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Comparative Analysis of Air Cooled and Water Cooled Air Conditioning System in a Laboratory Building

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Abstract: ***Today, the field of air conditioning design is more technologically challenging than ever before. While design innovation and product improvements promise more versatile, more powerful and more energy-efficient air conditioners, the challenge today lies in identifying the most appropriate product, or mix of products, for the application at hand.***
Without a doubt, today the accentuation is no more on understanding cooling 'items' however on making 'arrangements' and not simply arrangements, but rather 'modified arrangements' that suit particular cooling needs of particular business and foundations. The specialist or planner who comprehends the elements of those customers business will probably offer preferred long haul cooling arrangements over who does not.
In this paper Study is concerned to a laboratory building of 1, 10,000 sq ft, It shall be defined for central cooling system configurations. This would require approx 1000 tons of cooling capacity. The building is located in Chennai; covering main climatic condition is also a factor to be kept in mind while designing. Load and energy Calculations will be executed on HAP software.
This task is done to look at the execution of a vast limit Air cooled and Water cooled systems; Power rating, control utilization per unit cooling generation, KW/ton, has been picked as the paradigm for execution. The test information gathered amid all seasons will be painstakingly screened, and just predictable and dependable information will be chosen to measure normal month to month esteems for cooling creation, control for the assistants, water utilization, and encompassing DBT and WBT. The methodology utilized for this investigation can be reached out for assessing the yearly money saving advantages offered by the Water Cooled and Air Cooled systems. These two informational collections with a similar cooling load will be gathered and performance of both of these system will be determined.

I. INTRODUCTION

Air conditioning application engineering is as much an art as it is a science. Science has evaluated all the factors required to determine a heating or cooling load through years of experimentation, tests, and analysis. It is the application of these factors in determining the building or space load that much care and judgment must be exercised. It is the motivation behind the manual to give information and methodology to the heap computations for the summer and winter cooling in business and open get together applications. The aim of HVAC is essentially for the summer, winter, and all year molding systems utilizing unitary gear (multi or split system, including heat pumps) of assorted types introduced in business structures. This manual likewise apply to vast structures utilizing central systems utilizing developed or central station hardware for cooling purposes. For applications where life, safety, or specific processes depend on maintaining specified indoor design conditions, a consulting engineer in the particular application should be employed., it is sufficient to calculate the heat transmission through the various elements of the building with regard to orientation.

II. BACKGROUND

In order to perform an accurate estimate of heating and cooling loads, an accurate survey of the load components of the space to be conditioned must be made. The following factors affect the heat loss and heat gain of a space: Construction details, Physical dimensions, Orientation of building or space, Occupancy, Lighting, Appliances and equipment, Infiltration, Ventilation, Schedule of use, Outside design conditions, Inside design conditions

When all the factors entering into a cooling load calculation are considered and the judgment involved in these considerations is recognized, it can readily be seen that air conditioning application engineering is an art as well as a science. Constant study, diligent application, good judgment, and analysis are required to become an expert.

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Keeping in mind the end goal to upgrade the solace and prosperity of the inhabitants, indoor situations have been controlled with broad and frequently entangled (HVAC) systems. (HVAC) ventilating and cooling systems are no more an extravagance yet are turning into an indispensable and an important piece of a wide range of offices, including private, business, institutional or modern, to keep up worthy indoor condition. The main role of these systems in a building is to manage the dry-globule air temperature, humidity and air quality by including or evacuating heat energy.

III.AIR CONDITION SYSTEM

A cooling system basically has four sections: an evaporator, a blower, a condenser and an expansion gadget.

The part inside the home where the refrigerant dissipates is the evaporator, normally. Fans in the home blow air over the evaporator's coils. "As air from the house moves over the evaporator, refrigerant inside the coil grabs the temperature of the air. "The refrigerant is retaining heat from the air and changes phase from fluid to a vapor i.e, a cool fluid to a more sizzling vapor, and in the meantime, the air had warm gets expelled from it, so the air went from being hotter to colder."

