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DESIGN OF A VRF AIR CONDITIONING SYSTEM WITH ENERGY CONSERVATION ON COMMERCIAL BUILDING

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ABSTRACT

Today, the field if air conditioning design is more technologically challenging than ever before. While design innovations and product improvements promise sleeker, more versatile, more powerful and more energy – efficient air conditioners, the challenge today lies identifying the most appropriate product, or mix of products, for the application at hand. Indeed, today the emphasis is no more on understanding air conditioning products but on creating solutions and not just solutions, but customized solutions that suit specific cooling need of specific business and establishments. The consultant or designer who understands the dynamics of those clients business is more likely to offer better long term cooling solutions than who does not.

Every air conditioning application has its own special needs and provided its own challenges. Airports, hotels, shopping malls, office complexes and banks need uniform comfort cooling in every corner of their sprawling spaces and activities involving computers, electronics, aircraft products, precision manufacturing, communication networks and operation in hospitals, infect many areas of programming will come to a halt, so air conditioning is no longer a luxury but an essential part of modern living. There are various stages in the complete design of an air conditioning system. One of the important modules in the process is the duct design. The efficient duct design process enables the proper supply of air quantity, equal distribution of air at every corner of the Air conditioned space. Further the proper designing ensures minimum losses and hence energy conservation is obtained. In the present paper design of Air conditioning is done by using VRF (Variable Refrigerant Flow) for a commercial building. The main aim of his project is to conserve the energy by using VRF techniques when compared to conventional chille

KEYWORDS: Efficient Air conditioners, Aircraft products, Air conditioning, VRF , Manufacturing.

INTRODUCTION

If we are to define air conditioning we will have to say that it is the mechanical way of regulating the temperature, humidity, cleanliness and air flow inside a room or a building. The job of an air conditioner would be to control the temperature-humidity ratio at such a level that that it is both comfortable for us and is also healthful. As most air conditioners come with a filter it also clean the circulating air of the various contaminants like dust, soot, pollen, etc. Although not to the levels of an air purifier, air conditioners do in fact clean air considerably.

An air conditioner unit actually does is it draws in air from a room or a building and passes it across that side of the refrigeration apparatus which is much colder and absorbs the heat in the air. How cool the refrigeration apparatus is, is determined by how a thermostat is regulated. For water-cooling air-conditioning units, the heat is drawn away by the water flow. So fundamentally the principle is simple. However, there are a number of things that are associated with a modern air conditioner, which makes it more than just a cooling device. In fact if it remains just a cooling device, it would be actually wrong to call it an air conditioning unit. Ideally it should provide a comfortable temperature inside the room, no matter how hot or how cold is it outside. So many air conditioners come with a heat pump whose function is to just reverse the refrigeration cycle.

So when it is chilling cold outside, you can still be warm and cozy inside. Although the rudimentary ideas of the concept of air conditioning can be traced back to the early decades of the nineteenth century it was only in the first half of the previous century that air conditioner as we see it was introduced. Since then air conditioner had little stopping and it has become an integral part of our life. Although we generally tend to associate air conditioning with the comforts of life, it is also crucial to carry out several processes. For example certain operations like an open heart surgery can be conducted only under a controlled environment, and without air conditioner that would not be possible. Many industries, including the chemical and pharmaceutical industries cannot do without air conditioning. In fact it is hard to conceptualize today's world without air conditioning.

Types of Air Conditioning

There are various types of air conditioners like window air conditioner, split air conditioner, packaged air conditioner and central air conditioning system. This series of articles describes all types of air conditioners.

Types of Air Conditioning Systems

1. Window Air Conditioning System
2. Split Air Conditioner System
3. Central Air Conditioning Plants
4. Packaged Air Conditioners

Window Air Conditioning:

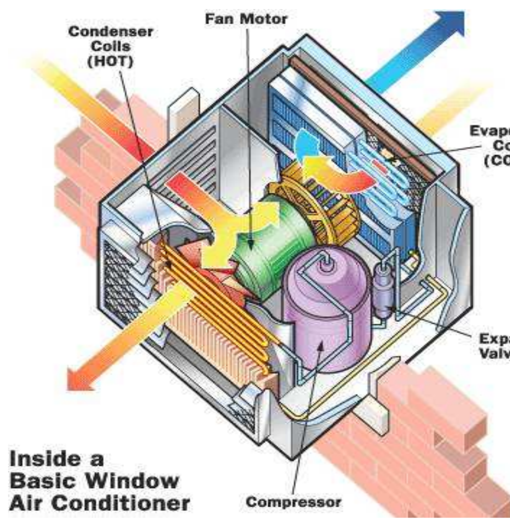

Fig No.1.1 Window Air Conditioner

Window air conditioners are one of the most commonly used and cheapest type of air conditioners. To install one of these units, you need the space to make a slot in the wall, and there should also be some open space behind the wall.

