President's Message

ASHRAE India Chapter (AIC) wishes everyone a happy, healthy and prosperous new year 2023!

I am grateful to AIC members and the AIC BOG team for supporting me in the successful completion of the last six months of my presidency (2022-2023). In this period, we had successfully organised several events for our members like student football tournament, online seminars, workshops, membership promotion events, industrial visits for students, expert talks, orientation programs etc.

ASHRAE India Chapter has received the “Certificate of Achievement” for achieving the Research Promotion (RP) goal at RAL CRC-2022, Istanbul. I would like to congratulate Mr. Abid Husain, Immediate Past President for receiving the “Presidential Awards of Excellence”, and Mr. K D Singh, Dr. Rajinder Singh and Mr. Indrajit Bhattacharya for getting felicitated for “Chapter Service Awards”.

I would like to thank and congratulate Dr. Om Taneja, Chair AIC Electronic Communications Committee (ECC) and his team to bringing out the second newsletter of the society calendar. This newsletter has three interesting articles for the member’s read on the topics of “climate change concerns related to excessive outdoor lighting in Delhi”, “codes and standards outlook on Indoor Environment Quality and Building energy Efficiency” and “sustainable architecture for mitigating climate crisis. I extend my warm gratitude to all the authors of the articles.

AIC is planning an array of events for the members of the society in 2023. I request you to follow us at our social media handles at Linkedin and Facebook.

I look forward to getting continuous support from the AIC members to bring valuable articles for the upcoming newsletter.

Regards,

KANAGARAJ GANESAN
President
ASHRAE INDIA CHAPTER
ASHRAE India Chapter feels glad to share glimpses of the 2nd Edition of the Intercollege Football Tournament held on 1st October, in Memory of Lt. Sh. N.C. Gupta - the Legend in the HVAC fraternity. The event was a huge success and was attended by Mr. Sunil Gupta - S/O Sh. N.C. Gupta, apart from the other dignitaries like Mr. Abid Husain - IIP & Historian, Mr. Richie Mittal - Region Director and Regional Chair, Mr. Kanagaraj Ganesan - President, Mr. Rajesh Jain - President, Dr. Rajinder Singh - Refrigeration Chair & Co-Chair-Student Activity, Mr. Abhishek Jain - Chair-Student Activity, Mr. Ashish Gupta - BOG Member &Co - Chair-Refrigeration, Mr. W. Siddiqui – BOG Member & Chair - Membership Promotion, Mr. Ankit Anand - Co-News Letter & Home Page Editor & ECC, Mr. Rakesh Chauhan -Director Hisense, Mr. N. Gandhi-Hisense, Mr. Nitish Mathur of DRI, Mr. P. Jain – Airflow Pvt.Ltd, and also SBAs like Dr. Satyaveer-IIMT College, Dr. Vaibhav Jain -MAIT College, graced the event.

The participating teams were RICS School of Built Environment, Amity University, Pusa Institute of Technology, Maharaja Agrasen Institute Of Technology, Delhi Technical University, IIMT Group of Colleges, and ABES Engineering College.

The winner of the Tournament was ABES Engineering College

1st runner-up was the Pusa Institute of Technology and 2nd runner-up was the IIMT Group of Colleges college.


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Lighting and excessive electricity consumption is adding to climate change problems!

An article by Kabir P Singh

Delhi is the capital of India, as well as a large hub for commercial activity which takes place within the country. As a result, many people are attracted to Delhi in search of high paying jobs and better opportunities. Delhi also has an extremely active ‘night life’ with busy markets. This has meant that many small shop retailers as well as bigger businesses experience stiff competition for customers. Therefore, businesses try and adopt aggressive marketing practices such as leaving their signages and brand marketing billboards brightly lit through the night for constant advertisement.

As more companies have started to advertise to attract the public eye, electricity usage has seen an enormous increase in demand within the markets of Delhi. As per studies done in 2016, electric billboards and shop signs which are left on the whole night have led to consumption of electricity in Delhi exceeding 1561 units per annum. This is far greater than the national average of 1122 units in 2016-17. This is set to increase further as more companies emerge and more advertisement billboards are being put up around the city. By the end of 2022, the electricity consumption is set to increase to more than 8,200 units. This is a 285% increase from the 2002 energy consumption levels of Delhi (4,400 units). Electric billboards need cooling systems attached, especially in the Delhi heat, to stop overheating which means that an average billboard uses 2 times more electricity than the average household further increasing the heat generated in Delhi.

These billboards around the markets of Delhi are lit up the whole day and night, requiring heavy electricity usage during the day as the screens have to be brighter. However, they do not seem to reduce in brightness at night, continuing to display ads at an uncomfortable level of brightness, thereby disturbing the drivers on the road as well as the surrounding environment. Above is a picture of an electric billboard outside the South Extension Market at 7:45 pm, which is when the market is open. However, the billboard and other retail shop lighting continues to stay on during the night as seen in the picture below which was taken at 10:43 pm when the market is shut.

Having said that, electric billboards and shop signs are not the only reason the electricity consumption are soaring through the roof. With Delhi achieving 100% electrification, and its population rising incredibly quickly, reaching 32,066,000 in 2022, which was already a 2.84% increase from 2021. With a rapidly increasing population, the demand for electricity has increased. Households have an average size of about 4.55 people per house. Energy levels of India have seen an estimate of 4% rise per year, reaching 927 Mtoe in 2021. With this level of increased consumption per year, the energy prices would be through the roof and unsustainable for the future.

Observations;

In Delhi, there is also a lot of unnecessary lighting of commercial/government buildings after office hours. A prime example of this wasteful use of electricity is the Central Cottage Industries Emporium building which has hanging lights in the front of its building throughout the night. They are not advertising any product and since their name is already light up, the hanging lights are unnecessary and lead to wastage of electricity. In the long term, this is harmful for Delhi as other buildings and companies will follow this example, and the light pollution caused will rise drastically leading to environmental rise in night temperature around such areas.

