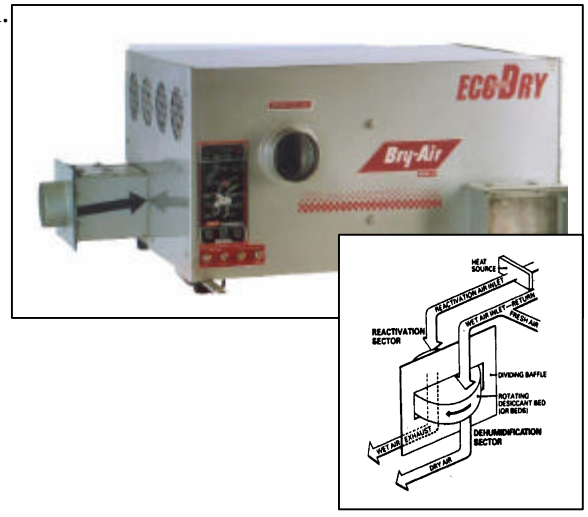

Figure-14

7.1 The Operating principle . . . . . .

. . . . . Solid Desiccant (Granular) based range

Bry-Air *Ecodry* compact and MVB dehumidifier a mixture of moist fresh and return air with a patented rotating bed filled with an adsorbing desiccant. The moist air enters the inlet and moves through the dehumidification side of one or more of these rotating beds. The desiccant in the bed(s) adsorbs the moisture in the air. The dehumidified air then moves through ducts to the

controlled area. The dehumidifying process may use pre-cooling of the moist air to assist in moisture removal. Once dehumidified, the air may be heated or cooled, if required, before moving to the controlled area.

As the bed rotates, desiccant which has adsorbed moisture moves into the reactivation sector of the dehumidifier. The hot air moving through the bed reactivates the desiccant by driving off the adsorbed moisture.

The Bry-Air dehumidifying principle produces continuous and even dehumidification, with no peaks or valleys. As the equipment works independent of dewpoint the dehumidifiers can maintain 1% RH or even lower.

Bry-Air Ecodry solid (granular) desiccant based Dehumidifiers use a single rotating bed as well as rotating multiple bed carousal concept.

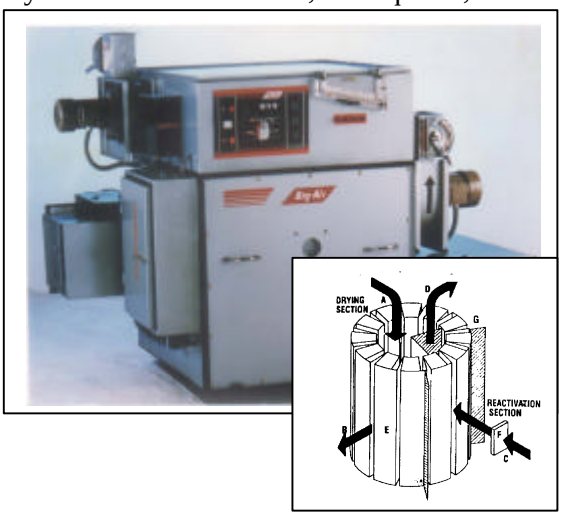

Figure-15

7.2 . . . . . Fluted Media Based Range

The Bry-Air EcoDry FVB (Fluted Vertical Bed) is the latest in desiccant dehumidifiers. The FVB incorporates a custom made fluted rotor which ensures highest moisture removal at lowest energy cost.

The FVB dehumidifier has a smaller foot print thus allowing for space saving, and is available in capacities ranging from 1500 cmh (880 cfm) to 7600 cmh (4473 cfm).

Bry-Air FVB can package the dehumidification with pre/after cooling, by-pass ducting and mixing chambers, volume controls, filter elements, etc, for complete environment control in a single package for any application.

Figure-16

7.3 People prefer cool and dry air . . . . . Dehumidifiers to maintain IAQ

The impact of indoor humidity on people has been neglected for decades. Ventilation rates required to obtain a certain perceived air quality, have been also assumed to be independent of humidity. It has been generally accepted that pollutants from indoor air sources viz. from human, tobacco smokes, VOCs etc, need to be diluted with outdoor air to a level perceived acceptable by the people. Thus, treating outdoor for humidity control has not been focus of designers. However, recent studies at various international forums have shown that perceived Indoor Air Quality (IAQ) is strongly influenced by both ***humidity*** and ***temperature*** of air we inhale!

