Abstract:
The heating, ventilation, and air-conditioning (HVAC) system is arguably the most complex system installed in a building and is responsible for a substantial component of the total building energy use. A right-sized HVAC system will provide the desired comfort and will run efficiently. Right-sizing of an HVAC system is the selection of equipment and the design of the air distribution system to meet the accurate predicted heating and cooling loads of the house. Right-sizing the HVAC system begins with an accurate understanding of the heating and cooling loads on a space; however, a full HVAC design involves more than just the load estimate calculation; the load calculation is the first step of the iterative HVAC design procedure. This strategy guideline discusses the information needed to design the air distribution system to deliver the proper amount of conditioned air to a space. Heating and cooling loads are dependent upon the building location, sighting, and the construction of the house, whereas the equipment selection and the air distribution design are dependent upon the loads and each other.

Keywords: Heating, Ventilation, and air-conditioning (HVAC), air handling unit, refrigeration cycle, heat load estimation, u factor.

1. INTRODUCTION

Heating, ventilation, and air conditioning (HVAC) is the technology of indoor and vehicular environmental comfort. Its goal is to provide thermal comfort and acceptable indoor air quality. HVAC system design is a sub discipline of mechanical engineering, based on the principles of thermodynamics, fluid mechanics and heat transfer. "Refrigeration" is sometimes added to the field's abbreviation, as HVAC&R or HVACR or "ventilation" is dropped, as in HACR (as in the designation of HACR-rated circuit breakers). HVAC is an important part of residential structures such as single family homes, apartment buildings, hotels and senior living facilities, medium to large industrial and office buildings such as skyscrapers and hospitals, vehicles such as cars, trains, airplanes, ships and submarines, and in marine environments, where safe and healthy building conditions are regulated with respect to temperature and humidity, using fresh air from outdoors The main parts of the HVAC system are a heating, a ventilation, and an air-conditioning unit Furthermore, modern systems include an air filtration and cleaning element as well.

1.1 Basic Refrigeration cycle

![Figure 1.1 Basic Refrigeration cycle](image-url)
**Compressor**: An air compressor is a device that converts power (using an electric motor, diesel or gasoline engine, etc.) into potential energy stored in pressurized air (i.e., compressed air).

**Condenser**: A condenser is a device or unit used to condense a substance from its gaseous to its liquid state, by cooling it. In so doing, the latent heat is given by the substance, and will transfer to the condenser coolant. **Expansion Valve**: A thermal expansion valve (often abbreviated as TEV, TXV, or TX valve) is a component in refrigeration and air conditioning systems that controls the amount of refrigerant flow into the evaporator thereby controlling the superheating at the outlet of the evaporator.

**Evaporator**: An evaporator is a device used to turn liquid form of a chemical into its gaseous form. The liquid is vaporized, into a gas.

**OUR PROJECT CONSIST OF 3 FLOORS, VARIOUS SYSTEMS ARE USED IN EACH FLOORS.**

**GROUND FLOOR**: CHILLED WATER, AHU (AIR HANDLING UNIT)

**1ST FLOOR**: CHILLED WATER, FCU (FAN COIL UNIT)

**2ND FLOOR**: VRF (VARIABLE REFRIGERANT FLOW)

2. **COMPONENTS OF AIR HANDLING UNITS OR FAN COIL UNITS**

As the name suggests air handling unit is the box type of unit that handles the room air. This article describes various parts of the air handling unit, its working and types.

![Air Handling unit](image)

**Figure 2.1. Air Handling unit**

2.1 **Box Enclosure**: All the parts of the air handling unit are enclosed in the box type of enclosure. This ensures compactness of the unit and protection of all the components inside it. The whole box is insulated to prevent the loss of heat from the unit.

2.2 **Cooling Coil**: The cooling is one of the most important parts of the air handling units. It is made up of copper tubing of several turns and covered with fins to increase the heat transfer efficiency of the cooling coil.

2.3 **Ducts**: The air handling is connected to the supply air and return air ducts. The supply air duct supplies the cool air from the air handling unit to various rooms, while the return air supplies hot return air from various rooms back to the air handling unit.

2.4 **Fan or Blower**: The fan or the blower sucks the hot return air from the room and blows it over cooling coil, cools it and sends it to the room to be air conditioned.

2.5 **Air Filter**: Air filter is one the important parts of any air conditioning system. The air filter removes dirt, dust, smoke and other impurities from the air and cleans. The air filter is usually attached to the cooling air and before it. The air is first absorbed or pushed over the air filter and then over the cooling coil.

3. **EXPERIMENTAL INVESTIGATIONS**

3.1 **Heat Load Estimate**:

The manner in which heat can flow can be any one or more for the following ways:

1. Solar radiation through transparent surfaces such as window.
2. Heat conduction through exterior wall/roof
3. Heat conduction through partitions, ceilings, floors of adjacent non-air conditioned spaces.
4. Heat generated internally by occupants, lights, appliances, equipments and process
5. Load due to intake of outside air for ventilation.
6. Other miscellaneous gains.

3.1.1 Building Survey:
1. Orientation of the Building
2. Application of the Space
3. Physical dimensions of the space
4. Ceiling height, floor to floor height, space above the false ceiling.

3.1.1.1 Load Estimation: The importance of accurate load calculations for air conditions design can never be over emphasized. In fact, it is the precision and care exercised by the designer in the calculation of the cooling load for summer and the heating load for winter that a trouble free, successful operation of air conditioning plant after installation would depend.

