© 2020 IJSRST | Volume 5 | Issue 7 | Print ISSN : 2395-6011 | Online ISSN: 2395-602X

4th National Conference on Advances in Engineering and Applied Science
Organized by : Anjuman College of Engineering and Technology (ACET) Nagpur, Maharashtra, India, In association with
International Journal of Scientific Research in Science and Technology

Analysis of Various Losses in HVAC System

Ahraz Alam Khan[1], Aniket Shafi Wakde[2], Roshan Dhanraj Wasade[2], Mohd Umaid Kashif[2], Shivam Kumar Singh[2], Krunal Muneshwar Nagalwade[2]

[1]Professor, Department of Mechanical Engineering & Technology, Anjuman College of Engineering and Technology, Nagpur, Maharashtra, India

[2]PG Scholar, Department of Mechanical Engineering & Technology, Anjuman College of Engineering and Technology, Nagpur, Maharashtra, India

ABSTRACT

Variable Refrigerant Volume (VRV) arrangement is one of the Heating, Ventilation and Air Conditioning (HVAC) type in the construction. VRV system is a multi-split type air conditioner that uses variable refrigerant flow supervises to offer consumers with the capacity to keep individual region be in charge of in each room and floor of a construction. VRV used in construction is made by DAIKIN Heavy Industries that was totally installed in 2020 with two pipes system format. The objectives of this study are to recognize the Variable Refrigerant Volume (VRV) system and also to study the root reason of its problem in Building, SARDA TILES, NAGPUR. The result of the study suggests poor workmanship during installation progression and not enough electrical bases are suspected as the causes of on-going and repeating troubles occurred. Hence, site engineer has worked out with the service provider to make out the core problem and leaking area before proceeding with repair and commissioning activities.

Keywords : Variable Refrigerant Volume (VRV), Variable Refrigerant Flow (VRF), Fan Coil Unit (FCU), heating Ventilation Air conditioning system (HVAC)

I. INTRODUCTION

Variable Refrigerant Volume (VRV) system is a heating, ventilation and air conditioning (HVAC) technology that quite new to the Indian market. In theory, VRV has a bunch to propose in terms of efficiency, running expenses, flexibility in use and manage. As with any system, it suits some buildings, applications and climates superior than others. In India, VRV has been installed in Sarda Tiles Building been serviced monthly by service provider. The objectives of this study are to know the Variable Refrigerant Volume (VRV) system and also to study the root reason of its crisis in Building.

II. BACKGROUND

Sarda Tiles Building consists of 4 main floors as a part of facilities in providing public services. There are 2 units of VRV outdoors to serve 12 units of VRV indoors. Also VRV system, there are a number of air-cooled split unit and air-cooled split ducted that have been install in construction as a part of HVAC system. VRV Indoors unit that have been used are wall mounted, ceiling concealed, ceiling balanced and cassette type. VRV system used in Building, are made by DAIKIN Heavy Industries which completely installed in 2020

Table 1.

Vrv System Design Summary For Shah Nanji Nagsi Office												
Sr.No	**Description**	**Length Rft**	**Width Rft**	**Area Sqft**	**No. Of Person**	**Type Of Indoor**	**Model No**	**Selected Tr.**	**UnitQty**	**TotalTr**	**Ci**	**Total Ci**
1	Sudeep's Cabin	12.1	10.1	122	4	Hi Wall Split	Fxaq40pve	1.3	1	1.3	40	40
2	Snehal's Cabin	12.1	10.4	124	4	Hi Wall Split	Fxaq40pve	1.3	1	1.3	40	40
3	Rajeshji's Cabin	12.1	9.7	117	4	Hi Wall Split	Fxaq40pve	1.3	1	1.3	40	40
4	Ashwin's Cabins	13.1	12.1	159	7	Cassette Unit 1 Way	Fxeq50av36	1.5	1	1.5	50	50
5	Javan's Cabin	12.1	10.4	126	4	Cassette Unit 1 Way	Fxeq40av36	1.3	1	1.3	40	40
6	Waiting & Reception			415	13	Cassette Unit 4 Way	Fxfq80avm	2.6	2	5.2	80	160
7	Workstation			1400	40	Ducted Unit	Fxmq140pbv36	4	3	12	125	375
7.1						Ducted Unit	Fxmq140pbv36	4.5	1	4.5	140	140
8	Workstation	19.7	17.8	351	11	Cassette Unit 4 Way	Fxfq100avm	3.3	1	3.3	100	100
				2815					**12**	**31.7**		
										Total Ci		**985**
										System Hp		**39**
										Diversity 116%		**34**

