

# VARIABLE REFRIGERANT VOLUME:- AIR CONDITIONING PART: A REVIEW

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**ABSTRACT:-** This paper provides an overview of variable refrigerant volume system technology, including the market situation, advantages and disadvantage for the customer, possible impact on the electric utility, applications recommendations, and technology attributes. The VRV technology was developed and designed by Daikin industry, japan who named and protected the term VRV system so other manufacture use the term VRV. Variable refrigerant volume (VRV) is an air conditioning system configuration where there is one outdoor condensing unit and multiple indoor units. VRV system uses 17% and 73% less energy than the rooftop system in cooling and heating seasons. VRV is a technology, that circulates only a minimum amount of refrigerant needed during a single heating or cooling period. One outdoor condensing unit can serve multiple indoor units. It's known for their high energy performance. VRV system is one of the Heating, Ventilation and Air Conditioning (HVAC) type in the building. VRV technology uses smart integrated controls, variable speed drives, refrigerant piping, and heat recovery to provide products with attributes that include high energy efficiency, flexible operation, ease of installation, low noise, zone controls, and comfort using all-electric technology. Variable refrigerant volume systems are popular in Asia and Europe. So we can say that the main purpose of VRV system to save the energy and electricity also.

## 1. INTRODUCTION

The variable refrigerant volume in air conditioning was invented in 1982 by the Japanese company Daikin. The VRV air-conditioning system is use to produce the less energy as compare to other system. It is a multi-split air conditioner. VRV system is easier modular and installation, space saving with multiple indoors in its connected to one outdoor unit. VRV is a energy efficiency easier & more cost effective maintenance and commissioning.

- a) Two Pipe/Heat Pump System.
- b) Three Pipe/Heat Recovery System.
- c) TWO PIPE/HEAT PUMP SYSTEM:- In two pipe system which commonly referred as heat pump system all of the zone and must either be all in

cooling or all in heating. In two pipe system only cooling can be done

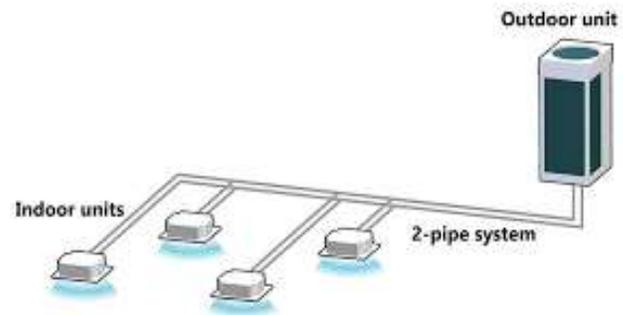


Fig.1 (Two Pipe / Heat Pump System)

(b)THREE PIPE SYSTEM:-A three pipe heat recovery system has the ability to simuletansionaly heat certain zone while cooling others in this system both heating & cooling. In Three pipe system both heating and cooling can be done.

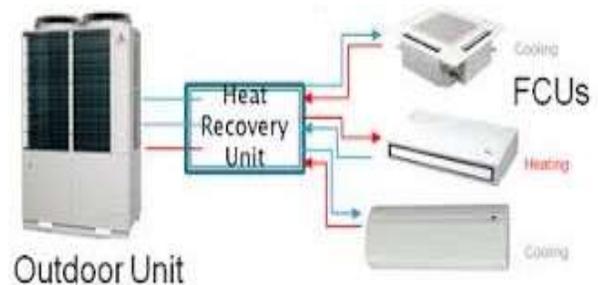


Fig. 2 ( Three Pipe / Heat Recovery System)

In both two pipe and three pipe system with refrigerant heat recovery one or more heat recovery units are included between the compressor unit & the fan coil units.

Variable Refrigerant Volume (VRV) system is a heating, ventilation and air conditioning (HVAC) technology that

relatively new to the Malaysian market as with any system, it suits some buildings, application and climates better than others. Occupancy is emulated with portable heaters and humidifiers so that variation in energy use between the two system are attributable only to system performance and weather. Variation from different weather condition can be normalized using air temperature normalization or calibrated simulation modeling.

**2. PRINCIPLE OF VRV SYSTEM**

Variable Refrigerant Volume (VRV) system is a multi-split type air conditioner use refrigerant as the cooling and heating medium. VRV system have a unique ability to extract heat out of areas requiring cooling and put into zones requiring heating system are larger capacity, more complex version of the ductless multiple system, with the additional capacity of connecting ducted style fan coil units.

The term variable refrigerant flow refers to the ability of the system to control the amount of refrigerant flowing to each of the evaporators, enabling the use of many evaporators of differing capacities the configuration and heat recovery from one zone to another. All very systems provide energy saving by varying compressor speed and matching the output of the system as closely as possible to the load.

