INDOOR AIR QUALITY (IAQ) *ASHRAE Standard*

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Are you wondering why we have gathered here today to talk about "**Indoor Air Quality**", when we should be more concerned about the "Outdoor Air Pollution", which is the single most vexing problem being faced by the city planners, environmentalists and health professionals, today, then, you are in for a surprise!!!

The reality is that "**Indoor air can be upto 10 times more polluted than outdoor air**". Strange, as it may sound, but the fact remains that the air we breathe, *working or living*, 85% of the time in conditioned spaces may be more injurious to health than outdoor air.

The world focus has now shifted from the '**environment**' to the '**invironment**'. Just as in the 70s, the concerns were "Energy Conservation", in the 80s it was "Global warming and Ozone Depletion", the focus in the **90s** and in the next **millenium** will remain "***Health Hazards***" and "***Indoor Air Quality***".

Over the last 15 years, our knowledge of environmental risk to public health due to poor air quality has increased drastically. Science advisory board has consistently ranked indoor air pollution among the top five environmental risks to public health. Poor Indoor air quality leads to an increased incidence of health related symptoms, which in turn can lead to an increase in **absenteeism** and **loss of productivity**.

What is Indoor Air Quality?

Indoor Air Quality refers to the nature of conditioned air that circulates throughout the space/area where we work and live, that is, the air we breathe during most of our lives. IAQ, refers not only to comfort, which is affected by temperature, humidity and odors, but, also to harmful biological contaminants and chemicals present in the conditioned space.

Most people control the environment in their homes to a degree, which is comfortable and healthy for them. They will open windows if the room feels stuffy and unaired; they will use exhaust fans in the kitchen and toilets to clear smoke and odors; they will not use freshly painted rooms until the smell has gone away. Although, by such practices they can avoid immediate adverse effects, they may not have enough awareness of the long-term effects, of the paint stripper used during refurbishing, which may increase the risk of heart or liver disease, or the long term effect of exposure to insecticides being commonly used.

What is easy to accomplish by an automatic behavior at home is much more difficult to accomplish when applied to buildings inhabited by people of widely varying sensitivities and sensibilities. In many modern large commercial structures, for example, occupants have virtually no control over the environment, they cannot open windows, they cannot turn on exhaust fans and cannot leave the room if a colleague has severe cold and cough. They have no control over the atmosphere in a cinema hall, which smells stuffy and unaired, when they walk in; restaurants or banquet halls, which smell stale and damp or boardrooms with heavy smoke, filled air.

The old adage, "**that you can please some of the people some of the time and all of the people none of the time**" holds true in the HVAC industry. **Artificial environments are geared to the norm and not to the individual**.

In a **conditioned space, since free passage of air is limited**, with little or inadequate fresh air ventilation, it produces an indoor air environment with relatively **high** levels of **contaminants**, **bacteria**, **fungi** and **dust**. The indoor air will certainly have all of the pollutants of the outdoor or surrounding air and those, that are generated within the building by people and their activities like **smoking, hair sprays, cleaning products, paints and pesticides spray residues, carpeting, copy machines** and **air-conditioning coolants**. As a result, indoor air may contain concentration of some components which are greater than the outdoors ambient air. The composite effect of multiple pollutants can seriously impact human respiratory systems leading to various short term and long term illness.

The origins of poor IAQ lie in the emphasis on energy conservation in the 1970's, which resulted in tighter buildings with recirculated air for building ventilation and minimum amounts of fresh air being brought into commercial buildings. **Ventilation for comfort began to compete with ventilation for health**. This minimized the amount of air to be heated or cooled and hence conserved on energy. This resulted in a situation described as the '**Sick Building Syndrome**' (SBS), a term which was used to describe the presence of acute non specific symptoms in the majority of people, caused by working in buildings with an adverse indoor environment. It was a cluster of complex irritative symptoms like **irritation of the eyes, blockened nose and throat, headaches, dizziness, lethargy, fatigue irritation, wheezing, sinus, congestion, dry skin, skin rash, sensory discomfort from odors and nausea**. These symptoms are usually short term and experienced immediately after exposure; and may disappear when you leave the building.

SBS is suspected when a substantial portion of the people spending extended time in a building report or experience acute on site discomfort.

The **building related illnesses** (BRI) are attributed directly to the specific airborne building contaminants, like the outbreak of the legionnaire's disease after a convention and sensitivity pneumontis with prolonged exposure to the indoor environment of the building.