Site Engineer has observed VRV systems in building which experience on-going problems, seeming to go from bad to worse. In addition, the troubles keep reported in Helpdesk system although the same problems have been resolved before. Most faults experienced on a VRV system will effect in the complete system being out of action. With systems serving 2-8 indoor units, a fault on one unit could affect many people. As noted above, this adds severe pressure to get the problem fixed and the system operational as soon as achievable.

III. THEORY

Variable Refrigerant Volume (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 offer clients with the capability to sustain individual zone control in each room and floor of a building. The compressor unit is controlled by a variable-speed drive, which may control more efficiently than conventional compressors of parallel size. VRV technology was invented in Japan by Daikin Company in 1982. At the present time, most of HVAC system manufactures

have propose VRV systems to be used in mid and large size buildings. Figure 1 shows a typical layout of VRV system.

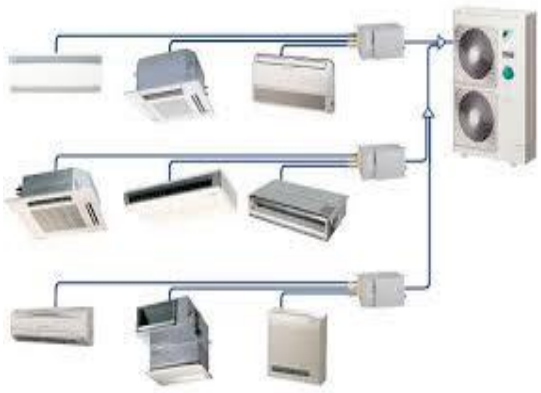

Fig 1 : Typical Layout of VRV System

VRV use refrigerant as the cooling and heating intermediate. This refrigerant is conditioned by a single outdoor condensing unit, and is spread within the building to multiple fan-coil units (FCUs).Approach in two system format, two pipe and three pipe systems. In a two pipe system which usually referred as heat pump system, all of the region must either be all in cooling or all in heating. A three pipe Heat Recovery (HR) systems has the capability to at the same time heat certain zones while cooling others. That is means VRV systems have a exclusive ability to extract heat out of areas have need of cooling and Put it into zones requiring heating. In both two-pipe and three-pipe systems

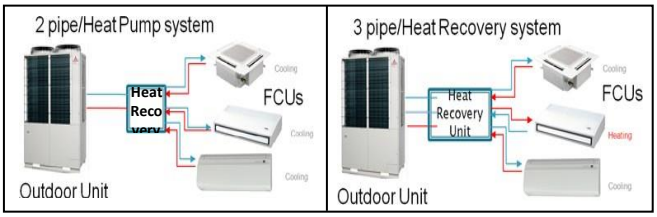

Figure 2. VRV Heat Recovery System Configuration Options

With refrigerant heat recovery, one or more heat recovery units are integrated between the compressor unit and the fan coil units. This unit controls the run of liquid and vapor refrigerants between the fan coil units in heating or cooling mode, and minimizes the load on the compressor. Methods vary by manufacturer who provides their own valves, heat exchangers, controls and other components. Figure 2 includes simplified diagrams of two configurations with heat recovery.

I. METHODOLOGY

The process flow chart of the study is explained in fig. 3. Process 1 is the definition of the problem and objectives of the study. Then process 2 is the specify study of the basic kind of the Variable Refrigerant Volume (VRV) system and collects the appropriate data from service report that had been prepared by contractor service. The next process is the analysis on the possible root reason with necessary proof and theory before concluding the study.