The vaporized refrigerant at that point goes into the blower, which is situated outside noticeable all around molding unit neighboring a home (or frequently on the top of a business), alongside the condenser. As the name suggests, the blower packs the gas to a condition of higher weight and higher temperature.

From that point, the hot, pressurized gas streams over the third part, the condenser. Here, the gas is dense once more into its fluid state as warmth is emanated away. Open air units regularly have metal balances on them to help disseminate the warmth all the more rapidly.

The chilled fluid is presently returned into the home. The extension gadget controls the stream of fluid refrigerant into the evaporator, where similarly as before it will retain warmth and change stage from a fluid into a low-weight gas.

The Comfort zone...the condition zone....Coil organization has turned into the leaders in the control of cooling line everywhere throughout the world. The organization has demonstrated exhaustion records in the assembling of world class hardware in the field of cooling item. We have dedicated our self in the generation of new and most recent items with a decrease in level and change in item productivity. Today our key ac's are on the whole huge five star inns, healing centers, eatery, extravagant strip malls, Airports and numerous other business utilities.

A. Applications

The most widely-used current applications of the air- conditioning are at hospitals, private homes and public buildings, shopping malls, restaurants, schools, colleges and in universities for digital libraries, laboratories etc.

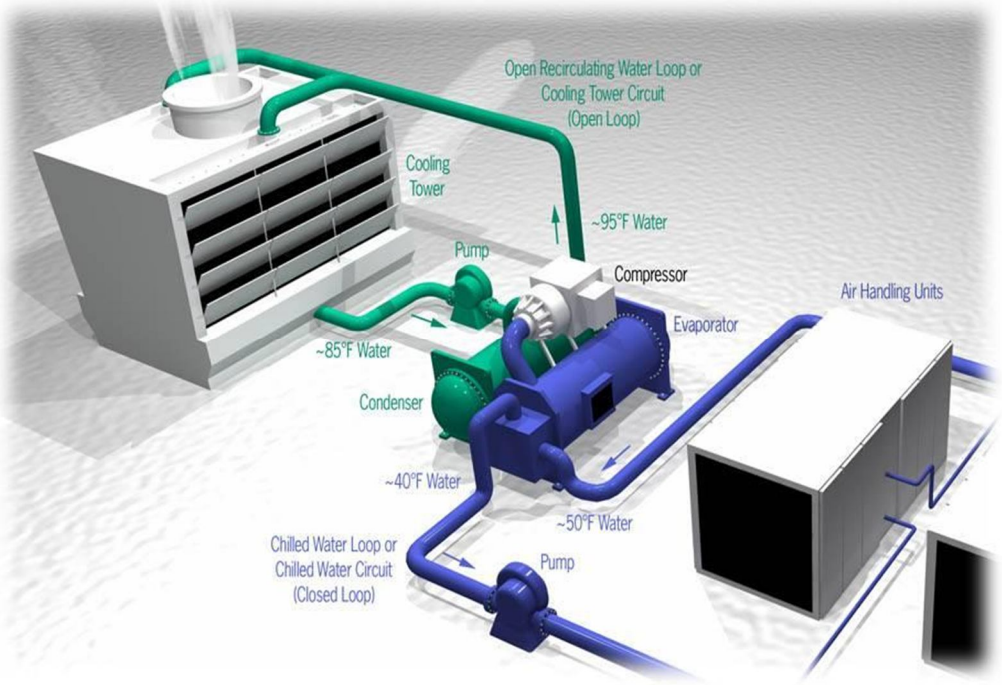


Figure-1 A Typical Central Chilled HVAC System

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IV. OBJECTIVES OF THE PROJECT

A. Selection of reasonable HVAC system for the proposed LAB building
B. Cooling Load calculations utilizing E20 Excel sheet or HAP (Hourly Analysis Program) Software
C. Detailed Design of HVAC system
D. To do the complete palcement and drafting on autocad software
E. Evaluate the Energy utilization of HVAC supplies
F. To compare the performance difference between water cooled and air cooled chiller systems.