The economic consequences of the SBS and BRI are decreased productivity, absenteeism and the legal implications if worker IAQ complaints are left unresolved.

While there is no proof that maximum comfort leads to maximum productivity, there is ample evidence that an improved environment decreases worker complaints and absenteeism thus directly enhancing productivity.

How does one know if the air inside your building is dangerous to your health?

Often it is difficult to determine which pollutant or pollutants are the source of person’s ill health or even if indoor air pollution is the problem. Many indoor air pollutants cannot be detected by our senses and the systems they produce can be vague and sometimes similar making it hard to attribute them to a specific cause.

Although it is extremely expensive and difficult to detect or measure the indoor air contaminants, **CO_2 carbon dioxide has been recognized by** ASHRAE (The American Society for Heating, Refrigeration and Air-conditioning Engineers) as **the surrogate ventilation index** or the only measurable variable. **Carbon dioxide levels** in an airconditioned room is a **good indicator of occupancy and ventilation** rate within a space. CO_2 by itself is not considered an indoor air contaminant and humans are the major source of CO_2. However, if, CO_2 levels in a room are higher than 1000 ppm, then it is an indication that not enough outdoor air is coming in to dilute the CO_2 level. The indoor air is being recirculated and the level of other pollutants is also high. Measurement of CO_2 is easy and instruments are available to measure it within the enclosed space.

The measurement of CO_2 levels in a building give us an idea about the ventilation rates in a building. This is important, as the cause of SBS over the years has been attributed to the building's HVAC systems and inadequate ventilation systems. Some specialists have even likened the HVAC system of a building to the heart, lungs and pathways in a human body. A building ventilation acts like the lung in conveying or reducing contaminants. The pathways convey the pollutants from one area to another.

Ventilation systems –

- **can bring in pollutants from outside,**
- **they can be the source of pollutants inside**
- **they can cause pollutants to flow from one location in a building to another or**

* **they can fail to dilute or remove pollutants from a building or a portion of it. When all these factors add up, the single biggest cause of IAQ emerges as –**
* **improperly designed, installed, operated or maintain ventilation systems.**

Some of the most commonly brought in air pollutants are smog, elevated mold spores or pollen due to seasonal growth, vehicle exhausts, legionella and other bacteria from adjacent cooling towers, bacteria or algae from standing water or decaying vegetation.

The most common pollutants generated within a ventilation system are mold spores and bacteria from water in condensate pans, fiberglass from insulation and general dust and debris from the system, which has not been cleaned or properly filtered.

Improper pressure relationships can direct pollutants where they don't belong. For e.g. bathrooms have exhaust fans to remove odors, bacteria. If there is a supply vent in the bathroom that's more powerful than the exhaust then air will flow from the bathroom to adjacent areas. Leaking ducts in an attic can direct air from the attic into occupied spaces.

Tightly constructed buildings, as most modern commercial buildings are, are dependant on fresh air supplied by the ventilation system to dilute contaminants normally generated and present within a building. When the fresh air supplied is insufficient, they can build up to a point where they become a health hazard for the occupants.

So far its only bad news, the good news is that indoor air quality can be improved. Once we have identified that a combination and cocktail of outdoor and indoor pollutants pose as a threat to **health, general well being** and **productivity**, what ***measures can be taken to improve the indoor air quality?***

The two main approaches are **Source Control** and **Removal of contaminants.**

1. In the **Source Control**, if the source is identifiable and removed then this is the best method. Some of the methods would be:

(a) Banning smoking or providing a separated ventilated space for smokers.

(b) Using and storing paints, solvents, pesticides adhesives in closed containers in well ventilated areas.

(c) Using these pollutant sources in periods of low or no occupancy.

(d) Allowing time for new building materials to gas off before occupancy.

(e) Fixing any water leaks.

(f) Replacing water stained ceiling tiles or carpets and drying and other damp areas

(g) Control of humidity to safe level so that mold, fungus and algae formation are prevented.

(h) Regular maintenance of HVAC systems including ducts cleaning.

(i) Providing **efficient filtration** is the HVAC system for keeping outdoor pollutants out.

(j) Exhausts air from rest rooms, copy rooms and printing facilities directly to be vented outside.