Window air conditioners are one of the most popular types of air conditioners being used. Whether it's your study room, bedroom, or hall, the window air conditioner can be used for almost all types of spaces. To fit the window air conditioner in your room, you need to make a slot in one of the walls of the room that is to be cooled. This system extends around two feet beyond the wall in the back side; hence behind the wall some free space should be available so that the hot air can be thrown easily from the condenser. The dew collected from the room is also thrown from the back of the air conditioner. Thus window air conditioners can be used only if there is place available in the wall to make the slot, Sand there is free space behind the wall for dissipating the heat and dripping water. Window air conditioners are comprised of components like the compressor, condenser, expansion valve or expansion coil, and the evaporator or the cooling coil, all housed in a single box. There is also a motor which has shafts on both sides.

On one side of the shaft the blower is connected, which sucks hot air from the room and blows it over the cooling coil, thus cooling it and sending it to the room. On the other shaft the fan is connected, which blows the air over Freon gas passing through the condenser. The window air conditioner is the cheapest of all air conditioning systems. If your room or office size is about less than 100 sq. ft. a window air conditioner of about 0.8 ton can be good enough. If the size of room is more than this but less than 200 sq. ft. your HVAC designer will recommend a window air conditioner of about 1 ton. For rooms of bigger sizes but less than 300 sq. ft. the system of about 1.5 ton is advisable. However, these sizes may change depending upon the number of people occupying the space, its alignment with respect to sun, and other sources of heat generation inside the room.

It is better to consult your HVAC designer to find out the exact size of window air conditioner suitable for your space. One of the complaints that window air conditioners have had is that they tend to make noise inside the room. But this problem has been greatly overcome by the present day efficient and less noisy rotary compressors, which also consume less electricity. Today a number of fancy and elegant looking models of window air conditioners are available that enhance the beauty of your rooms.

Split Air Conditioner System:

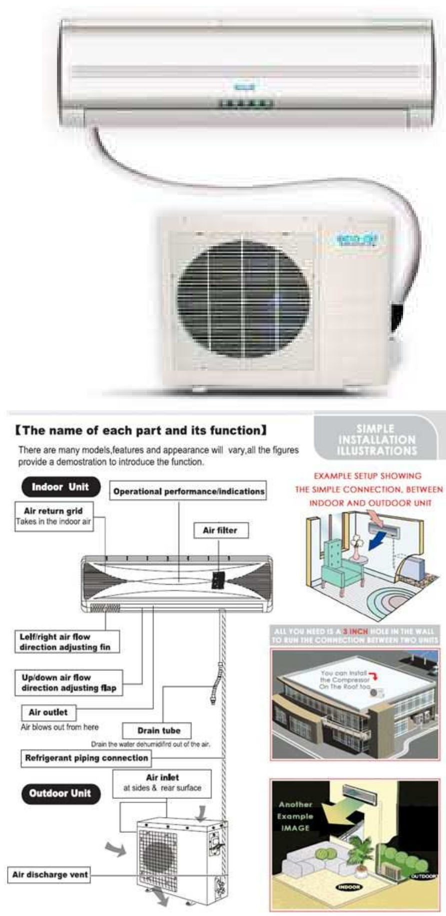

Fig No.1.2 Split Air Conditioner

This is what people most commonly think of when they speak of wanting air conditioning. Split central air allows you to place the noisy portion or your cooling unit outside where it will be less noticeable. Split central air requires that your house have ducting to the various rooms in your home (usually the same ducting you use for your central heat). Central air allows you to cool all parts of a house evenly and quietly.

Central Air Conditioning Plants:
Chilled water system:

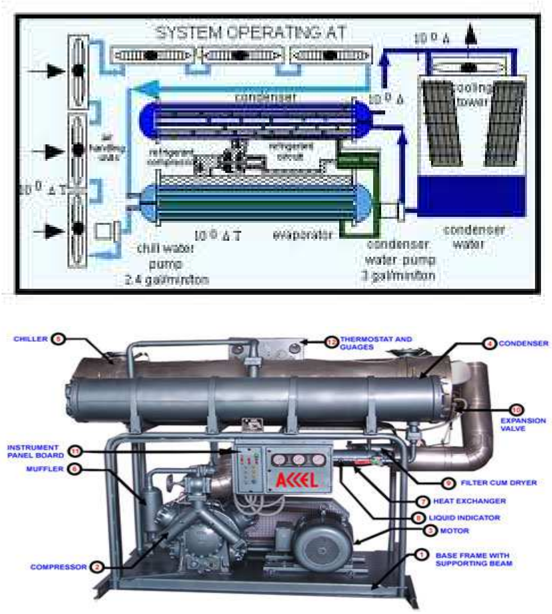

Fig No. 1.3 Chilled water system

A chilled-water applied system uses chilled water to transport heat energy between the airside, chillers and the outdoors. These systems are more commonly found in large HVAC installations, given their efficiency advantages.