V. PROJECT METHODODLOGY

A. Conducting a writing audit and exploring the related contextual investigations, distributed universal papers, related ASHRAE
B. Selection of HVAC system in view of the measure of the building and Energy productivity.
C. Equipment determination according to ASHRAE measures.
D. HVAC system configuration utilizing HAP, diverse ideas and ASHRAE, SMACNA measures for finish plan of the HVAC system according to codes.

The two systems which are going to be compared are explained below:

1) *Chiller System:* A chiller is a machine that expels heat from a fluid through a vapor-pressure or refrigeration cycle. These machines can actualize an assortment of refrigerants. chillers use water as the refrigerant. The parts of water cooled chillers and air cooled chillers are fundamentally the same as. Every item contains an evaporator, condenser, blower, and an extension valve. The essential contrast is whether air or water is utilized to give the condenser cooling. The characterization depends on the sort of cooling strategy utilized for condenser cooling.
2) *Air Cooled Chiller:* Air cooled chillers retain heat from process water, and the heat is then exchanged to the air around the chiller unit. This kind of chiller system is by and large utilized as a part of uses where the extra heat it releases isn't a factor. Truth be told, it's frequently useful to utilize the overabundance heat to heat a plant amid the winter, in this manner giving extra cost reserve funds. Air cooled chillers require less support than water-cooled units. Air cooled chillers don't require a cooling tower or a condenser water pump. Devour around 10% more power than a water- cooled unit because of wet surfaces exchanging heat superior to anything dry surfaces.

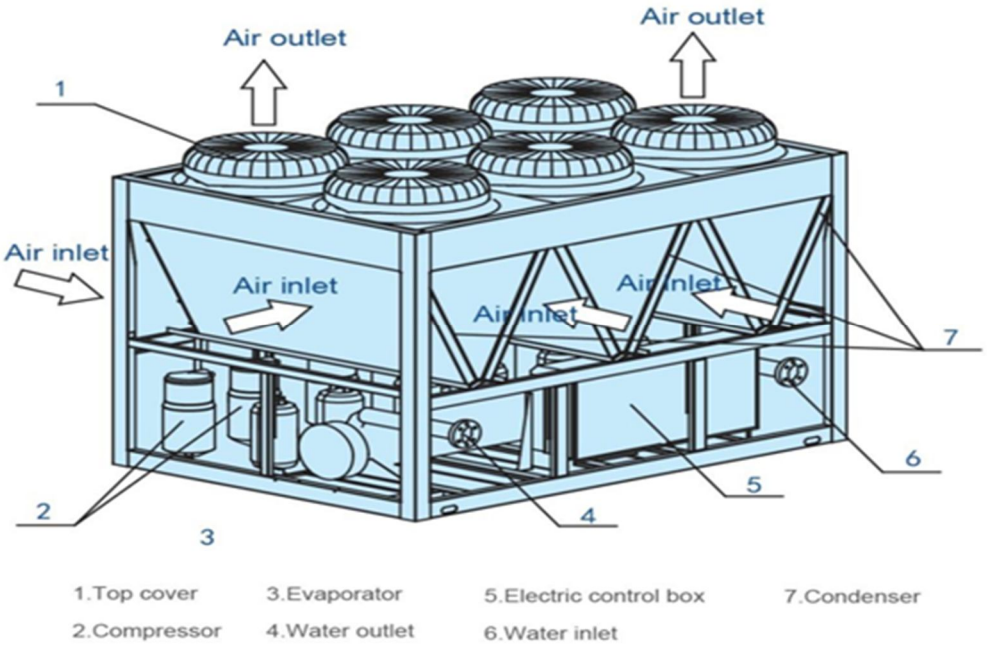


Figure-3 Air Cooled Chiller

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An air-cooled chiller has a condenser that is cooled by nature air. The air-cooled chillers are favored for little or medium establishments yet of late the quality change in their structure, permits the utilization, in secluded kind, for expansive establishments moreover. An air-cooled chiller is favored particularly in cases that there isn't sufficient water or the water is exceptionally costly