2. **For removal** . . . . one of the method is to use Air cleaners and Ionizes and Electronic Precipitators. Though these can rid indoor air of some microscopic particles such as dust and combustion products, they do not purify the air and at best can be used in addition to source control and adequate ventilation.

Increasing the ventilation rate and air distribution rate is a good and cost effective way of reducing indoor pollutant level. At the minimum, heating, ventilating and air conditioning systems should be designed to meet **ventilation standards** in local building codes. Advanced designs of new buildings feature mechanical systems that bring outdoor air into the home. Some of these designs include energy efficient heat recovery ventilators.

Do we have any ventilation standards to follow?

What were the earlier standards and how are they different from the present standards? Who defines these standards? Who monitors them and what are the legal implications of non-compliance? Some of these questions will be answered in detail during the seminar by the experts. However, I will briefly talk you about the standards being practiced and followed the world over and their legal as well as financial implication.

If you trace the history of ventilation standards, we see that the rationales for ventilation began with a concern for health and about a century ago began to gravitate toward a concern for comfort, with particular regard to odor and sensory irritation. Based upon the knowledge available then, for years afterwards, ventilation rates necessary to achieve comfort seemed readily to surpass those necessary to maintain health. Research on health and IAQ performed over the last two decades has justified a return to a concern for health.

ASHRAE - The American Society for Heating, Refrigeration and Air Conditioning Engineers have exercised jurisdiction over Indoor air quality over the years. ASHRAE’s standard carries significant weight because its existing standard has become the most widely used and cited document for IAQ in the world.

Initially the ASHRAE standard 62-1973 recommended levels of ventilation were intended to suffice “for the preservation of the occupant's health, safety and well being”.

In ASHRAE 62-1981 it changed to specify indoor air quality and minimum ventilation rates which will be acceptable to human occupants and will not impair health”.

ASHRAE 62-1989 and 90, the next revision stated the purpose as “to specify minimum ventilation and indoor air quality that will minimize the potential for adverse health effects”.

The standard 62-1989 recommends fresh air intake of 20 cfm per person. There is an ongoing debate about the new standard which is eight years into its making intends to incorporate the chemical, physical and biological contamination contaminant's, as well as moisture and temperature that can effect human health and perceived air quality. Another main aspect is that it will be written in a code compliant language. It will address factors, which go beyond design and will address construction, startup, operation and maintenance. Ventilation rates now include a building component as well as occupant component recognizing that office machines, copiers etc. also are a source of contaminants in space.

On August 15, 1998, the American Society of Heating, Refrigerating & Air-conditioning Engineers (ASHRAE) **proposed a new industry standard for ventilation**.

Known as “**Ventilation for Acceptable Indoor Air Quality**”, the proposed new standard would impose:

(1) New and renovated buildings to be designed with strict adherence to complex heating and air conditioning system design procedures.

(2) Failure to perform routine maintenance operations, like changing air filters, becomes a building code violation.

(3) Businesses are required to retain all inspection and service records for the life of heating and air conditioning systems.

(4) Every business must designate a “responsible party” to manage indoor air quality-a person, department or contractor who must be trained in indoor air quality principles and regulations.

(5) Acceptable indoor air quality cannot be achieved in the presence of environmental tobacco smoke, regardless of the ventilation and filtration systems installed (a major problem for restaurants and bars).

Non adherence to building codes and ventilation standards in advanced nations, particularly in U.S.A., have caused the number of litigations regarding IAQ problems increase dramatically in recent times. A study regarding why so many building get into litigation revealed the following as answers.

- Ignoring signs and symptoms
- Continuous degradation
- Addressing short-term concerns

* Looking for the inexpensive fix
* Failure to involve key/users
* Failure to communicate
* Failure to manage a crisis

Who Can Be Sued for SBS?

Architects, contractors, HVAC contractors, building owners and managers, manufacturers, distributors of products, leasing agents, and real estate agents.

Education and communication are important parts of any air quality management programme. When everyone associated with the building, designers, architects, contractors, owners, managers and occupants fully understand the issues and communicate with each other they can work more effectively together to prevent and solve problems.

Architects when designing and building new homes and building can incorporate ideas as well the choice of materials that ensure that IAQ issues of ventilation, humidity control and source control of pollutants are kept in mind. Some of them can be

* Use radon resistant construction techniques
* Choose building materials and furnishings that will keep indoor air pollutant to a minimum
* Provide proper drainage and seal foundations in new construction
* Install mechanical ventilation systems
* Ensure that combustion appliances are properly vented.