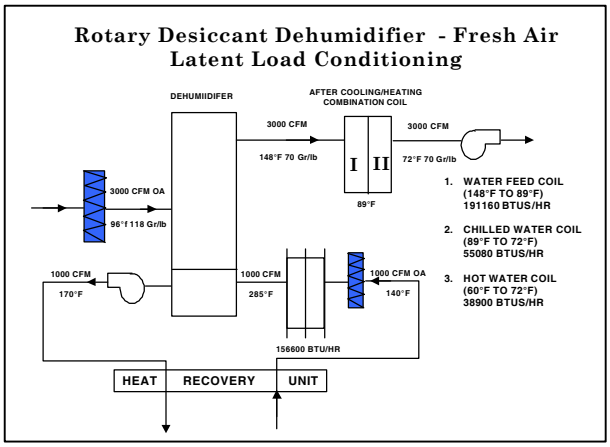

Figure-17

Increased awareness of IAQ and health consciousness has resulted in increased concern for methods used to treat fresh air.

8. TREATING FRESH AIR WITH ROTARY DESICCANT DEHUMIDIFIERS TO CONTROL HUMIDITY

Conventional treatment of air, where air is cooled, condenses the water, which tends to create health problems due to mould, mildew and bacteria formation.

Using a rotary desiccant dehumidifier to precondition air is preferred in service industry or similar areas where 100% fresh air is required to be treated.

The fresh air is either precooled partially and then passed through a rotary desiccant dehumidifier, where the moisture content is reduced to the desired level. This air is passed over a heat exchanger coil fed with a cooling tower and/or chilled water to bring down the temperature to the desired level.

Such treatment units are more cost effective, ore hygienic and the problem of mould, mildew formation and bacteria growth is totally eliminated. Also, additional advantage is elimination of usage of CFC based system to a large extent. Payback of such system range between 1 year to 3 year.

9. ENGINEERING AND INSTALLATION OPTIONS . . . . . .

Though Bry-Air equipment is highly standardized, it is versatile in its applicability.

The equipment can be used in various systems or a combination of systems to arrive at the best selection for a job.

The selection options are :

* Stand Alone (standard)
* Packaged Systems (Engineered)

Packaged system can be engineered to include cooling, heating, humidification, dehumidification, Heat Recovery, filiteration and dust control.

Both the standard and engineered units can be applied as:

* Recirculatory
* Once through (100% Fresh Air)

Recirculatory would mean that dry air having a certain dewpoint is being fed into a storage or process area and after picking up moisture from the process or circulating around stored material, is recirculated through the dehumidifier to give a continuous supply of dry air.

9.1 The Recirculatory System can be applied as -

* Closed Loop System
* Open Loop System

Closed Loop System

The system is applied when conditioning of a total process or storage area is called for, that is, the whole volume of air existing in the area needs to be dehumidified.

Dry air is supplied to the room by a concentrated air supply and recycled through the dehumidifier, giving primary control of the humid environment of the room or place to be dehumidified.

9.3 Open Loop System

As opposed to total conditioning of the space, only an object, machine or limited space needs to be conditioned.

The open loop system gives primary control of the internal humid environment in the object to be protected.

In the *Open Loop System* dry air may be fed into equipment which is -

* Shrouded
* Unshrouded

In *shrouded system* equipment to be protected is placed in covers of plastic sheeting or boxes which are connected to the dehumidifier to give a storage effect.

In *unshrouded system* dry air is passed through the equipment to circulate inside the equipment and bled off from openings or crevices to provide a dry environment for the internals as well.

The versatility of Bry-Air equipment in engineering and installation options makes it the ideal choice for any application ..... anywhere.

10. DESICCANT BASED COOLING (DBC) SYSTEMS

Desiccant ventilation has come of age and has moved from 'research' to commercialisation. Desiccant based evaporative cooling system provide environment friendly technology for comfort airconditioning with added advantage of simple robustness and low power consumption.