3) *Water Cooled Chillers:* Water cooled condensers utilize water as consolidating medium and utilize a pump to course water through the condenser and out to cooling tower that rejects the heat to the air. A cooling tower is a specific heat exchanger in which air and water are carried into coordinate contact with each other to diminish the water's temperature. As this happens, a little volume of water is dissipated, diminishing the temperature of the water being flowed through the pinnacle. The utilization of the cooling tower gives water-cooled systems an effectiveness edge over air-cooled systems. The water-cooled chillers have water cooled condenser associated with cooling tower and are generally favored for medium and huge establishments where there is adequacy of water. Likewise, they are additionally favored in cases that is requested steady execution of the system, freely of the surrounding temperature (mechanical ventiating and cooling, ventilating of computerized systems and so forth), on the grounds that the limit of the water-cooled chillers are not influenced by the encompassing temperature changes.

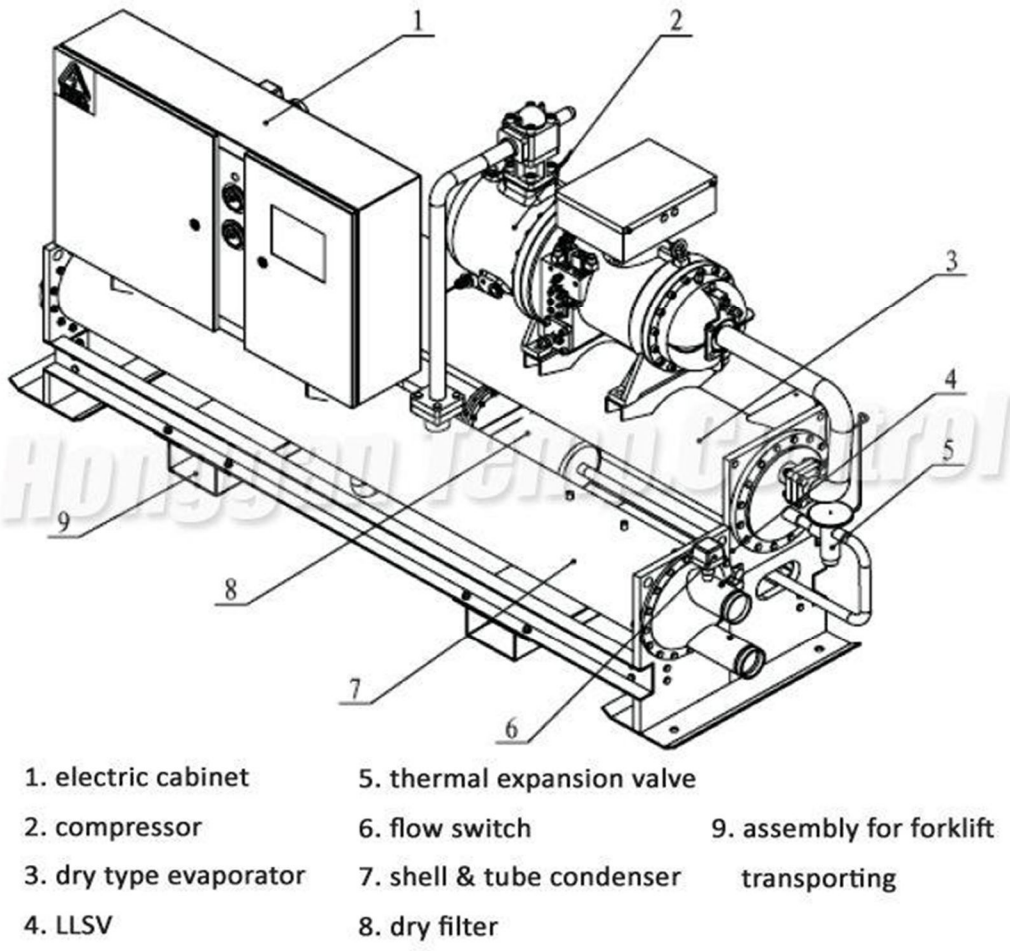


Figure-4 water Cooled Chiller

4) *Description of Building:* The building considered in this Project is a 1 story building located in chennai, Tamil naidu in the south of India. The floor area of the building is 120,000 sq ft and its floor to floor height is 15 ft. Each Floor has specific use. The walls of the building consist mainly of brick and plaster without any insulation. The roof consists of 125mm concrete block and without insulation. The windows are dotted plane with a shading coefficient of 1.0 is considered. The HVAC systems used in the building is central chiller system one for each zones on each floor.