It is also important that architects provide adequate space, while designing a building, for ventilation and ventilation equipment so that airconditioning consultants can incorporate the same.

Most building is not designed to accommodate equipment which can improve ventilation.

Thus, engineers, and designers, today, constantly face the challenge to conceptualise, design and specify cost-effective solution for conditioning large volumes of fresh air. An ideal 'airconditioning' equipment should sanitise, cool, heat, humidify/dehumidify, evenly distribution air through the area and all; cost effectively. That is the challenge, the designer faces today.

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.

ASHRAE equipment handbook 1988 refers to six types of air to air heat exchange devices. There are some which are sensible only and some are total heat exchangers (sensible and latent heat or enthalpy). The twin tower loop is a total heat exchanger. The rotary exchanger or heat wheel can be either a sensible only or a total heat device. The rest are essentially sensible heat exchangers in which transfer of latent heat, if any, is incidental.

Types of Recovery Devices

1. Rotary Energy Exchangers
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 chart below 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.

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. The flutes are triangular or semi-circular in cross-section. The structure, commonly referred to as the honeycomb matrix, is produced by interleaving flat and corrugated layers of a high conductivity material, usually aluminium, surfaced with a desiccant. Stainless steel, ceramic, and synthetic materials may be used, instead of aluminium, in specific applications. The flutes in most wheels measure between 1.5 mm to 2.0 mm in height. 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.

The psychrometrics of recovery is explained in the figure (slide). In simple sensible recovery, cold air is heated from 1 to 2 while hot air is cooled from 3 to 4. In this case, the cold air temperature is above the dew point of the hot air and no condensation takes place in the media.

A sensible process in which condensation occurs in the hot air stream along with evaporation in the cold one. In this case, latent heat transfer enhances the overall wheel effectiveness.

The total heat recovery process of the enthalpy wheel, assuming mass flow rates in the air streams are the same, and latent and total heat effectiveness are equal.
(*The above processes are explained through enclosed slides)*

A Historical Perspective

Use of rotary heat exchangers in comfort air conditioning dates back to mid fifties with folded wire mesh pads. These devices were essentially sensible heat devices. Wheels with the familiar honeycomb matrix were introduced in the mid sixties. The medium was asbestos paper impregnated with lithium chloride. Due to inherent absorption properties of asbestos and lithium chloride these rotors had a short life and in the late seventies asbestos was replaced by kraft paper; however, lithium chloride continued to remain the preferred desiccant due to its ease of impregnation of media.

In the mid seventies, two new enthalpy wheel models hit the market and continue to be offered till date. The oxidised aluminium wheels offered by some manufacturers, has corrugated aluminium foil wound on a mandrel and braced by steel strips on the sides. The assembly is dipped into a bromide solution to cause the aluminium to oxidise and form a layer of alumina - a known desiccant. Such wheels have heat transfer characteristics comparable to the others at a lower cost. However, they have a weaker structural integrity and suffer from a desiccant migration problem. The other type of wheel uses silica gel as desiccant which is bonded to the aluminium substrate through a coating process. The matrix is supported by spokes and rim assembly.

In the 1980s, considerable advances were being made in the fabrication of silica and other compounds for the semiconductor industry. A derivative of these innovations was the development of molecular sieves - synthetic zeolites that could be designed at the molecular level. At the same time, manufacturing processes had been developed to allow the bonding of a breathable layer of desiccant to metal or plastic surfaces. These technologies have influenced the newer generation of enthalpy wheels. The chronology of wheel development is graphically depicted.

Advancements in Enthalpy Wheels . . . . . . What you see!

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 contaminations 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.

* 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.

Advancements in Enthalpy Wheel . . . . . . 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.

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. A portion of the air that would normally be recirculated through the system is exhausted through the wheel and fresh air is introduced into the building in its place. 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 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.