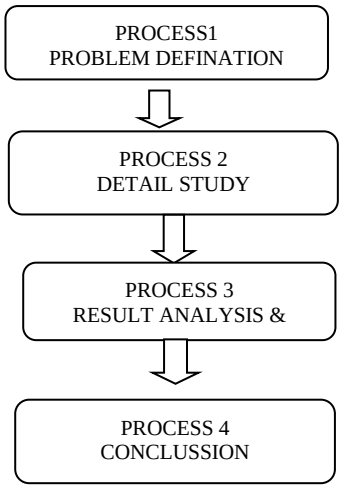

Figure 3. Flowchart of the methodology

II. RESULTS AND DISCUSSION

VRV system in the construction can save space for installation. The space efficiency is improved by the compact size of the individual units, the long maximum piping length, and the ability to use a large scale air conditioning system with a single piping circuit. Besides that, the system provides higher design flexibility especially in changing of layout that can be made easily. New compressor technology eliminates the need for piping calculations, which cut down the time needed for design. Outdoor units can be placed on the roof where they have no consequence on the design of the building interior. The lightweight and compact units of VRV mechanism can be transported using a regular lift. The pipes are few in number, making design simpler. Hence, the technology in VRV system simplifies the installation process in term of time and charge.

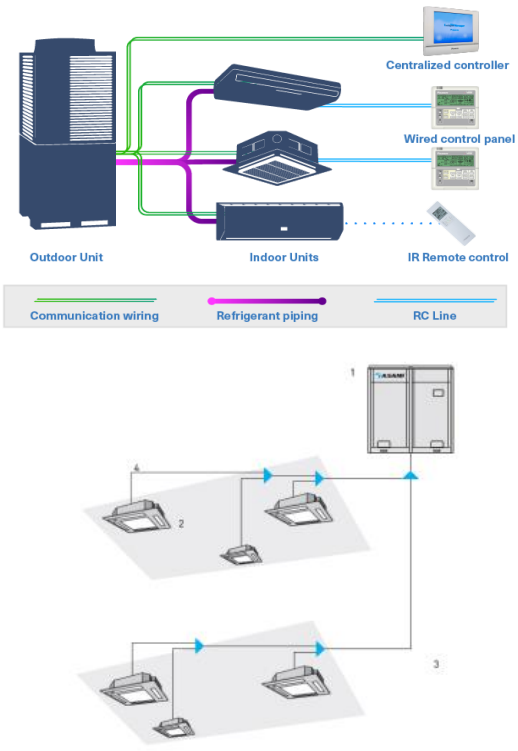

Figure 4 : Central air conditioning layout

VRV systems approval individual climate control settings for every zone to supply the maximum in comfort to commercial building setting. For vacant room, the system can be switched off individually as compared with centralized air conditioning system that use chilled water from chiller. Hence, the operational cost of the building will be reduced. Precise individual manage and inverter technology decrease energy consumption to transport best energy savings. VRV can get about 30% or higher energy cost saving relatively with other conventional HVAC system. In addition, VRV offers adaptable design that helpful to the building designer in selecting the matching unit in order to suit with their requirements. Modular design of outdoor units and wide selection of indoor units ensure system designs that are perfectly suited to the environments where they are installed. The noise level of VRV system is also extremely low. Units are designed to operate quietly and are also equipped with a function for silent operation that gives benefit to operate at night without disturbing people. In addition, the lesser number of compressors that can serve a lot number of FCU will contribute towards low level of noise for the whole building.

III. Types of Failure Found

The leaks specially on joints which may involve re-purging the lines with nitrogen or reassembling flared joints. The systems must then be thoroughly evacuated, to eliminate all air and moisture that may take several days.