Another area of Delhi which is using high amounts of electricity is the Connaught place market. With lit up shop signs and whole buildings to
Therefore, all this light pollution is causing climate change to worsen by the predators, the moths cannot fulfill their ‘job’ in nature of plant artificial light also effects the surrounding ecosystems by attracting Studies have shown that areas which are brighter cause the trees to bud However, shops and retailers within Connaught place market continue to waste electricity by leaving the lights on after the market has shut. The picture above was taken at 11:11pm, when the market was closed. Despite the shops no longer welcoming costumers, the lighting is continuing to glow brightly, lighting up the building. Studies have shown that areas which are brighter cause the trees to bud earlier. This draws the leaves to grow towards the artificial light. This artificial light also effects the surrounding ecosystems by attracting moths and with them, predators towards the light. With easy picking for the predators, the moths cannot fulfill their ‘job’ in nature of plant pollination. Therefore, this disrupts the overall ecosystem of the plants. Therefore, all this light pollution is causing climate change to worsen by adding excess heat into the air as well as disrupting natural cycles within ecosystems.

What are the alternatives?

Well clearly, the more sustainable method when producing mass amounts of electricity is to generate as much of it as you can through renewable sources such as solar, wind and hydropower. With advancement in technology and a better understanding of how to maximise the efficiency of renewable power, using it would mean a cheaper and more environmentally friendly way to produce energy for the future.

The Delhi government introduced a policy called; “Delhi Solar Policy 2016”, which saw SPV panels being installed on top of government buildings, metro stations and bus stops. This was a good step towards wider use of solar panels around Delhi. Now, the next steps would be to install solar panels on bigger commercial buildings which have a much higher use of electricity.

As Delhi is a hot area, harvesting the solar energy and converting it into power would help reduce our dependency on fossil fuels. As solar panels cost anywhere between 32,000 – 40,000 rupees, its annual electricity cost is far cheaper than using non-renewable energy. By putting solar panels up in high energy consumption areas of Delhi such as housing complexes and shopping areas, the production levels of fossil fuel energy can decrease, decreasing the release of harmful gases into the atmosphere. This would help reduce the pollution levels of Delhi which are at an all-time high and continue to rise as more harmful gases are released. Reports have stated that going out in Delhi is “equivalent of smoking 45 to 50 cigarettes a day” which is extremely harmful for the lungs. Therefore, using more renewable energy would help make the population of Delhi healthier and reduce the public health bills of the government.

Using more renewable energy would also create more jobs in manufacturing, production and research & development. This would not only stimulate the economy but also help progress it towards the tertiary sector, making it more advanced. With enough solar panels set up within the city and some external wind panels around the city/country, not only Delhi but most of India has the potential of running mainly on renewable energy, with only needing non-renewable energy when surges occur. Using renewable energy also means that it will never run out, unlike fossil fuels which is a finite resource and therefore will increase in price over time. In Delhi, making running electric billboards using solar panels mandatory would reduce the electricity usage significantly as well.

Turning the lights off in small shops in markets can save money for them by reducing their electricity bill per month. The saving would grow more rapidly for the city as a whole if more people were to do this across the city. The government can encourage this through programs such as “Lights off Khan Market” on particular days of the week.

Economic incentives such as Tax benefits for commercial establishments, retailers and homes who run exclusively on renewable sources of energy would promote public participating significantly. This would have a long term and sustainable effect on making a more futuristic city with a lower carbon footprint.

Furthermore, due to some old construction in parts of Delhi, many shop retailers continue to use florescent and incandescent lighting which emit excessive amounts of light at very inefficient rates. Florescent lights convert 95% of the energy required into heat and only 5% into light. Switching to LED’s are 80% more efficient as 95% is converted into light and 5% is wasted as heat energy. This allows for shop retailers to reduce
their power consumption and therefore their high electricity bill. Most offices which use the florescent lights contaminate the environment due to the chemicals such as mercury contained within the light itself. Disposal of florescent waste leads to higher amount of toxic, non-renewable waste into the environment. Broken pieces of bulbs lead to the build-up of mercury and can cause poisoning of the surrounding area. Switching to LED which does not contain any of these chemicals reduces the harmful waste produced. LED’s also do not emit UV rays and don’t heat up and release CO2 into the atmosphere. Lasting longer than traditional lights, they need to be changed fewer times and reduce the waste disposed by small shops and other retailers. Making LED’s mandatory in new building establishments can help battle the rising emissions of carbon over time.

Benefits of a changed approach;

The incentives to switch to increased renewable energy are many and benefit the government as well as the wider society.

- Renewable energy is a clean way to produce electricity, reducing Delhi’s carbon footprint
- There is not only one way to produce energy through a renewable source which allows us to produce the energy in various different ways, not relying on one type
  - Solar
  - Wind
  - Hydro
  - Geothermal
- Gives India greater independence as we no longer have to buy electricity from other countries. Renewable energy also gives us energy security for the future when non-renewable sources such as oil and coal run out/ become extremely expensive.
- Any non-renewable energy produced can be sold to other countries, gaining some extra income and stimulate the economy
- Using renewable energy would allow for the user to have consistent power without relying on the main energy grid. It would also reduce their electricity costs as they won’t have to pay 8 rupees per unit.
- Reducing the carbon emissions will also improve the air quality of Delhi, and the health of the city.
- Reduced water pollution of toxic chemicals released from electricity production by fossil fuels
- Helps create more jobs in manufacturing and implementation of the renewable energy structures around Delhi
- Research and development in creating more efficient renewable energy material would also create more advanced jobs and stimulate the economy towards the tertiary sector
- Other forms could include:
  - Tax incentives
  - Subsidies towards implementing solar panels
  - Sponsoring manufacturing/selling of the renewable products