3.1.1.2 Solar Heat Gain Through Glass: Glass, which is transparent, allows the sunrays to pass through it. This results in heat dissipation inside the room. The amount of heat dissipated into room depends upon the glass area that is exposed to sun.

3.1.1.3 Solar Heat Gain Through Walls And Roofs: Heat gain through the exterior construction (walls and roof) is normally calculated at the time of greatest heat flow. It is caused by the solar heat being absorbed at the exterior surface and by the temperature difference between the outdoor and indoor air. The heat flow through the structure may then be calculated, using the steady state heat flow equation with equivalent temperature difference (ETD).

\[ Q = U \times A \times ETD \]
\[ Q = \text{heat flow rate in (KJ/Sec)} \]
\[ U = \text{transmission rate (W/Sq. M K)} \]
\[ A = \text{Area of surface (Sq m)} \]
\[ ETD = \text{Equivalent Temperature Difference (K)} \]

Heat loss through the exterior construction is normally calculated at the time of greatest heat flow.

3.1.1.4 Transmission Heat Gain Through Glass: This is heat gain that is obtained due to the difference in outside and inside conditions. The amount of heat that is transmitted through the glass into the room depends upon the glass area, temperature difference and transmission coefficient of glass. Here total glass irrespective of the direction is taken into consideration in total glass area.

3.1.1.5 Transmission Through Partitions And Walls: Heat gain here also depends upon the temperature difference between the outside and inside conditions, transmission coefficient and wall area exposed or partition wall area. Here the total area of the wall is taken irrespective of its direction. The temperature taken is generally 2°C less than the temperature gradient that is existing. Equivalent temperature difference is taken in these calculations.

3.1.1.6 Occupancy Load: Heat is generated within the human body by oxidation commonly called metabolism. The metabolic rate varies with the individuals and with his activity level. The amount of heat dissipated by the human body by radiation and convection is determined by the difference in temperature between the body surface and its surrounding. The heat dissipated by evaporation is determined by the difference in vapor pressure between body and the air. The metabolic rate is 85% for the male, and for children it is about 75%. The excess heat and moisture brought in by people, where short time occupancy is occurring may increase heat gain from people by as much as 10%.

3.1.1.7 Lighting: Lights generate sensible heat by the conversion of the electrical power input into light and heat. The heat is dissipated by radiation to the surrounding surfaces, by conduction into the adjacent materials and by convection to the surrounding air.

Fluorescent = total light watts*1.25
Incandescent = total light watts

3.1.1.8 Appliances: Most applications contribute both sensible and latent heat to a space. Electric appliances contribute latent heat, only by virtue of the function they perform that is, drying, cooking, etc., whereas gas burning appliances, contribute additional moisture as a product of combustion. A properly designed hood with a positive exhaust system removes a considerable amount of the generated heat and moisture from most types of appliances.

3.1.1.9 Electric Motors: Electric motors contribute sensible heat to the space by converting the electrical power input to heat. Some of this power is dissipated as heat in the motor frame and can be evaluated as: \( \text{Input} \times (1-\text{motor efficiency}) \)

3.1.1.10 System Heat Gain: The system heat gain is considered as the heat added to or lost by the system components, such as the ducts, piping, air conditioning fan and pump etc. this heat gain must be estimated and included in the load estimate but can be accurately evaluated only after the system has been designed.

3.1.1.11 Heat Gain From Outside Air: To estimate the infiltration of air into the conditioned space, the crack method is considered to become more accurate. The leakage of air is a function of wind pressure difference \( P \), which is determined by the equation:

\[ dp = 0.00470C^2 \]

Where \( dp \) is in the cm of WG and \( C \) is in Km/hr is the local wind velocity. Tables are available for infiltration in m/hr/m of crack for different \( dp \) values. After the calculation of all these components of room loads, the room sensible heat and the room latent heat are determined.
4. FINAL ACHIEVED DESIGN

Figure 4.1. Ground Floor DLD

Figure 4.2. 1st Floor DLD
4.4. Design Inside Conditions In Air conditioned Area:

4.4.1 Psychrometric Calculations:
In this chapter the method of loading calculation is presented for area of clean rooms for different inside conditions. Heat load calculations for rooms, which need comfort conditions, are also presented. All the heat loads calculation charts are presented in the appendix. The load calculations of typical clean rooms, which differ in size of particulate, amount of filtration required, and class to be maintained are only discussed. The area that needs comfort condition is also discussed.
5. SOFTWARE USED

Figure 5.1 Duct sizer software by McQuay

![Duct Sizer Software](image)

Figure 5.2 Pipe Sizer Software by McQuay

![Pipe Sizer Software](image)
6. CONCLUSION

The rate of change in our industry will be exponential. Some changes will be caused by improvements in technology whereas others will be the result of influences outside our immediate control. As engineers, we have an obligation to be proactive in encouraging changes that are of benefit to the society we serve. This in turn will have direct benefit to our industry and to each of us individually. You can be part of that positive change by sharing your knowledge with other engineers through publications, serving with standard writing organizations and participating in technical societies. We are a "people-oriented" profession. Our designs have a direct impact on the people who occupy our buildings. We will continue to discover ways to assure their comfort and health, while reducing our impact on the environment and natural resources. Changes will occur and for the better. Our vision for our industry can be fulfilled as we take action through our contributions to the technology of HVAC.

7. REFERENCES


[12]. J.C. Lam, C.M. Hui, A review of building energy standards and implications for