The components of the chillers (evaporator, compressor, an air- or water-cooled condenser, and expansion device) are often manufactured, assembled, and tested as a complete package within the factory. These packaged systems can reduce field labor, speed installation and improve reliability. Alternatively, the components of the refrigeration loop may be selected separately. While water-cooled chillers are rarely installed as separate components, some air cooled chillers offer the flexibility of separating the components for installation in different locations.

This allows the system design engineer to position the components where they best serve the space, acoustic, and maintenance requirements of the building owner. Another benefit of a chilled-water applied system is refrigerant containment. Having the refrigeration equipment installed in a central location minimizes the potential for refrigerant leaks, simplifies refrigerant handling practices, and typically makes it easier to contain a leak if one does occur. The central air conditioning system is used for cooling big buildings, houses, offices, entire hotels, gyms, movie theatres, factories etc. If the whole building is to be air conditioned, HVAC engineers find that putting individual units in each of the rooms is very expensive initially as well in the long run.

The central air conditioning system is comprised of a huge compressor that has the capacity to produce hundreds of tons of air conditioning. Cooling big halls, malls, huge spaces, galleries etc is usually only feasible with central conditioning units.

1) Central Air Conditioning Plants
2) Direct Expansion or DX Type of Central Air Conditioning Plant
3) Chilled Water Type of Central Air Conditioning Plant

Packaged Air Conditioners :

Summer & Winter Air Conditioning:

In most of the places the summer season is hot and humid. Hence, in order to provide comfortable conditions to the occupants during summer, it is required to supply cold and dry air to the occupied space. This requires systems wherein the hot and humid air can be cooled to temperatures lower than the dew point temperature, so that the water vapor in air can be removed by condensation, and the resulting cold and dehumidified air supplied to the conditioned space in required quantity for providing thermal comfort. Thus it can be seen that a typical summer air conditioning system requires a refrigeration system that reduces the temperature of the air to temperatures much lower than the surroundings. Of course, in some areas such as deserts, the summer is hot and dry.

Air conditioning systems for these hot and dry climates also require cooling of air below the ambient temperatures, however, instead of removing water vapor it may be required to add water to the air supplied to the conditioned space.

Energy recovery ventilation systems provide a controlled way of ventilating a home while minimizing energy loss. Air is passed through an "enthalpy wheel" (often using silica gel) to reduce the cost of heating ventilated air in the winter by transferring heat from the warm inside air being exhausted to the fresh (but cold) supply air. In the summer, the inside air cools the warmer incoming supply air to reduce ventilation cooling costs.[3] This low-energy fan-and-motor ventilation system can be cost-effectively powered by photovoltaics, with enhanced natural convection exhaust up a solar chimney - the downward incoming air flow would be forced convection (advection).

A desiccant like calcium chloride can be mixed with water to create an attractive recalculating waterfall, that dehumidifies a room using solar thermal energy to regenerate the liquid, and a PV-powered low-rate water pump. Active solar cooling wherein solar thermal collectors provide input energy for a desiccant cooling system: A packed column air-liquid contactor has been studied in application to air dehumidification and regeneration in solar air conditioning with liquid desiccants.

A theoretical model has been developed to predict the performance of the device under various operating conditions. Computer simulations based on the model are presented which indicate the practical range of air to liquid flux ratios and associated changes in air humidity and desiccant concentration. An experimental apparatus has been constructed and experiments performed with monoethylene glycol (MEG) and lithium bromide as desiccants. MEG experiments have yielded inaccurate results and have pointed out some practical problems associated with the use of glycols. LiBr experiments show very good agreement with the theoretical model. Preheating of the air is shown to greatly enhance desiccant regeneration. The packed column yields good results as a dehumidifier/regenerator, provided pressure drop can be reduced with the use of suitable packing.

ENERGY CONSERVATION IN AIR CONDITIONING

Energy conservation refers to reducing energy through using less of an energy service. Energy conservation differs from efficient energy use, which refers to using less energy for a constant service. For example, driving less is an example of energy conservation. Driving the same amount with a higher mileage vehicle is an example of energy efficiency. Energy conservation and efficiency are both energy reduction techniques.

Need of Energy Conservation

Energy Saving Ideas for the Seasons

With energy prices rising across the country, now is a good time to learn how to use energy wisely. Here are some simple tips to help you reduce your energy consumption

In Winter

During the winter months, set your thermostat at 68 degrees Fahrenheit during the day and 60 degrees Fahrenheit at night. You can save 3 percent on your heating costs for every degree you reduce the temperature below 70 degrees Fahrenheit.