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Table-1 Description Of Proposed Building

Characteristics	Description of the Base Case
Location	Chennai, Tamil nadu
Orientation	Front Elevation facing West
Plan Shape	Rectangle and slant bend
Number of floors	G+1
Floor to Floor Height	15 FT
Floor Area	65,000 sqft
Type of Glass	Plane dotted glass 4mm
Solar Absorbance (for Exterior Surfaces)	0.6
Exterior Walls	9” thick Brick walls
Roof	6” mm Concrete slab
Floors	2
Lighting Power Density	Working Area 1.5 w/sft
Infiltration	0.5 ACH
System Type	Chilled water system
Thermostat Setting	75 degree F
Weather File	ISHRAE

VI. RESULT

HVAC System of the proposed laboratory building is designed for both Air cooled and water cooled chiller system, to evaluate the energy consumption. The Energy consumption of the building is evaluated using HAP 4.51 Software. It is found that the Annual net cooling energy consumption of the building for a Air cooled System is 78,09,560 kWh, and for a water cooled system is 57,30,338 kWh.

1) *Energy Consumption Of Air Cooled System Was Found To Be As Shown:* Floor Energy Consumption kWh Total 78,09,560
2) *Energy Consumption Of Water Cooled System Was Found To Be As Shown:* Floor Energy Consumption kWh Chiller Power 40,63,067; Condensor Water Pump 5,45,991 Cooling Tower Fan 11,21,280 which forms a Total of 57,30,338 Kwh
3) From this data calculated from Hap software for air conditioning system, It is found that the net energy savings of 20,79,222 kWh, for a air cooled air conditioning system which accounts to 26.62 % of the energy consumed for cooling for this particular building.