Desiccant Based Cooling eliminate CFC's and essentially comprise of the following :

* Desiccant dehumidifying rotor
* Sensible heat recovery wheel
* Evaporative pads
* Regeneration heating system
* Blowers

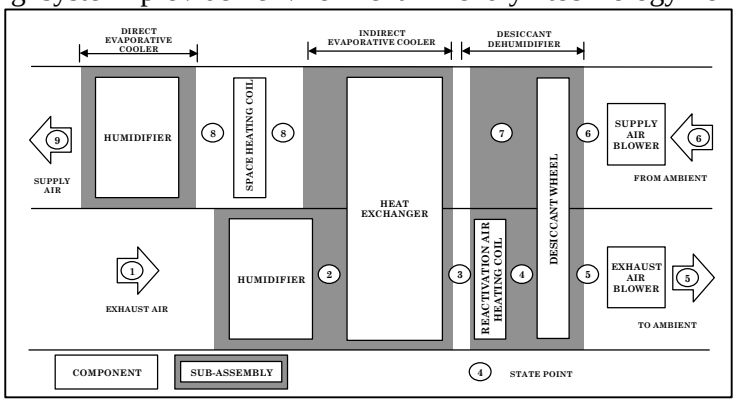

Figure-18

11. THE EQUIPMENT FOR THE NEXT MILLENNIUM

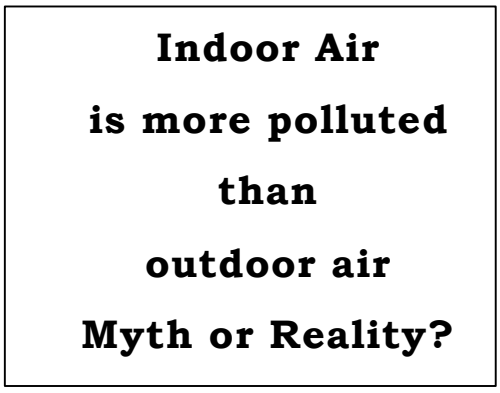

Figure-19

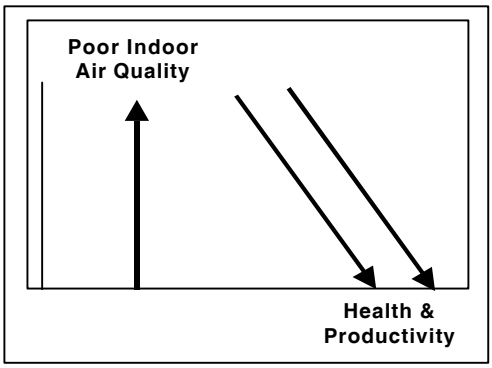

Figure-20

Having understood the basic operating principle of various equipments available for treating fresh air, it is evident that the solution to the problem faced by the designer, today, can be provide a by basically the last three products discussed in the earlier pages i.e. the Treated Fresh Air units incorporating Energy Recovery Devices, Desiccant Based Dehumidifiers and Desiccant Based Cooling Systems.

Let us look a little more closely at needs of Indoor Air Quality (IAQ) which dictate the choice of a system for Treating Fresh Air.

In recent years, the attention of environmental researchers has been focused on indoor air pollution, as a result of reports of symptoms or specific diseases that occur mainly in airconditioned and mechanically ventilated buildings. Studies have proved that level of contaminants in the indoor air can be often several times higher than outdoor air. This combined with the fact that people tend to spend spend 90% of their time indoors, proves the point that a person's major source of exposure to airborne contaminants can be indoors Airconditioning is a major factor affecting Indoor Air Quality (IAQ). Majority of airconditioning systems are

designed with very little or almost no provision for fresh air, as fresh air means, more kilowatts of conditioning and thus, higher energy cost.

Inadequate ventilation, coupled with recirculation of state air, result in Poor Indoor Air Quality (IAQ), due to a build up of pollutants like cigarette smoke, carbon-dioxide, mould, bacteria, viruses and PO potentially dangerous chemicals emitted from copying machines, furniture, carpets and paint. The high concentration of pollutants in indoor conditioned space causes a phenomenon known as the "**Sick Building Syndrome**". This is a term that describes the presence of acute non- specific symptoms in the majority of the people caused by working in buildings with an adverse indoor environment. It is a cluster of complex symptoms that include irritation of the eyes, blocked nose and throat, headaches, dizziness, wheezing, sinus, congestion, dry skin rash and nausea.