Special Advice to Heat Pump Owners: Heat pumps need to stay at a constant setting, unless you have a programmable electronic heat pump thermostat with adaptive recovery. Check with your heating or air conditioning contractor to determine the type of thermostat you have.

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- Winterize windows with weather stripping (for all moveable joints) and caulk (for non-moving parts). Also, install a window kit to the inside of your windows to help keep cold air out and warm air in.
- Change filters once a month. A well-maintained heating system can save money and increase the comfort level in your home.
- When you cozy up to a crackling fire on a cold winter day, you may be losing more heat than you are generating if your fireplace is not airtight.
- Inspect ductwork for any air leakage. If you do feel air leaking at joints, use silver metal duct tape to seal them. You could save up to 10 percent of your heating costs by eliminating those leaks.

In Summer

- During hot weather, a central air conditioner can account for 30 percent of your energy bill. Check the air filter regularly – a clean air filter improves system efficiency, which should lead to energy savings.
- Set your thermostat at 78 degrees Fahrenheit, a reasonably comfortable and energy-efficient indoor temperature.
- Have a professional check your air conditioning system to ensure that it works properly and is not leaking coolant.
- Be sure all windows are shut and outside doors are closed when the AC is on.
- It is important not to have lamps, televisions or other heat sources close to the air conditioner thermostat – heat from these sources may cause the air conditioner unit to run longer than it should.
- Check to ensure that no furniture or other obstacles are blocking ducts or fans. This will enable cooled air to circulate freely, making your home more comfortable.
- Year-round
- Your water heater is the third highest energy expense in your home. If the water temperature is set at 140F, turning it down to 130F will save a few dollars each month.
- Using a microwave to cook meals uses about half the energy of a conventional oven.
- Washing clothes in cold water instead of hot is another energy saving tip that can save you about $50 per year.
- Another way to save energy in the laundry room is to put a dry towel in the dryer with each load of wet clothes. The towel will absorb dampness and reduce drying time, saving energy and money.
- Replace incandescent light bulbs with more efficient, compact, fluorescent ones. Besides saving energy, you will also save money in the long run, since the life span of a fluorescent bulb is substantially longer.
- If you have a crawl space, inspect it regularly to ensure that the insulation inside is dry. When insulation gets wet, its optimal effectiveness is significantly reduced. Be sure to find the source of the moisture and replace any damaged insulation.
- Vacuum the coils on your refrigerator at least every three months. The dirt build-up makes the refrigerator work harder to keep the contents cool and therefore uses more energy.

Energy Conservation in Refrigeration & Air Conditioning Systems

There is tremendous scope for energy conservation in refrigeration and air conditioning. Energy can be conserved at various levels. The RAC system can be divided into two major sub-systems, refrigeration equipment and delivery equipment. The first consisting of the components required to produce the consisting of the components required to produce the cooling effect and the latter to deliver this cooling effect to various sites in different modes. This article will review the opportunities for energy conservation relevant to the first sub-system the refrigeration equipment, and its comments. Various options to optimize the coefficient of performance (CPO), defined as the ratio of useful effect to the energy input, and ways to co-generate cold and hot utilities or cool utility and electricity or cold and hot utility along with electricity will be looked into.

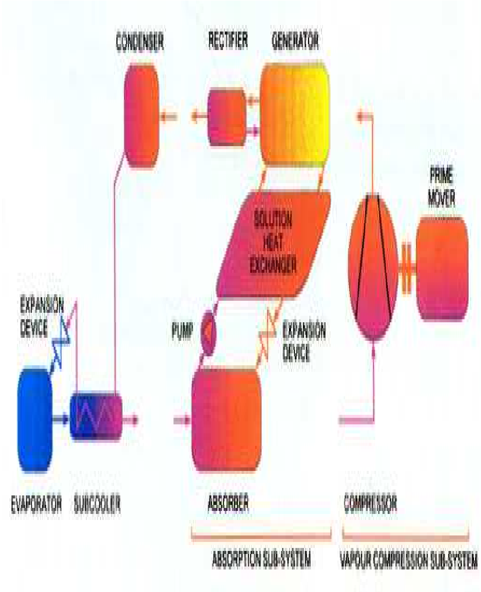

Fig No. 2.2 Energy Conservation in Refrigeration & A/C Systems

A review of the opportunities for energy conservation will help in specifying the most suitable system. The choice of operating cycle, system and its components play an important role in reducing energy consumption. Variation in primary energy consumption, energy cost, total operating cost, initial or retrofitting cost and life cycle cost are the issues to be taken into account while identifying the best system.