* Current standards for outside air ventilation can be met or exceeded with minimal energy cost impact on the building.
* Incoming outside air is dehumidified by the desiccant wheel, allowing the rest of the ventilation system to run dry. As a result, indoor humidities are maintainable well below the conditions that would favour the growth of mould, mildew and other microbial contamination.
* The need for cooling capacity that normally would be required to dehumidify and cool outside air is eliminated. This is typically 30 to 50% of total system capacity. In most cases, the cost of the energy wheels is almost less than the cooling capacity it is replacing. The first cost of a building's cooling system can actually be reduced with a wheel system.
* Many utilities charge extra for the electrical energy used during peak cooling periods. A wheel system can significantly reduce peak demand charges.
* In the winter, wheel systems can preheat and humidify incoming cold dry air.
* Because the system is capable of recovering 80% of the heating or cooling energy that is exhausted from a building, the cost of fresh air ventilation is reduced. Annual savings can range from US$1 to $2 annually for each cfm of fresh air ventilation.
* Given that the cost of the system is similar to the cost of conventional heating and cooling capacity, the system has an immediate payback. In retrofit applications, where cooling capacity is already in place, payback would typically take place in 1 to 3 years.

The Treated Fresh Air (TFA) Units incorporating Energy Recovery Devices; also known as Energy Recovery Ventilators or Fresh Air Pre-conditioners.

Treated Fresh Air Units incorporating Energy devices or TFAs as they are commonly known as, 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.

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

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

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:

* Typical recovery: 80%.
* 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 $6.0m^3/s$.

Advantage of "Ecofresh" 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 arrangements ensure no cross leakage of air stream between the supply and exhaust section.
* Other options for recovery devices :
  - Heat pipe based heat recovery unit
  - Cross plate based heat recovery unit
  - Cross plate heat exchanger

As the above heat exchangers are essentially for sensible recovery, as such these do not find many applications in a country like India.

Let us discuss a few more equipment, which are being used for Treating Fresh Air these days. One of them is the rotary desiccant based dehumidifier. Now, Dehumidifiers have been traditionally viewed as equipment for “industrial” usage.

However, in the recent times, dehumidifiers are being increasingly used for treating fresh air for IAQ needs.

Rotary desiccant based dehumidifier for Treatment of Fresh Air

People prefer cool and dry air!

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 at various international forums have shown that perceived Indoor Air Quality (IAQ) is strongly influenced by both ***humidity*** and ***temperature*** of air we inhale! Increased awareness of IAQ and health consciousness has resulted in increased concern for methods used to treat fresh air.

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 mold, 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 mold, 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.

Another next generation equipment is the . . . .
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

Outdoor air to be treated is passed through a dehumidification rotor, where the moisture is reduced. The air leaves the dehumidification rotor at lower moisture content but at an elevated temperature.

(The process takes place along the enthalpy line or a psychometric chart).

This, hot, dry air is passed through the rotating sensible wheel, where it give up sensible heat, and cools down.

This air which now has a very low moisture content, (much lower than desired in the area to be conditioned), passed through the direct evaporative pads, where the air cools and picks up moisture. (This process takes place along the wet bulb line on a psychometric chart). This cool air is now delivered into the area to be conditioned.

The dehumidification rotor needs regenerating, and is precooled using evaporative pads and made to pass over the rotary sensible heat exchanger (where is exchanges the energy, gained by the wheel from the air leaving the process outlet side of the dehumidifier) and picks up the heat and the temperature rises.

The air is further heated up to desired regeneration temperature, and then passes through the dehumidifier to pick up the moisture and exhaust it into the atmosphere.

Last but not the least, we will touch on a system,9 which based on the natural phenomenon of evaporative cooling.

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.

The evaporative pads or cooling pads as they are also known as, are made of treated, corrugated cellulose paper.

Application needs and cooling efficiency dictate pitch size and angle of the flute of the corrugated paper.

Evaporative cooling pads, under brand name, Ecocool is now being manufactured in India by Arctic India Engineering and can be customised to application requirement.

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

Fresh air, which is warm or hot, is blown (with the help of a fan) through the wet Ecocool pad. The water evaporates when it comes in contact with the warm/hot air, thus cooling as well as humidifying the air entering the area.
Some typical applications of Ecocool Evaporative cooling pads based
systems are for -

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

The equipments for the next millennium

Having understood the basic operating principle of various equipments available for monitoring Indoor Air Quality (IAQ) and treating fresh air, it is evident that the solution to the problem faced by the designer, today, can be provide a by basically the Treated Fresh Air (TFA) units incorporating Energy Recovery Devices, rotating desiccant based dehumidifiers and desiccant based cooling systems.

Innovative designs of the building and efficient design of the HVAC system with incorporation of energy recovery systems can reduce energy bills and reduce first costs as well as.