In conclusion, the excessive use of lighting within Delhi is damaging our environment by releasing excess heat and changing natural weather patterns which disrupt the ecosystems. There is a clear need for a combination of implementation of existing environmental rules and incentivising the general population of one of the largest cities in the world to achieve its plan for reduced carbon footprint as pledged by our honourable prime minister during the COP26 conference. With aims to be “net zero” by 2070 and “clean and green” by 2030, Delhi the capital city of India with its population of 32 million has much work to do.
In continuation with previous issue

Analytical, Performance & Prescriptive Codes & Standards Essential for Future Of Buildings to enhance IEQ & Improve Building Efficiency

Om Taneja, PhD, PE, FASHRAE

Framework for a successful interaction —
An organization’s operational and individual activities are related to each other through the potential impact they create (Figure below). Increasingly, we are less and less out in nature and more and more living, working and enjoying in enclosed buildings requiring lighting, heating, cooling, and support services. (Elkington, ACEEE 2017).

Raising Awareness of Occupants & neighborhood towards reducing energy use by shutting down systems and equipment when not required.

INTEGRATED DESIGN – For, High Performance & Sustainable Buildings- Policies & Guidelines To Lower Environmental Impact, Enhance IEQ, Optimize Energy Performance, And Protect & Conserve Water

Many of our operational and individual activities are related to each other through the potential environmental aspects that they create

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<tr>
<th>Operational Activity</th>
<th>Aspect</th>
<th>Individual Activity</th>
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<td>Site Acquisition</td>
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<td>Building Design</td>
<td>Energy &amp; Water Consumption</td>
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<td>Stormwater Runoff</td>
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<td>Building Demolition</td>
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<td>Property Sale / Transfer</td>
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<td>Wastewater Discharge</td>
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Pursue Integration via Guiding Principles

Guiding Principles for Federal Leadership in High Performance and Sustainable Buildings

- Factors that Degrade Performance to create Performance Gaps - Be aware of changes in performance when equipment rated performance degrades when operated in part-load mode vs full load rating. Most equipment runs less than 10% of time at full load. Install Advanced Meters to monitor utilities, services and energy use vs performance & Benchmark with other similar buildings. Develop Skills of Middle Managers & O&M Staff. Adjust Post Occupancy Changes that affect equipment use schedule and capacities. Use of 24X7 use building equipment, data centers and Tech Centers that require over-sizing and back-up equipment use. Need for Periodic Sensors & Equipment Tuning, Testing, Calibration & Retro-Commissioning, Data Gathering, Analytics & Actions. Timely Reliability Based Maintenance. There are other Building Specific Factors that can degrade performance and need review and analysis.
• Place Greater Emphasis on Field Services.
  - Energy Management Services: Reduce waste and lower utility costs.
  - Commissioning Management: Independent Inspections & Quality Controls.
  - Facilities Testing, Adjusting & Balancing: For Efficient Operations throughout the life cycle.
  - Operation Maintenance Services: Tag and color-code systems and equipment and develop equipment operations and maintenance schedules.
  - Training & staff skill Development

• USE Of Modern Technologies to interact & Share

Mobile communication entails services delivered to smartphones over the internet, with context-based services adapted to a user’s profile and location.

Social media refers to on-line platforms based on communication driven by social ties defined by users.

Internet of Things refers to the interconnection of distributed networks of sensors and actuators capable of monitoring and controlling specific phenomena in real time.

Cloud computing is based on services that store and process information on the internet and deliver those services through a range of front-end devices.

CONCLUSIONS

The development of codes and standards as well as the skill and technical experience of designers, builders and operating staff is our collective ethical responsibility. All too often a building’s performance does not meet design expectations. Across the Green Construction and high-energy efficiency performing building industry, unrealistic performance goals have come from, among other things, inadequate modeling and benchmarking practices, unreliable monitoring and equipment controls systems, significant changes in space usage and processes during occupancy and unpredictable tenant improvements. Failure to include operations staff and lack of adequate budgets for testing and commissioning are barriers to improvements.

Bridging the Gap Between Intended and Actual Performance

The Building codes make a distinction between new construction and renovations of existing buildings, and need to be adapted to local climatic conditions using hourly HDDs and CDDs for each climate zone.

Periodic survey of occupants and education to shutdown equipment and lighting when areas are not occupied reduces unwarranted burden of wasted plug loads.

However, this process should not be a static, but must adapt to time of the day changes, solar loads, and supply and demand side changes

• Outcome Based Codes offer the maximum opportunity to direct performance meeting targets
• Life Cycle Cost Analysis is necessary for Public Funding of Energy Conservation Projects

• Challenge continues to be, “how to mitigate code officials’ fear of change and be prepared to enforce the energy codes on an on-going process for as many as three years after the building is occupied.

• It would be challenging to change the hearts and minds of code officials who are entrenched in prescriptive ways of doing things

About the Author

OM TANEJA
Ph. D., P.E., Fellow ASHRAE Consulting Engineer

Dr. Taneja holds a Bachelor’s degree in Mechanical Engineering from Indian Institute of Technology, New Delhi, Master’s degree in Control systems and a Ph.D. degree in Systems Sciences and Operations Research from New York University. He is a licensed professional engineer, ASHRAE Fellow, USGBC Member with specialization in innovative technologies adoption, smart infrastructure, smart buildings, smart cities, power generation and distribution, sustainability, energy-efficiency, training and capacity development along with associated, operations and maintenance issues.