AIR CONDITIONING SYSTEMS:

Vapour Compression Refrigeration System

Vapour-compression refrigeration is one of the many refrigeration cycles available for use. It has been and is the most widely used method for air-conditioning of large public buildings, offices, private residences, hotels, hospitals, theatres, restaurants and automobiles. It is also used in domestic and commercial refrigerators, large-scale warehouses for chilled or frozen storage of foods and meats, refrigerated trucks and railroad cars, and a host of other commercial and industrial services. Oil refineries, petrochemical and chemical processing plants, and natural gas processing plants are among the many types of industrial plants that often utilize large vapour-compression refrigeration systems. Refrigeration may be defined as lowering the temperature of an enclosed space by removing heat from that space and transferring it elsewhere. A device that performs this function may also be called a heat pump.

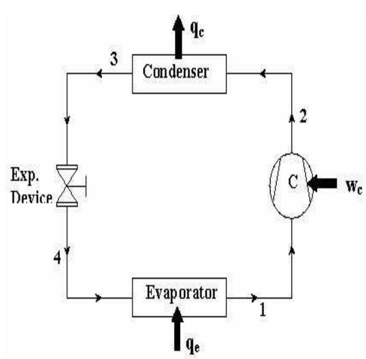

Fig No.3.1 Vapour-compression refrigeration

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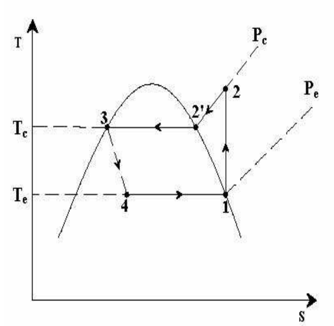

Fig No.3.2 Standard Vapour compression refrigeration system

VRF AIR CONDITIONING SYSTEMS

Introduction to VRF,VAV System

Variable Air Volume (VAV) is a type of heating, ventilating, and/or air-conditioning (HVAC) system. The simplest VAV system incorporates one supply duct that, when in cooling mode, distributes approximately 55 °F (13 °C) supply air. Because the supply air temperature, in this simplest of VAV systems, is constant, the air flow rate must vary to meet the rising and falling heat gains or losses within the thermal zone served.

There are two primary advantages to VAV systems over constant-volume systems. The fan capacity control, especially with modern electronic variable-speed drives, reduces the energy consumed by fans, which can be a substantial part of the total cooling energy requirements of a building. Dehumidification is greater with VAV systems than it is with constant-volume system, which modulate the discharge air temperature to attain part load cooling capacity.
The air blower's flow rate is variable. For a single VAV air handler that serves multiple thermal zones, the flow rate to each zone must be varied as well.

A VAV terminal unit, often called a VAV box, is the zone-level flow control device. It is basically a quality, calibrated air damper with an automatic actuator. The VAV terminal unit is connected to either a local or a central control system. Historically, pneumatic control was commonplace, but electronic direct digital control systems are popular especially for mid-to-large size applications. Hybrid control, for example having pneumatic actuators with digital data collection, is popular as well.

A common commercial application is shown in this diagram. This VAV system consists of a VAV box, ductwork, and four air terminals.

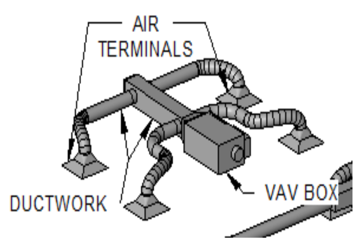

Fig No. 4.1 A Common Commercial Application

Control of the system's fan capacity is critical in VAV systems. Without proper and rapid flow rate control, the system's ductwork, or its sealing, can easily be damaged by over pressurization. In the cooling mode of operation, as the temperature in the space is satisfied, a VAV box closes to limit the flow of cool air into the space. As the temperature increases in the space, the box opens to bring the temperature back down. The fan maintains a constant static pressure in the discharge duct regardless of the position of the VAV box. Therefore, as the boxes close, the fan slows down or restricts the amount of air going into the supply duct. As the boxes open, the fan speeds up and allows more air flow into the duct, maintaining a constant static pressure.

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VRF systems are similar to the multi-split systems which connect one outdoor section to several evaporators. However, multi-split systems turn OFF or ON completely in response to one master controller, whereas VRF systems continually adjust the flow of refrigerant to each indoor evaporator. The control is achieved by continually varying the flow of refrigerant through a pulse modulating valve (PMV) whose opening is determined by the microprocessor receiving information from the thermistor sensors in each indoor unit. The indoor units are linked by a control wire to the outdoor unit which responds to the demand from the indoor units by varying its compressor speed to match the total cooling and/or heating requirements.

VRF systems promise a more energy-efficient strategy (estimates range from 11% to 17% less energy compared to conventional units) at a somewhat higher cost.