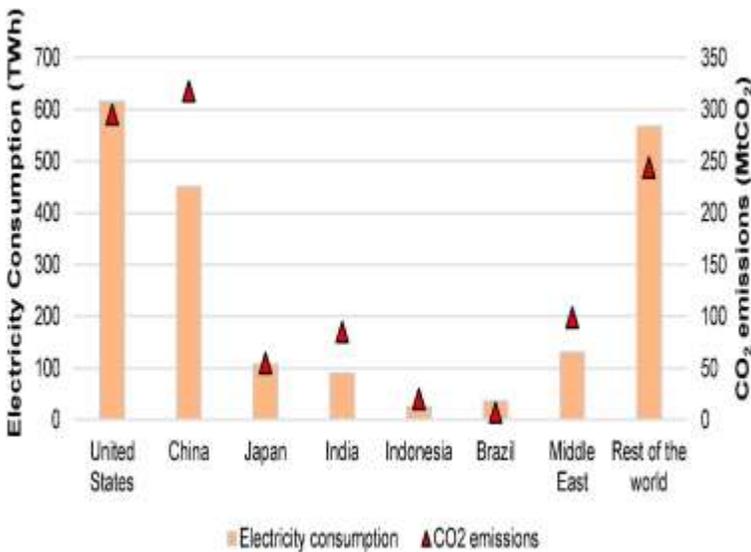


Fig.3 (Electricity Consumption and CO2 due to cooling demand in 2016)

**3. RESEARCH PROGRESS:-**

1. In[1] Dongsu Kim et al 2017 have done their work on Evaluation of energy savings potential of variable refrigerant flow in the U.S. climate locations. Variable refrigerant volume air-conditioning systems are known for their high energy

performance. This paper check out the performance of Variable Refrigerant Flow (VRF) and Rooftop Variable air volume systems (RTU-VAV ) in a reflection environment applying widely-recognized whole building energy modeling software, energy plus. A comparison study between the reflection results of VRF and RTU-VAV models is made to determine energy savings potential of VRF system. Variable Refrigerant Flow system have been popular in many Asian and European countries with various benefits including: ease of launching, model flexibility, maintenance, and energy efficiency. Their reflection results showed that Variable Refrigerant Flow system could consume about 11%-22% less energy use when compared to Fan Coil Unit (FCU) and VAV system, respectively. Im and Munk (2015) evaluated the energy performance of a multi-split VRF system compared to the typical RTU-VAV systems, which were both installed in the Oke Ridge National Laboratory’s Flexible Research Platform (FRP) building.in the research of both the energy saving of the system were around the 20% over other system during cooling operation. To check the performance of VRV systems, these systems are placed in 16 different cities of US in different buildings in different-different weather conditions.

2. In (2) Suhafizudin Bin Zainal Anuar et al have done their work on studying the VRV system and determining the root cause of its problem in building. This study is done in Malaysia on the VRV system. VRV system is one of the Heating, Ventilation and Air Conditioning (HVAC) type in the building. VRV system is a multi-split type air conditioner. VRV has also been referred as Variable Refrigerant Flow (VRF) that uses variable refrigerant flow control to provide customers with the ability to maintain individual zone control in each room and floor of a building. The compressor unit is controlled by a variable-speed drive, which may operate more efficiently than conventional compressors of similar size. Nowadays, most of HVAC system manufactures have offer VRV systems to be used in mid and large size building. VRV use refrigerant as the cooling and heating medium. This refrigerant is conditioned by a single outdoor condensing unit, and is circulated within the building to multiple fan-coil units (FCUs). This system is failure due to different-different issues like oil leakage at pressurized test. The most common cause of an electric or compressor motor failure due to the system’s oil becoming acidic. This can happen due to undiagnosed refrigerant leaks, poor system evacuation or previous compressor

failures. The most common cause of a mechanical or more specifically a compressor failure is a lack of oil at the compressor, usually caused by sludge and blocked strainers and oil-ways within the outdoor unit. Hence, Bahagian Kejuruteraan (BKJ) has worked out with service contractor to identify the main problem and leaking area before proceed with repair and commissioning activities.