Dr. Taneja has more than 40 years of diversified experience in the area of design, construction, operations and maintenance of large facilities, including the United Nations Headquarters, General Electric Headquarters, US Government General Services Administration and a 17 years in the Infrastructure Development for hospitals, court houses and varied commercial, industrial and historical facilities. He also worked as Senior Engineering Manager for long range capital improvements plan for the United Nations Headquarters in New York City, and Refurbishment of the Rockefeller Center for General Electric & National Broadcasting Company. Mr. Taneja has recently been the “Director of Manhattan Service Center” for the United States General Services Administration where he managed the Federally owned and leased Properties with diverse and growing portfolio of assets and with emphasis on smart buildings, greening, energy and water efficiency, analytics, technology adoption, alternate work space designs, emergency preparedness and improved operations, and maintenance.

Dr. Taneja was designated an ASHRAE fellow after serving on different Chapter and Technical Committees with USGBC, ASME and ASHRAE. He was the Program and Student Committee Chairman and President of ASHRAE NY Chapter during 2008-2009. Thereafter, he was the “Regional Vice Chair” for Student Activities for ASHRAE Region 1. He is serving as a Distinguished Lecturer® for ASHRAE since FY 2012, conducting seminars on technology adoption, smart buildings, transformation of facilities management, operations, maintenance and staff development.

Need Measures for Closing the Gap

Bring in More Consultants

BRIDGING THE GAP BETWEEN PLAN & ACTUAL PERFORMANCE
True Sustainable Architecture for Mitigating the Climate Crisis

by Ms. Nimisha Negi

Today as the cities are developing with the bursting population, the demand for spaces fails to slow down and construction activities cease to end. With our blue and green world becoming greyer by every second, Climate change is one of the greatest challenges faced by humans in the 21st century. As per the 2021 Global Status Report for Buildings and Construction, in 2020, the buildings and construction sector accounted for almost 40% of global energy-related GHG emissions, 35% of final energy demand, and a large share of global resource extraction. This alarming figure ought to push Architects and builders to contemplate and act towards changing the way we build today.

The present conventional building materials are futile to keep up with the changing climate and fail to provide thermally comfortable interior. As experienced by all, our regular brick and cement house are felt hot indoors during summers and cold in winter and, to reduce the discomfort we depend more on ACs and heaters leading to incessant energy consumption and carbon emissions.

Today cement is the most consumed building material. It is readily available but has a high carbon footprint making it a big contributor to Greenhouse gas emissions. Without articulating we, many times, end up overdesigning the structure by providing RCC (Reinforced cement concrete) columns at places where it is not even structurally required. Choosing to build a load-bearing structure instead of a frame structure is one of the initial ways to cut down concrete consumption. The load-bearing structure is one where load-bearing walls take up the entire load to the foundation thereby directly omitting the need for RCC columns, i.e. the steel and concrete. It can be made up to three floors, with the optimum design of foundations.

What is Sustainable Architecture?

Architecture, itself is a threat to nature. True sustainability lies in not building at all. But as far as sustainable architecture is concerned, it is about building in harmony with nature, causing minimal vandalism on the environment and focusing on conservation of water, energy and other resources to sustain future generations.

‘Designing with the environment’

A sustainable approach is about striving for a balance between ecological harmony and construction activities by humans. An optimal architectural solution lies in an efficient combination of site-oriented and climate-responsive design that ensures comfortable indoors without the dependence on mechanical cooling, heating and ventilation forming the main goal of sustainable architecture to combat climate change.

Understanding of climate, natural topography, geology, locally available materials, resources and other contextual analysis of the site, along with designing with Sun and Wind, and other natural systems are important aspects to begin the process of building sustainably.

Elements of Sustainable Design

Considering Sun’s position, the solar radiation falling on all faces of building vary, thus Orientation of the building matters. It becomes an important aspect in designing for daylighting and heat gain and loss and thermal mass in buildings. This factor helps in efficient fenestration (i.e. window openings) and facades of buildings, minimizing the need for artificial lighting.

It also assists in determining the functions in the house, for example toilets/store rooms/laundry- the less utilized spaces can be on West and South- west acting like a buffer protecting the more occupied spaces of Living room, kitchen etc from harsh heat. Orienting longer side along East-West axis allows it to harness the heat from South and utilize diffused light from North.

To go in detail, we can even calculate solar azimuth angle and design shading devices for each opening in building to provide shade in different seasons.

For thermally comfortable spaces, air movement plays a pivotal role. Each space in a building needs cross- movement or displacement ventilation for fresh air exchange. Provision of Tall windows with vents on top and windows on the ends of opposite walls ensure better air distribution in any room.

Heat gain and loss in building is maintained to a large extent by the materials used for wall, floor, roof etc. Earth based wall materials like Stabilised mud block or Compressed earth block, Rammed earth, cob etc are not only good for the environment, but also helpful in improving the microclimate of indoor spaces. Mud is a breathable material, which means it allows air movement between inside and outside helping in controlling the humidity and providing thermally comfortable spaces.

In linked to this, earth based plasters or other natural plasters like lime are great eco-friendly options. There are various indigenous techniques, local craftsmanship based in different parts of India that reflects artisans brilliance and magic with natural plasters and finishes. Some of which are named as Thaapi, Lohi (Rajasthan), Chettinad Egg plaster(Tamil Nadu).Going ahead with these techniques keeps the Indian legacy continued.

For deciding the materials to build with, locally available and non-manufactured materials should be preferred, the high embodied energy materials like cement, steel need to be avoided as well. (Embodied energy is the total energy expenditure in the processes, right from its extraction to transportation and distribution).
Materials like Stone, Hollow Clay block, bamboo also add to this list of materials that pose a positive impact.

Talking about foundations, Stone masonry, arch foundation, well ring foundation, boulder pack foundation and Rammed earth foundations are some of many foundation types which have significantly reduced concrete and steel usage making them a great alternative to conventional RCC column footings.