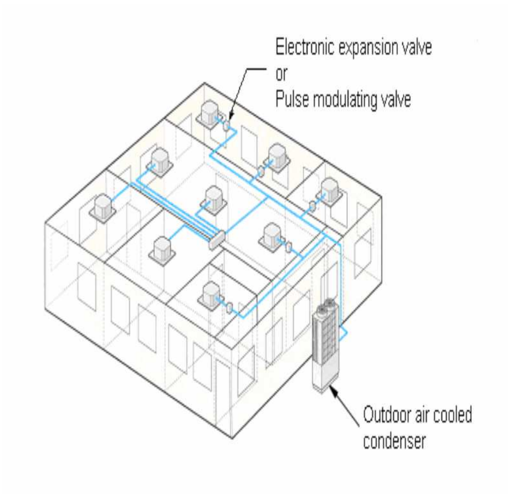

Fig No. 4.2 VRF System with Multiple Indoor Evaporator Units

The modern VRF technology uses an inverter-driven scroll compressor and permits as many as 48 or more indoor units to operate from one outdoor unit (varies from manufacturer to manufacturer). The inverter scroll compressors are capable of changing the speed to follow the variations in the total cooling/heating load as determined by the suction gas pressure measured on the condensing unit. The capacity control range can be as low as 6% to 100%.

Refrigerant piping runs of more than 200 ft are possible, and outdoor units are available in sizes up to 240,000 Btuh.

A schematic VRF arrangement is indicated below:

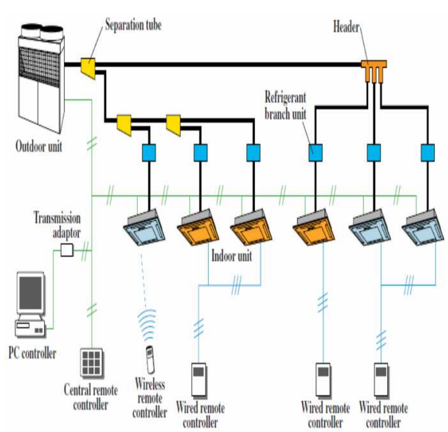

Fig No. 4.3 A Schematic VRF Arrangement

VRF systems are engineered systems and use complex refrigerant and oil control circuitry. The refrigerant pipe-work uses a number of separation tubes and/or headers (refer schematic figure above).

A separation tube has 2 branches whereas a header has more than 2 branches. Either of the separation tube or header, or both, can be used for branches. However, the separation tube is NEVER provided after the header because of balancing issues.

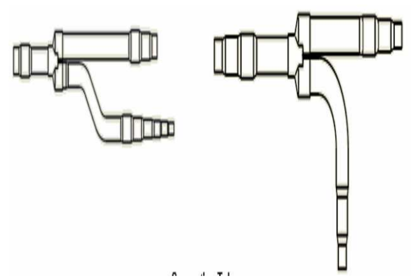

Fig No. 4.4 Separation Tube

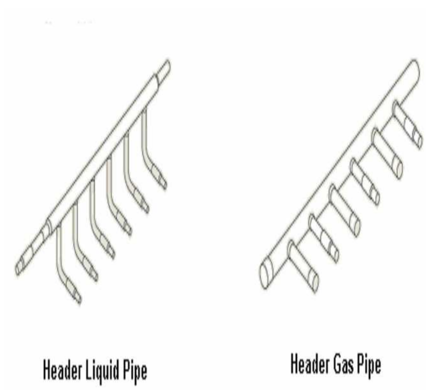

Fig No. 4.5 Header Pipes

Compared to multi-split systems, VRF systems minimize the refrigerant path and use less copper tubing. Minimizing the refrigerant path allows for maximizing the efficiency of refrigerant work.

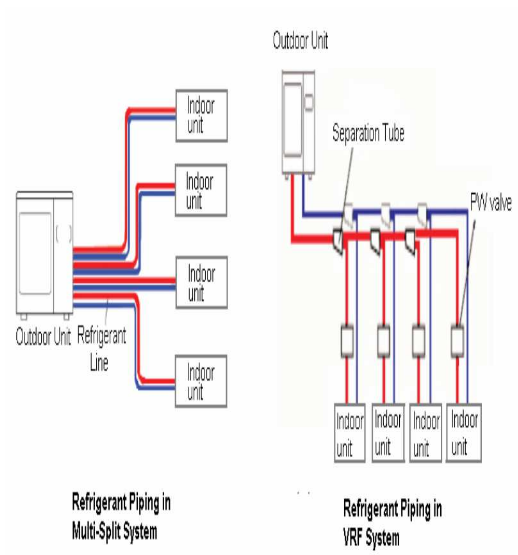

Fig No. 4.6 Comparison of Multi-Split System with VRF System

DESIGN OF VRF SYSTEM

The Load calculation for the VRF system is done as shown below:-

Job name :-
Space used for:- Commercial Building
Size: 13.9' x 12.92' = 179.588 sq.ft x Height
= 179.588 sq.ft x12
Volume = 2155.056 cubic feet