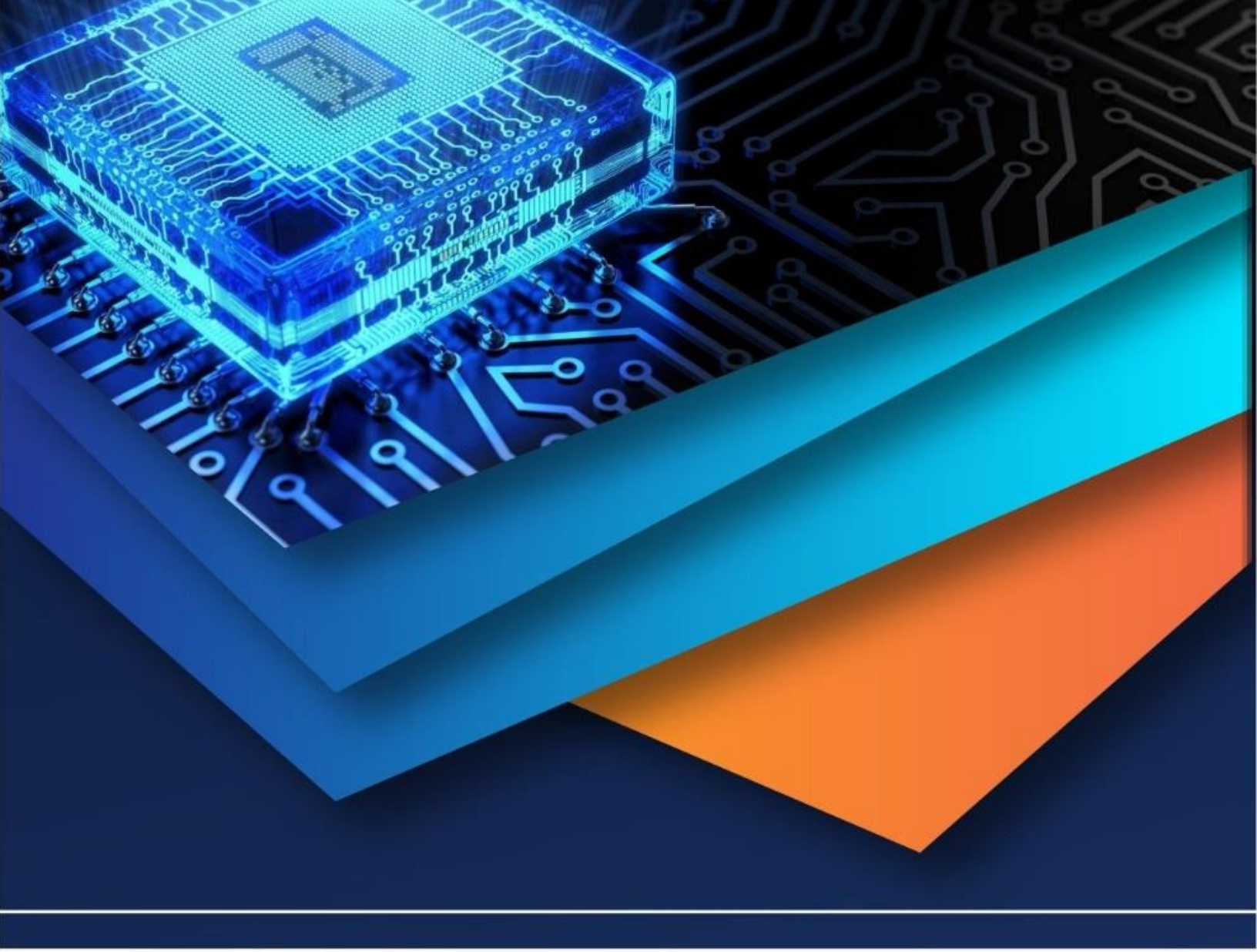
VII. CONCLUSION

This field study is carried out and is completed to analyze the execution of a large capacity Air cooled and Water cooled systems; Power rating, control utilization per unit cooling creation, kw/ton, has been picked as the model for execution. The trial information gathered amid the sum total of what seasons has been carefully screened, and just steady and solid information will be chosen to assess normal month to month esteems for cooling generation, control for the assistants, water utilization, and encompassing DBT and WBT. The methodology utilized for this examination can be reached out for assessing the yearly money saving advantages offered by the WC and AC systems. These two informational indexes with a similar cooling creation have been gathered and dissected. Assessing a theoretical HVAC configuration can turn out to be testing. There are numerous strategies that estimators have received throughout the years to help precisely for entire system with restricted data. Air conditioning hardware is a standout amongst the most critical segments in the system since it has a tendency to have the most astounding generally speaking energy cost. Ensuring an estimator has measured these pieces is imperative since alternate parts, for example, ducting are affected by these amounts. Knowing the kind of building and how it will be utilized is extremely useful to the gauge since this impacts the measure of energy consumption that will be required. Estimators with past experience, and utilizing the strategies and techniques talked about, can help give precision when attempting to appraise energy amounts for a theoretical HVAC system.

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