*Filler slab* is another important element of sustainable architecture. Using filler materials such as terracotta pots, tiles, coconut shells in a slab reduces the amount of concrete and steel. It adds to the thermal insulation in building and even brings aesthetics in terms of patterned ceiling.

**Way forward**

‘Designing with nature’ provides satisfactory comfort levels with reduced demand for energy consumption. Building industry hasn’t commanded enough attention to this, however rapid awareness about sustainable architecture is evident. Architecture needs to find new expressions and a renewed approach for harmony of nature. Architects need to explore newer materials and techniques which are greener and healthier and invasion of products like Hempcrete, Ashcrete, Fly Ash, Concrete debris keep us hopeful in the path towards bigger targets of COP 26, Glasgow.

**About the Author**

Ms. Nimisha Negi, Architect
IGBC APASSOCHAM GEM CP

**Source:** Sathya Consultants
Refrigerant-working Fluid of Vapour Compression Refrigeration System and Vapour Absorption Refrigeration System

by Dr. Rajinder Singh

1.1 REFRIGERANT

Refrigerant is the working fluid of vapour compression refrigeration system and vapour absorption refrigeration system. It abstracts heat from one place to be cooled and rejects the heat to some other place through its phase change.

1.2 REFRIGERANT CLASSIFICATION

Refrigerants can be classified based on the following:

1.2.1 CHEMICAL COMPOSITION

These are further sub-divided as:

1.2.1.1 Halocarbon compounds

These compounds are obtained by replacing one or more hydrogen atoms in ethane or methane with halogens.

1.2.1.2 Oxygen and Nitrogen Compounds

These refrigerants having either nitrogen or oxygen molecules in their structure, such as ammonia, are grouped separately and have a separate nomenclature from the halogenated refrigerants.

1.2.1.3 Cyclic organic Compounds

The compounds coming under this category are R316, R317 and R318 etc.

1.2.1.4 Unsaturated Compounds

Compounds such as ethylene, propylene etc. is grouped under unsaturated compounds.
1.2.1.5 Inorganic Compounds
These are further divided into two categories: Cryogenic and Non-cryogenic.
Cryogenic fluids are those which are applied for achieving temperatures as low as -160 °C to -273 °C. But below - 160 °C, this is not possible since the COP of the cycle becomes very low. To attain temperatures below - 160 °C, we are using refrigerants such as oxygen, nitrogen, helium, hydrogen etc.
The inorganic compounds which are employed above the cryogenic temperature ranges come under the category of Non-cryogenic inorganic refrigerants.

Fig.1.5 Inorganic compounds– Ammonia
Inorganic compounds shall be assigned a number in the 700 series, identification numbers are formed by adding the relative molecular mass of components to 700. Example: R717 corresponds to ammonia which has a molecular mass of 17.

1.2.1.6 Azeotropes
These are the mixtures of two or more refrigerants and behave as a compound.

Fig.1.6 Azeotropic and zeotropic mixtures
Azeotropic and zeotropic mixtures: Mixtures are designated by their respective refrigerant numbers and mass proportions. Refrigerants shall be named in order of increasing normal boiling points of the components.

Zeotropic mixtures shall be assigned an identifying number in the 400 series. This number designates which components are in the mixture but not the amount of each. To differentiate among zeotropes having the same components with different amounts (percent by mass), an uppercase letter shall be added as a suffix. The numbers are in chronological order of the refrigerant’s approval by ASHRAE. Example: R407A (R32/R125/R134a (20/40/40)), R407B (R32/R125/R134a (10/70/20)), R407C (R32/R125/R134a (23/25/52)), R407D (R32/R125/R134a (15/15/70)), R407E (R32/R125/R134a (25/15/60))

Zeotropic mixtures shall be assigned an identifying number in the 500 series. Example: R507 (R125/R143a (50/50))

1.2.2 Working
Under this category, we have the primary and the secondary refrigerants.
The primary refrigerants are those that directly used as working fluid of vapour compression cycle. R22, Ammonia, carbon dioxide etc. come under this category of refrigerants.
The secondary refrigerants are those that are indirectly used as a medium for heat transfer are referred. Brine solutions of sodium chloride and calcium chloride water, ice-slueries etc. come under this category.

1.2.3 Safety Considerations
Under this category, we have the following three sub-divisions:

1.2.3.1 Highly flammable refrigerants
The refrigerants under this category are propane, ethane, butane, isobutene, methene, ethylene etc.

1.2.3.2 Toxic and moderately flammable
Ethylchloride, dichloroethylene methyl format, sulphur dioxide, ammonia etc. come under this category.
Refrigerants are divided into two groups according to toxicity:
Class A signifies refrigerants for which toxicity has not been identified at concentrations less than or equal to 400 ppm;
Class B signifies refrigerants for which there is evidence of toxicity at concentrations below 400 ppm.

1.2.3.3 Safe refrigerants
These are the non-toxic, non-flammable refrigerants such as R22, R13, R14, R21, R113, R114, methyl chloride, carbon dioxide, water etc.

Fig.1.6 Carbon Di-Oxide

1.2.4 Miscellaneous
This group contains those compounds which cannot be grouped under the other components. These are indicated by the 700 series with the last numbers being their molecular weight. Examples include sulphur dioxide, air, carbon dioxide etc.
1.3 PRIMARY AND SECONDARY REFRIGERANTS

Primary refrigerants are those which can be directly used for the purpose of refrigeration. The refrigerants used in refrigerators like R-134a, used in window air-conditioner like R-22 etc. are primary refrigerants.

Secondary refrigerants are those fluids, which are used for transferring heat from one place to other indirectly. Secondary refrigerants are also known under the name brines or antifreezes.