	DBT	WBT	RH	GR/LB	DP
OUTSIDE	106	-	-	100	-
ROOM	75	-	-	65	-
DIFFRENCE	31	-	-	35	-

Table No. 5.1 Design conditions

Estimation --20
Q = A x ⌂T x U- factor
Q = Heat transfer (Heat generated)
A = Area
⌂T = Temperature difference
U-factor = Co-efficient factor

Co-efficient factor: the rate of heat transfer through the building barriers
U- factor =1 / ∑R
∑ R =Ri + X1 R1 + X2 R2 + …………XnRn +R0
Ri = Resistance of inside
ASHRAE = American society of heating Refrigeration & Air conditioning Eng
Solar heat gain through glass

Specification of Glass:
It is a heat absorbing glass, Venetian blind with 45 degree slant on outside with light colour on outside and dark colour on inside, vertical glass, with storm windows

Specification of Wall:
It is a poured concrete blocks, and the internal finish is made of insulating 1" board plain or plastered on furring
Roof = A x ⌂T x U

Specification of Roof:
Roof is made of concrete mixed with sand & gravel aggregate with 4" thickness suspended plaster ceiling with 1" insulation on top of deck
Transmission Heat gain through roof = 179.588 x 51 x 0.28
= 2564.5 BTU / hr
Transmission Heat gain through glass
All single glass = 24 x 31 x 1.13= 840.72 BTU/hr
Partition = 309.6 x 12sft glass
=216 sq.ft x (31-5) x 0.37
= 2978.352 BTU/hr
Floor = 179.588 sq.ft x 26 x 0.31
= 1447.47928 BTU/hr

Specification:
Hollow concrete block made of light weight aggregate with 4" thickness both sides finished with cement plastering with 3 / 8" of thickness on wall
Infiltration & outside Air

Infiltration is not considered as there are no doors and windows.
Outside Air = cfm x ⌂T x BF x 1.08
BF - By pass factor
Contact factor + BF = 1
CF = 1- BF
BF = 1- CF
The air which is cooled is called contact factor
Ventilation CFM
40w + 40w = 80w / 98.96 sq.ft
= 0.8

ITEMS	BR	MBR	LIVING/HALL	FAMILY	DINING
PEOPLE	2	2	6	6	6
LIGHTING(W/SQFT)	0.8	0.9	1	0.7	0.6
APPLIANCES(WATTS)	350	350	400	200	300

Table No. 5.2 No of People

People = no .of people x cfm /person
= 3 x 20 = 60 cfm
Air change = no of air change / hr x volume
= 10/60 x 2155.056= 359.176 cfm
Outside air = cfm x ⌂T x 1.08 x BF
= 359 x 31 x 0.1 x 1.08
= 1201.932 BTU/hr

Internal Heat:
People = no. of people x sensible heat gain / person
= 3 x240 = 720
Lights = no. of lights x heat gain / watt x factor x 3.41
= 1 x 179.588 x 2 x 3.41 = 1224.79016
Appliances = 1000x 3.41 = 3410

Room sensible heat
= 2564.5 + 840.72 + 2978.352 + 1447.47928+ 1201.932 + 5354.8
= 14387.8 BTU / hr
Factory of safety (10%) = 1438.779008 BTU / hr
E.F.F room sensible heat (Qs) = 15826.6 BTU / hr

Latent heat:
Infiltration = cfm x ⌂gr x BF x 0.68
Out side air = cfm x ⌂gr x BF x 0.682
= 359 x 35 x 0.1 x 0.68
= 854.42
People = no .of people x latent heat gain / person
=3 x 160 =480
Room latent heat = infiltration + outside air + people
= 854.42 + 480
= 1334.42 BTU / hr
Factory of safety 5% = 66.7221
Effective room latent heat (Ql) = 1401.141
Eff room total heat (Qt) = Qs + Ql
= 15826.6 +1401.141
= 17227.741 BTU / hr

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Outside air heat :
Sensible = cfm x ⌂Tx BF x 1.08
= 359x 31 x 0.9 x 1.08
= 10817.388 BTU / hr
Latent = cfm x ⌂gr x BF x 0.68
= 359x35x0.9x0.68
= 7689.78 BTU / hr
Grand subtotal heat = Qt + S.H + L.H
= 17227.741+10817.388+7689.78
= 35734.87809
Factory of safety (2%) = 714.6975618 BTU / hr
Grand total heat = 36449.57565 BTU / hr
1 TR ------ 12,000BTU / hr
TR = 36449.57565 / 12,000 = 3.04TR
Effective sensible Heat factor (ESHF) = Qs / Qt
= 15826.6 / 17227.741 = 0.92

ESHF	0.84	0.85	0.86	0.87	0.88	0.89	0.90	0.91	0.92
ADP	52	52.25	52.5	52.75	53	53.25	53.5	53.75	54

Table No.5.3 Apparatus Due Temperature

ADP = 54 ° F
Dehumidified Rise = (1-BF) x (Rm Temp - ADP)
= 18.9º F
Dehumidification CFM = Qs / 1.08 x DR
= 15826.6 / 1.08 x 18.9
= 775Cfm

The TR of this particular room was 3.
Similarly load calculations are done for all the rooms where the VRF units will be installed.