3. **In (3) Oak Ridge et al** 2014 have done their work on evaluation of variable refrigerant flow (VRF) systems performance in oral's flexible research platform (FRP). This paper discuss a research project that evaluates energy performance of a Variable Refrigerant Flow (VRF) systems that has been installed and operated in Oak Ridge National Laboratory's new research facility, Flexible Research Platform (FRP) the hourly and daily energy consumption of both systems were characterized based on corresponding outdoor air temperatures. The analysis shows that the VRF system uses 17% and 73% less energy than the rooftop system in cooling and heating seasons, respectively. The VRF system was designed based on the load calculations from Manual (Rutkowski 2008), and the corresponding indoor and outdoor units were chosen. The study to investigate a multi-split VRF system's energy performance compared to a typical RTU with terminal reheat was introduced in this paper.
4. **In (4) W. Goetzler** April 2007 have done their research on Variable Refrigerant Flow systems. In this paper the author research about the benefits, disadvantages, applications and future directions of VRF systems. The VRF system can easily installed, easy maintenance, human comfort, energy efficiency is high as compare to other. Currently, non-proprietary building energy simulation tools like Energy Plus and DOE-2 cannot model VRF systems, also ventilation systems used in conjunction with VRF systems are engineered separately on a case-by-case basis. The short age of skilled installers is problematic for the HVAC industry as a whole, but expanding the numbers of installers who are comfortable with extensive refrigerant piping works is particularly critical for the VRF market. VRF system are not suitable for all commercial building applications.

## 5. EVALUTION OF THE TECHNOLOGY:-

Ductless space conditioning products, the VRV system were first introduced in japan in the 1982s with single indoor units and outdoor units. when the VRV system was invented at that time only single indoor unit and outdoor units are used, but after many development in VRV system in present time 60 or more indoor units to operate off one outdoor unit, enabling application in large commercial building.

## 6. ADVANTAGE OF VRV SYSTEM

- Installation Advantage is VRV systems are lightweight and modular, so VRV can easily installed as compare to other systems. Due to the lightweight and component units of VRV components can be transported using a regular lift. Hence, the technology in VRV system simplifies the installation process in term of time and cost.
- Design Flexibility:- In VRV system a single outdoor condensing unit can be connected to many indoor units. At the roof of the building an outdoor units installed and connected to this outdoor unit with multiple indoor units in a building.
- Maintenance and Commissioning:- The maintenance of a VRV air-conditioning system can be done easily. In maintenance of a VRV system mainly changing filters and cleaning coils. By only replacing indoor and outdoor unit and other components can be reuse.
- Energy Efficiency:- The energy efficiency of a VRV air-conditioning is high as compare to others conditioning systems. The VRV air-conditioning produce less noise as compare to others. The improved efficiency of the newest VRV systems compared to older generations is high due to component changes such as fan motors and compressors.

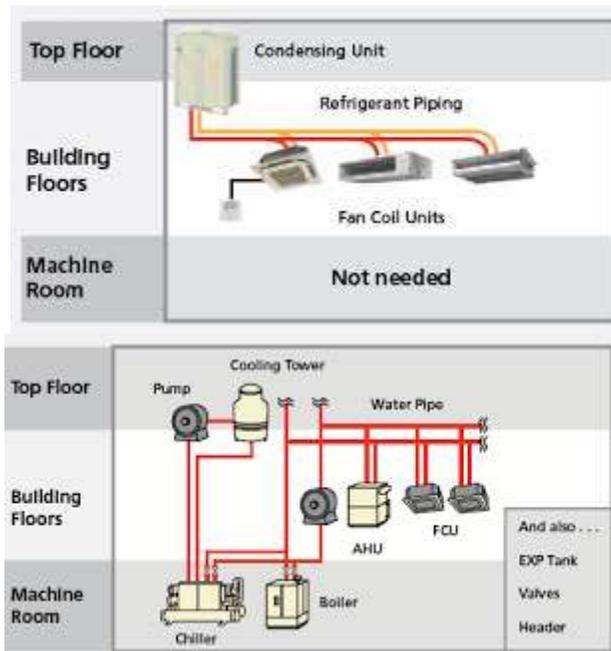


Fig.4 (Comparison of VRV layout with Chilled water central plant)

### 7. DISADVANTAGES OF VRV SYSTEM

- The first issue in installation of VRV system the initial cost is high as compared to other.
- It may be less economical to provide high efficiency components (such as Fans, or Filter system) for many decentralized indoor units compared to the efficiency of these systems when installed in a single larger centralized system.
- The on – off sequencing between zones could be alternated to minimize temperature changes to minimize occupant discomfort.
- In VRV system the water requirement is high.
- The leaks especially on joints which may involve re-purging the lines with nitrogen or re-assembling flared joints.
- A compressor failure is the most common serious problem and generally classified as electrical (compressor motor) or mechanical (compressor) failure.
- The most common cause of an electrical failure is due to undiagnosed refrigerant leaks.

### 4. CONCLUSION

This type of system consists of a number of indoor units connected to one or more external condensing units. VRV systems are not suitable for all commercial building applications. However, they are an excellent option for certain projects and one more tool for engineers to consider. A VRV

system offers flexible installation and energy saving cooling and heating comfort and should be considered as an alternative to traditional systems for those applications where zoning or part load operation is required.

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