In some applications we cannot allow the refrigerant to come in direct contact with the items being refrigerated, and then the refrigerant used is termed as a secondary refrigerant.

If direct refrigeration, such as in cooling a large cold storage, is allowed, then the amount of refrigerant required may be so large that its cost becomes high. These are some typical situations for which we can use of secondary refrigerants. Water and brine solutions, ice slurries etc. are common examples of secondary refrigerants.

Sodium chloride brine solutions are most common up to - 15 0C while calcium chloride brine solutions can be used up to -50 0C. However, these solutions are very corrosive to metals such as brass, copper and aluminum. In place of them, sometimes certain chemicals known as antifreeze are used with water to prevent clogging.

1.4 DESIRABLE PROPERTIES OF REFRIGERANTS

Refrigerant selection depends upon the operating conditions of the refrigeration system. There is no refrigerant that can be advantageously used under all operating conditions and in all types of refrigeration systems. In spite of that, we can state certain desirable properties that a refrigerant should possess. These properties can be divided into physical, thermodynamic and chemical.

1.4.1 PHYSICAL PROPERTIES

1.4.1.1 Miscibility with Oil

The refrigerant should not be miscible with the oil, else the lubricating viscosity of the lubricating oil.

It should not be soluble in the oil else there will be reduction in possibility of loss of lubricating action due to either thickening or thinning system or with which it comes into contact. It should be chemically inert.

1.4.1.2 Viscosity

Viscosity should be as small as possible to ensure that the pressure drop in the system is as small as possible. A low viscosity refrigerant will require less energy for its circulation through the refrigeration system.

1.4.1.3 Leakage and Detection

Pressures higher than atmospheric are usually employed in refrigeration systems, due to that there is a possibility of leakage of refrigerants after long period of operation. It is desirable to detect leak at early stage else the system would operate under reduced capacity or stop functioning altogether.
Refrigerant selection depends upon the operating conditions of the refrigeration system. The refrigerants used in refrigerators like R-134a, used in home refrigeration systems, are suitable than the latter. But, ammonia is toxic and this does not allow its use in home refrigeration systems.

1.4.2 CHEMICAL PROPERTIES

1.4.2.1 Chemical Stability and Inertness

Refrigerant should be chemically stable for the operating ranges of temperature and it should not react with the materials of the refrigeration system or with which it comes into contact. It should be chemically inert.

1.4.2.2 Flammability

The refrigerant should be inert and not catch fire when subjected to high temperatures. From this point of view, CO₂ is the most suitable, as it is not only non-flammable, but also acts as a fire-extinguisher. Butane, ethane, isobutene are highly undesirable as they catch fire quickly.

1.4.2.3 Action on Rubber or Plastics

Rubber and plastics are used in the seals and gaskets of the refrigeration system. They help to prevent the leakage of the refrigerant and ensure the smooth functioning of the compressor. The refrigerant should not react with these materials or else there might be leakage of refrigerant from the system or loss of functioning of the compressor.

1.4.2.4 Effect on Oil

The refrigerant should not react with the lubricating oil else, there is a possibility of loss of lubricating action due to either thickening or thinning of the oil. It should not be soluble in the oil else there will be reduction in the viscosity of the lubricating oil.

1.4.2.5 Toxicity

The refrigerant used in air conditioning, food preservation etc. should not be toxic as it will come into contact with human beings.

1.4.2.6 Effect on Commodity

If the refrigerant is directly used for chilling, then it should not affect the commodity kept in the conditioned space. Also, in case where direct cooling is not employed, the refrigerant should still not affect the commodity if there is any leakage.

1.4.3 THERMODYNAMIC PROPERTIES

1.4.3.1 Freezing Point

Freezing Point of the refrigerant should be as low as possible.

1.4.3.2 Specific Heat

The specific heat of the liquid refrigerant should be as small as possible. This ensures that the irreversibilities associated with throttling are small and there is greater subcooling of the liquid refrigerant. On the other hand, the specific heat of vapour refrigerant should be high to have less superheating of the vapour refrigerant.

1.4.3.3 Enthalpy of Vaporization

Enthalpy of Vaporization should be as large as possible to minimize the area under superheat and the area reduction due to throttling. Also, the higher value of enthalpy of vaporization lowers the required flow rate per ton of refrigeration.

1.4.3.4 Compression Ratio

The compression ratio to be as small as possible otherwise the leakage of refrigerant occurs across the piston and the volumetric efficiency is affected.

1.4.3.5 Thermal Conductivity

The thermal conductivity of the refrigerant should be as high as possible so that the size of the evaporator and condenser is manageable. Ammonia has a better thermal conductivity than that of R22 and is more suitable than the latter. But, ammonia is toxic and this does not allow its use in home refrigeration systems.

1.4.3.6 Density

The density of the refrigerant should be as large as possible. In reciprocating compressors, the pressure rise is accomplished by squeezing the entrapped refrigerant inside the piston-cylinder assembly. Hence, density decides the size of the cylinder. Again in centrifugal compressors pressure rise is related to the density of the vapor. A high value of density results in high pressure rise.

1.4.3.7 Critical Temperature and Pressure

The critical temperature of the refrigerant should be as high as possible above the condensing temperature in order to have a greater heat transfer at a constant temperature. If this is not taken care of, then excessive power can be consumed by the refrigeration system. The critical pressure should be moderate and positive. A very high pressure will make the system heavy and bulky whereas in case of very low pressures, there is a possibility of air leaking into the refrigerating system.