The project can realize significant benefits by using VRF Technology. Efficiency and modern modular design are just the beginning.

The modular design of VRF results in superior energy savings giving occupants the choice to air condition or heat only the zones in use. A VRF system provides exceptional dehumidification and temperature control by rapidly adapting to changing loads.

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Item	Description	VRF System	Unitary System
1	**Condensing units components**		
1.1	Single or multiple compressor	Yes	Yes
1.2	Oil separator for each compressor or for all compressors	Yes	Yes
1.3	Oil level control	Yes	Yes
1.4	Active oil return	Yes	In some units
1.5	Option for heating and cooling	Yes	Yes for hot gas defrost
	Simultaneous heating / cooling	Yes	No
1.6	Air cooled or water cooled condenser	Yes	Yes
1.7	Liquid receiver	Yes	Yes
1.8	Control of the refrigerant level in the liquid	Yes	Yes
1.9	Condensing temperature control	Yes	It is an option
1.10	Capacity control by the suction pressure	Yes	Yes
1.11	Compressor cooling capacity control by	Yes	Yes
1.12	Suction accumulator	Depending on the	Yes
2.0	Refrigerant lines		
2.1	Long liquid lines to many evaporators	Yes	Yes
2.2	Refrigerant pipes special design	Yes	Yes
3.0	Internal units		
3.1	Several units any size	Yes	Yes
3.2	Independent control for each evaporator	Yes	Yes
3.3	Mechanical sub-cooling	Provided for pressure drop (if necessary) and to improve performance	Provided to improve Performance
3.4	Expansion valve able to handle different cooling capacities and pressure differential	Electronic expansion valve	Thermostatic or electronic expansion valve
3.5	Coil and drain defrost	Only necessary for the external unit heating	Operational and protection
3.6	Air filter	Yes	Not necessary
3.7	Drainage pump	Depends	Depends
4.0	**Controls**		
4.1	Microprocessor control condensing unit	Yes	Yes

4.2	Microprocessor in the evaporator	Yes	Yes
4.3	BMS available	Yes	Yes
4.4	Inverters for power	Yes	Yes
	Alarm codes	Yes	Yes

Table No. 5.4 Comparison of VRF and Unitary HVAC Systems:

CONCLUSIONS

The paper involved in designing the VRF system for Commercial building, the designing with respect to Load calculation is the same for VRF as well. The cost comparisation between Duct able Spit units is show, the initial cost difference in not their but when we go on to operating cost, the difference is going to be huge as per the usage of the system. The load calculation is done based on Peak load calculation which is we consider the hottest day as the basis of our calculation, but in practical it is found that the we run our systems on Partial load for almost 85% time and the efficiency of VRF is very high when the VRF system is used on Partial load, the power consumption is huge when 100% Load at 42Deg C DB Ambient Temp. @ 9.40Kw power consumption and the same system at 20% Load at 42Deg C DB Ambient Temp. @ 1.38Kw power consumption, the power saving is 6.8 times than the ductable split air conditioning unit as the power consumption of it is almost same for 100% and 20%.

REFERENCES

[1] Bhaduri, A., "Use of PCM materials in HVAC Installations", Air Conditioning and Refrigeration Journal, Mumbai, 2001 July-September.
[2] Jianyi Zhang, Eckhard, A Groll., "Saving Energy in Refrigerated Warehouse using PCM ethylene , Air Conditioning and Refrigeration Journal, China, April-June 2001.
[3] Nimial, C. Gupta., "Air-Cooled Chillers: Myths & Facts", Air
[4] Conditioning and Refrigeration Journal, New Delhi, October-December 2003.
[5] Gupta, P., "Impact of Cooling Tower Blade Modification on Energy
[6] Consumption", A Conditioning and Refrigeration Journal, New Delhi, October-December 2001.
[7] Stulz Gmb,H., "Precision or Comfort Air Conditioning", Air
[8] Conditioning and Refrigeration Journal, Germany, January-March 2002.
[9] GeorgeSze, Lek Siang Hwa., "Hospital HVAC Design: A Challenge for
[10] Energy Recovery and System Reliability", Air Conditioning and Refrigeration Journal. Singapore, July-September 2002.