Figure-21

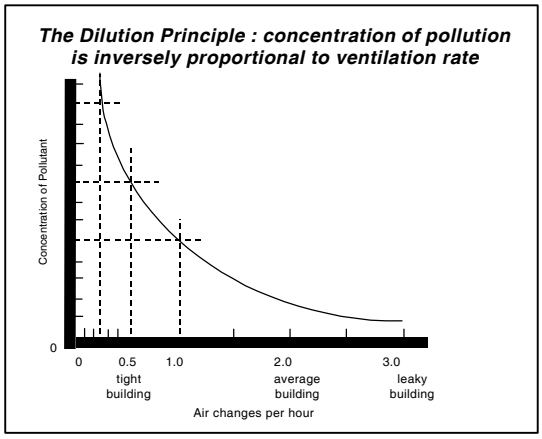

Figure-22

These symptoms are generally work related, that is, they begin shortly after the person enters the building and disappear within a few hours, after he leaves it.

A more and long term effect on health may arise due to a continued exposure to a building related illness.

11.1 The Solution to Pollution is Dilution

Environment researchers have found that increasing ventilation helps in diluting the pollutants. In fact, concentration of pollution is inversely proportional to ventilation rate; doubling the ventilation, halves the concentration. Thus, increasing ventilation is the most effective method for improving IAQ.

Regulations and Guidelines pertaining to IAQ

Regulatory Body	Country	Standard	Ventilation	CO2 (not exceeding)
OSHA	US	29 cfr 1910.1033 (Proposed)		800ppm
ASHRAE	US	62-1989	15 cfm/person 20 cfm/person 7 people/1000ft2 for office	1000 ppm
		Codes for new homes/construction		
NBCC	Canada		0.5 AC/HR	1000 ppm
	Sweden		0.5 AC/HR	1000 ppm
	France		0.5 AC/HR	1000 ppm
	Japan		15 cfm/person	1000 ppm

11.2 Energy Cost Vs IAQ

Increasing ventilation, however, hikes up energy costs substantially. With the recent adoption of ASHRAE (American Society of Heating, Refrigeration and Airconditioning Engineers) Standard 62-89, the recommended levels of outside air brought into buildings has been increased by as much as 400%. This imposes much higher latent and sensible loads on the cooling and heating equipment.

Figure-23

Reproduced below are the recommended ventilation rates under the ASHRAE 62-89 standard.

Application	Ventilation Rate/person	Application	Ventilation Rate/person
Office space	20 cfm	Smoking Lounge	60 cfm
Restaurants	20 cfm	Beauty Salon	25 cfm
Bars/Cocktail	30 cfm	Supermarkets	15 cfm
Hotel Rooms	30 cfm/room	Auditorium	15 cfm
Conference Rooms	20 cfm	Classrooms	15 cfm
Hospital Rooms	25 cfm	Laboratory	20 cfm
Operating Rooms	30 cfm	General Retail	15 cfm

Source : ASHRAE Standard 62-1989

This translates in two ways.

an improved work environment for employees.

but significant higher utility bills for buildings.

Thus, Indoor Air Quality (IAQ) and energy conservation have become the fundamental design goals of HVAC designers.

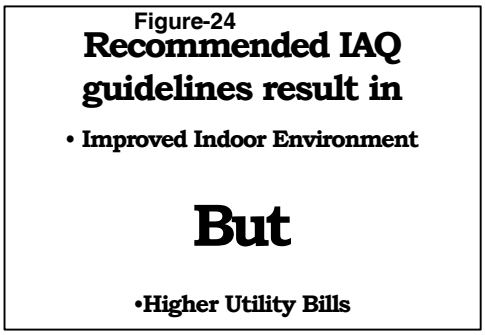

Figure-25

12. CONCLUSION

There have been changes in the air! The rules have changed for the way the buildings have to be designed and built. The demands for stringent indoor air quality, additional fresh air ventilation, concerns about humidity and microbial contamination and the need to find non toxic replacements for CFCs have posed a challenge to the technical creativity and design finesse of the engineers, to find solutions to these needs.

The new generation of desiccant based systems for treating fresh air improves “environment” for *man and his machine* as well as saves energy costs in fact they meet all the criteria of an effective HVAC system.