1.4.3.8 Compression Temperature

When a refrigerant gets compressed in compressor, there is a rise in the temperature of the refrigerant resulting in the heating of the cylinder walls of the compressor. This necessitates external cooling of the cylinder walls to prevent volumetric and material losses. Refrigerants having lowest compression temperatures are thus better than others.
1.4.3.9 Evaporator and Condenser Pressure
Both the evaporator and condenser pressures to be above atmospheric pressure otherwise there is a possibility of air leaking into the system. Presence of air drastically reduces the capacity of the refrigeration system. Also, due to presence of moisture in air, acids or other corrosive compounds may form and this may affect the tubing of the refrigeration system.

1.4.3.10 Volume of Refrigerant Handled Per Ton of Refrigeration
This should be as small as possible in order to have a small size of the compressor. The type of compressor is decided by this value. For refrigerants like R22, R500 etc., a reciprocating compressor is suitable. For others like R11 and water, a centrifugal compressor is required to handle the large volume.

1.4.3.11 Coefficient of Performance
The Coefficient of performance (COP) has a direct effect on the running cost of the refrigeration system. Higher the magnitude of COP, lower will be the running cost. Since, the COP of any refrigeration system is limited by the Carnot COP, for large operating pressures a multi-stage refrigeration system should be employed.

1.4.4 Economic Criteria:
Apart from the thermodynamic, chemical, physical and safety criteria, there is another criterion by which we judge an ideal refrigerant. The economic criterion takes into account the availability and supply levels of the refrigerant, the cost of the refrigerant, cost of storage and handling.

1.4.4.1 Availability and Supply
The refrigerant should be easily available in the market and in abundant quantity. This ensures that the cost of the refrigerant is not prohibitive. An abundant and free supply of the refrigerant ensures that refrigeration systems will be designed specifically for use with them.

1.4.4.2 Cost of Refrigerant
The cost of the refrigerant has a large impact on the overall cost of the refrigeration system. Hence, its cost should be as low as possible. From this viewpoint, ammonia and water are ideally suited, but their low thermodynamic and chemical properties restrict their use in all types of refrigeration systems. Particularly, for flooded type evaporator or condenser, the refrigerant amount required is high and their cost needs to be factored in while making the initial investments.

1.4.4.3 Storage and Handling
The refrigerant should be such that it can be conveniently stored and handled during transportation and charging. It should be stored in as small a pressure vessel as possible. Also, if we have to handle a toxic or flammable refrigerant, then the cost involved will be higher compared to handling and storage cost of non-toxic and non-flammable refrigerant.

1.4.5 Safety Criteria:
Under safety criteria, we consider the toxicity, flammability, action on perishable food and formation of explosive compound on exposure to air. An ideal refrigerant should be non-toxic, non-flammable, have no effect on food products and should not react with atmospheric air. No refrigerant satisfy these criteria fully. We can therefore, group refrigerants into different sub-groups based on their flammability and toxicity levels.

From the above discussions of the ideal properties of refrigerants, we can come to the conclusion that none of the refrigerants in current use and available satisfy these conditions fully. As such, we have to make a detailed analysis of the different factors like cost, performance of the refrigeration system and safety issues before deciding on using a particular refrigerant.

This Chapter will be continue in the next class.

About the Author
Dr. Rajinder Singh’s Classroom
Senior Faculty, Pusa Institute of Technology.
(Past President (2015-16), Chair Student Activities-ASHRAE India Chapter and Student Advisor-ASHRAE Pusa Institute of Technology Student Chapter)

This classroom is started in view to strengthen the theoretical knowledge of Engineers from Industries in Refrigeration & Air-Conditioning field. This will also be helpful for the students interested in this field. This will be continuing in our quarterly Newsletter issue. In the sixth class we are covering the working fluid of vapour compression refrigeration system-Refrigerant.
HVAC System of a Rocket launch site: The launch Tower

by Akshat Goel (Member, ASHRAE Student Branch Mait, AIC)

Introduction

Ever wonder what the function of a rocket launch tower was? How does it facilitate in the launch of a rocket and what are its inner workings?. This article explores the HVAC system of a launch tower and its specifications.

The rocket-launch industry especially in the commercial satellite market is growing much faster than ever before, slated to be potentially a $1 trillion market in the coming decades. Of it the small-satellite market is receiving the most attention. The projected growth for global small-satellite market is from the current USD 3.4 billion in 2020 to USD 13.71 billion by 2030, at a compound annual growth rate (CAGR) of 16.4% from 2020 to 2025. Given it is a profitable sector, it needs the backing of strong and robust launch systems.

The launch tower

HVAC is a major part of aerospace and structural engineering especially at the ground level, (here) the launch towers. A lot of parameters, like wind, humidity, climate etc.; have to be looked upon before launching a rocket carrying essential payloads up into various orbits. This is where the launch tower comes into play. Its job is to sustain the rocket before and up to its launch. For that the launch tower also needs a good and sturdy HVAC system (Figure 1b) providing good cooling and humidity solutions with regard to the persisting environmental conditions. A rocket may stand outdoors for weeks on end waiting to be launched in the most suitable weather conditions. While waiting to be launched, it may get exposed to rapid and sudden temperature fluctuations. For example, temperatures may drop below -4 or -5°C at night or they may exceed 18 or 20°C in the daytime and there is always the possibility of high wind and rain. Therefore, launching a rocket is a very tedious process and demands a high level of reliability and stability which is maintained by the ground staff and the mission control.

Figure 1: (a) Live image of a launch tower at SHAR, India just before launch (isro.gov.in)

(b) Schematic diagram showing air-conditioning equipment on a rocket launch site (nissin-ref.co.jp)
A Case Study

Many conventional launch towers are fitted with air conditioning equipment which are designed by integrating four fixed speed compressors (Figure 2b). Temperature and humidity control can be achieved only by adjusting the air supply or by staged modulation. In some cases, to meet the control requirements, we need the help of supplementary means like electric heating. At low temperature and load conditions generally at night, the evaporator of the unit often frosts over which makes it difficult to run continuously.

