APPLICABILITY OF VRV/VRF HVAC SYSTEM – A JUDICIOUS AND RATIONAL APPROACH

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ABSTRACT

Use of Variable Refrigerant Volume (VRV)/Variable Refrigerant Flow (VRF) based HVAC systems are being prescribed as an alternate solution to centralized HVAC systems in today's buildings without any judicious approach / thinking. This system has been encouraged due to its energy efficiency appeal at part loads and also as a good substitute where scarcity of water is an issue. Its use in small places can be encouraged where there is lot of variation in occupancy. However its applicability in existing office buildings, educational institutions, laboratories has left some question marks. The drainage of condensate water and ventilation is posing many problems which need to be addressed by the designers in close coordination with the architects / structural design engineers. The paper gives an overall view of the limitations which have been experienced after installation of these unitary systems in new upcoming buildings which need to be addressed while designing in close coordination with designers of other services / structural designers /architects. VRV/VRF based HVAC systems are not meeting the site requirements owing to inherent shortcomings. Their generous use for every application is not recommended and calls for a judicious and rational approach.

1. INTRODUCTION

Variable Refrigerant Volume or Variable Refrigerant Flow (depending on manufacturer) has been around for about a quarter of a century. It originated in Japan around 1977 and captured markets in Korea, China and then in India. A large outdoor unit (condenser / compressor) serves multiple indoor units (evaporator / chiller). Each indoor unit uses an LEV (electronic liquid expansion value) to control its refrigerant supply to match the demand of the space it serves. Thus at any instant, there will be variable volume / flow of refrigerant flowing. Various strategies are used to vary the output of the outdoor units including:

- Modulating fan/s
- Heat exchanger valued in sections
- Variable speed inverter drive compressor/s
- Multiple compressors
- Twin or multiple modular output units

2. PRINCIPLES OF OPERATION

Every indoor unit is provided with indoor temperature sensor which controls the electronic expansion value on the refrigerant line. The quantum of flow of refrigerant through the indoor unit is regulated to meet the set indoor temperature requirement on account of variation in indoor load, the requirement of refrigerant flow varies. This is achieved by modulating the compressor capacity and this reduces power consumption at part load. The speed of condenser fan is also regulated as per system requirement and this also reduces its power requirement.

3. SYSTEM TYPES

VRV/VRF system can be used for cooling, pumping and heat recovery. On heat pump models indoor units can be in either mode but all must be in the same mode if served by the same outdoor unit. The most sophisticated VRV/VRF systems can have indoor units served by a single outdoor unit in both heating and cooling modes simultaneously. This mixed mode operation leads to energy saving as both ends of

the thermo dynamic cycle are delivering useful heat exchange. If a system has a cooling COP of 3 and a heating COP of 4, then heat recovery operation could yield a COP as high as 7.

Control system of variable capacity are mainly of two types. Digital Scroll Compressors or Inverter Technology. Though the manufacturers of both the technologies vouch for their products yet the end consumer finds not much of difference in their end deliveries. Indoor units do not have facility of adding fresh air. Treated fresh air systems are needed for adding fresh air with pipe / duct to every indoor unit.

4. DERATION

Deration on account of following factors can take place:

(i) Increase in ambient temperature beyond 35°C CDB. Average reduction in capacity from 35°C to 45°C is 1.1% per deg C whereas from 45°C to 50°C is 1.38% per deg C. Total cooling capacity at 45° C is 11% less than that at 35°C and 17.2% less than at 35°C for ambient of 50°C.

(ii) Decrease in indoor temperature lower than 27°C DB. Cooling capacity decreases as the indoor temperature falls.

(iii) Difference in mounting level of outdoor and indoor unit.

(iv) Increase in refrigerant pipe length.

(v) Metal temperature of condenser on account of exposure to sun.

5. MERITS OF VRF / VRV SYSTEM

(i) No space required for plant room / AHU room

(ii) No water requirement.

(iii) Faster installation.

(iv) Modular system.

(v) Indoor temperature can be set as per individual requirement.

(vi) Indoor unit not in use in a particular place can be switched off if not in use.

(vii) False ceiling not required except for cassette unit, if called for.

(viii) Both cooling and heating at higher efficiencies possible.

6. DEMERITS OF VRF/VRV SYSTEM

(i) The system does not offer a perfect air-conditioning solution as is the case with conventional air-conditioning system.

(ii) The refrigerant copper pipes from outdoor units to indoor units run in metres and need proper workmanship in handling, installation, joint connectivity and subsequent upkeep during operation and maintenance. This makes system too fragile as compared to ruggedness of a conventional air-conditioning system. Due to non-availability of trained skilled manpower, plumbing works of refrigerant work suffers badly and is the root cause of faulty installation and subsequent trouble during operation.

(iii) The condensate from indoor units need to be drained out. Due to longer length and height restrictions, proper gravitational slope of pipes cannot be maintained and is source of seepage / water leakages. Damage to the insulation of drain pipes creates a source of water leakage above false ceiling.

(iv) Copper refrigerant pipes installed at the terrace / shafts throughout the building is subjected to pilferages and mishandling during movement of men maintaining other services.

(v) VRF/VRV system does not offer any fresh air inside the conditioned space. Treated fresh air system have to be added to ensure fresh air inside the conditioned space.

(vi) There is no provision of humidification /de-humidification with VRV/VRF systems and hence calls for additional accessories to maintain desired level of relative humidity inside the conditioned space.

7. DESIGNER'S ROLE

Wherever VRF/VRV system is to be provided in a building, the designers/consultants need to analyse the various modes of HVAC system and their applicability in a particular building. A comparative study is called for to weigh all the options available and apply the system which is desirable for a particular building. The use of VRF/VRV system in large office areas, commercial spaces, hospitals, conference halls etc., may not be encouraged. However VRF/VRV system can be used in a medium cooling load requirement with wide load variation and where the ambient is in the moderate range of 35°C to 45°C.

8. CONCLUSION

The usage of VRV/VRF system should be decided on a case to case basis and not a panacea for all air-conditioning needs