To ensure the reliability and feasibility of a HVAC unit, constant analysis are carried out relevant to the current systems deployed in the launch towers. The results of analysis and testing at this launch center (Fig.2), show that the energy profile of the four systems, consisting of the fixed-speed compressors, of the HVAC unit are notable to ascertain the step-less adjustments in cooling capacity.

Conclusions

Today, space agencies around the world, which are just tapping into this market want strong engineering solutions related to safe and cost-effective satellite launches and the commercial HVAC industry needs to provide them. In the coming days, HVAC is going to be the backbone of a sustainable and productive engineering environment built around a multitude of lucrative businesses in various sectors in which space is going to be one of the foremost ones.

Figure 2: Results of an HVAC system deployed at one of a National space agency’s satellite launch center,
(a) Continuous fresh air load under different outlet dew point temperature (b) Fix compressors stage modulation(danfoss.com)

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Mentor
Dr. Vaibhav Jain - SA Mait College
Co-Chair SA - AIC
7th Oct, 2022

Workshop

AIC organised workshop on Role of People, Technology & Sustainability in Shaping MEP for Low Carbon Solution on 7th October 2022

8th Oct, 2022

ASHRAE Advocacy & Membership Promotion

Ventconf-2022 held on 8th October, Hotel Grand Vasant Kunj, New Delhi

11th to 14th Oct, 2022

Report on RAL CRC, Istanbul

RAL CRC-2022 was held on from 11th to 14th October, 2022 at Istanbul and was attended by Mr. Kanagaraj Ganesan - President, Mr. Rajesh Jain - President Elect., Mr. Abid Husain - Past President & Historian, Mr. Richie Mittal – IPP & DRC, Mr. Ashok Virmani – Past President & DRC, Mr. Ashish Rakheja - Past President & Vice President ASHRAE, Mr. Abhishek Jain - Chair –Student Activity, Mr. Priyank Garg - Past President & Co-Chair – GAC, Mr. Balvinder Pal Singh Chadha - AIC Members. This Year the Conference was attended by representatives from 17 Countries including 25 chapters. All 7 Chapters participated from India. Each of the Chapter Displayed posters about the happenings. The meeting included technical session, business session and social visits. The meeting also had brief presentation by some selected members and representation of the chapter motions.

This year at RAL CRC Istanbul received the following awards:

- Presidential Awards of Excellence
- Special Citation - Presidential Awards of Excellence
- Certificate of Achievement – RP Goal
- Chapter Service Award - KD Singh, Rajinder Singh & Indrajit Bhattacharya
20th Oct, 2022

**Campus Visit**

On 20th October the ASHRAE India Chapter Team visited the Campus of RICS School of Built Environment - AMITY, to motivate them to have an AIC Student Branch. The visit was led by the Student Activity Chair - Abhishek Jain, Rajkumar Balasubramaniyan - YEA Chair, Indrani Rawat - Coordinator, and Ranjit Mondal. More than 250 students were present in the Auditorium along with around 8 faculty members. The faculty members assured to form a student branch, immediately after Diwali. Sharing here some glimpses of the Talk.

29th Oct, 2022

**Webinar on HVAC Design & Systems**

Glimpses of a session with student activities
RVC - Dr. Yash Shukla
Student Activity Chair - Abhishek Jain and student Branch Advisors
Dr. Vaibhav Jain - Maharaja Agrasen Institute of Technology - MAIT, Mr. Satyaveer Singh of IIMT COLLEGE OF ENGINEERING, GREATER NOIDA, Mr. Krishna of IIMT COLLEGE OF ENGINEERING, GREATER NOIDA, Mr. Mohit Bansal of ABES Engineering College and Dr. Saurabh of RICS School of Built Environment, Amity University.

The session was very informative, as Dr. Yash Shukla explained every aspect to become an active student branch. He briefed on the grants, scholarships, and competitions where students should be encouraged to participate actively. He advises applying for project grants etc.

ASHRAE India Chapter is thankful to Dr. Yash Shukla for such a knowledgeable presentation to motivate Student Branch Advisors.
18th Nov, 2022

Expert Talk

On 18th November 2022, an expert talk was organized in the ASHRAE Maharaja Agrasen Institute of Technology - MAIT Student Branch. Entrepreneur and a Co-Chair of student activities Ms. Vandana Kapuria gave an excellent interactive session on the topic 'Success by Design' where she talked about 'Life goals', about setting up goals and making plans to achieve them.

The students, faculty members, and the HOD of the Mechanical division were keen to organize one more session in the coming days. The session was very knowledgeable and very well appreciated.

Site Visit Students of IIMT College of Engineering

On the 18th of November 2022, Ashrae India Chapter organized a site visit for civil engineering students of IIMT COLLEGE OF ENGINEERING, GREATER NOIDA. The students were very happy to gain practical knowledge of the construction.

25th Nov, 2022

Orientation Program

ASHRAE Student benefits orientation Programme on IIMT Collage Great Noida held on 25th November-2022.

Mr. Gurinder Singh - Unifeb Insulation 'A Proprietorship Company' has been recognized for supporting in sponsorship for Membership Promotion of ASHRAE India Chapter -21-22.
ASHRAE INDIA CHAPTER INVITES YOU TO JOIN ASHRAE

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- Building EQ Portal
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Grow your network at the local, regional, and international level, both in-person and online.

- 187 Chapters within 15 Regions keep members connected at the local level through meetings and events.
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- Connect with members across the globe on social media.

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Reader Feedback
ASHRAE India Chapter Bulletin Newsletter wants ideas from readers on what you would like to see in future newsletters. Tell us what you think.

Members interested to send their technical articles are requested to send the same at ashraeindia6@gmail.com