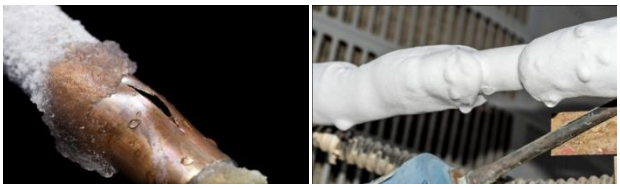

Figure 5. Leaking detected during pressurized test

Electrical, electronic and control component failure can and do arise. These can be exacerbating by vibration from fans & compressors, excessive temperatures and poor quality power supplies. Obsolescence of control boards has been an issue with some brands with early generation apparatus. A compressor failure is the most regular serious problem and generally classified as electrical (compressor motor) or mechanical (compressor) failure. Assessment of the system's oil condition and physical inspection of the failed compressor provide the clues as to what may have contributed to the crash.

IV. Root Cause

After a problem being reported in Help Desk system, Site Engineer staff with service contractor will investigates the problem on site. Among the troubles reported was indoor unit is not functioning which leading the room not being cool. A large amount of trouble occurs is due to leaking on pipe work which roots causes stemming from poor installation, poor workmanship and also poor maintenance practice. With dry nitrogen, brazing work, retighten, vacuum work, and renew refrigerant R-410A and also testing and commissioning.

Figure 6 : Improper installed pipe due to poor workmanship

Comparison between R22 and R410a

	R22	**R410a**
REFRIGERANT	SINGLE COMPONENT REFRIGERANT	NON-AZEOTROPIC REFRIGERANT
REFRIGERANT OIL	MINERAL OIL	SYNTHETIC OIL
PRESSURE	1.9 MPA	3 MPA
COMPONANT PROPERTIES	CONTAIN CHLORINE (Ci)	DOES NOT CONTAIN CHLORINE
EFFECTS ON ENVIRONMENT	LESS ECOLOGICALLY FRIENDLY	MORE ECO FRIENDLY FOR ENVIRONMENT

The most common reason of a mechanical or more specifically a compressor failure is be short of oil at the compressor, usually caused by sludge and blocked strainers and oil-ways within the outdoor unit. As a result, that cause mechanical harm to the compressor bearings, suction and discharge valves. The service statement is likely to say 'compressor failure'.

Mechanical or valve break can only be confirmed if a compressor is cut- open for diagnosis. As per record in INDIA, 1 unit of compressor has been replaced. There is one unit of compressor that shown symptom of failure that wants to be replaced.

PROBLEM	CAUSE	SOLUTION
COMPRESER WILL NOT OPERATE	NO ELECTRICAL POWER	TURN ON POWER. PUSH RESET BUTTON
	LOW OIL LEVEL	CHECK OIL LEVEL, REPLACE OIL IF NECESSARY
	PRESURE SWITCH NOT MAKING CONTACT	SEE PRESURE SWITCH ADJUSTMENT
EXCESSIVE NOICE IN OPERATION	LACK OF OIL IN CRANK CASE	CHECK FOR POSSIBLE DAMAGE TO BEARING REPLANISH THE OIL LEVEL
EXCESSIVE OIL CONSUMPTION	OIL LEAK	TIGHTEN BOLT OR REPLACE GASKET
COMPRESSOR SUDDENLY STOPS WORKING	BAD UNLOADER VALVE	REPLACE THE UNLOADER VALVE

V. CHALLENGES

Mechanical damage due to constant lack of oil or foaming oil due to low refrigerant levels will result in metal fines being released as metallic components wear extremely. These fines will chunk strainers within the refrigeration system which are normally non serviceable and hard to find, causing a further lack of oil return to the compressor. As mention above if this process is allowed to repeat, further compressor failures are likely to result. Physical leak finding is difficult as the refrigerant pipes are insulated, and is even harder where they are run in hard to find or difficult to access spaces. Also leaks on internal parts of equipment, such as indoor units, can be not easy to find without disassembly. It is almost not possible to decide how much refrigerant has been lost. If the oil has become acidic it must be virtually totally removed from the system. To achieve this, the suction accumulators should be replacing along with failed compressors. The piping and indoor units should also be ruined, but this is very hard and time-consuming. Therefore the new compressor starts out life in an acidic environment, which is likely to lead to another early failure. If this process is allowed to replicate, a runaway trail of compressor failure is likely to result.

CLIMATE

The air conditioning companies are recognized to be the busiest especially when the weather is very cold or very hot. The extreme temperatures are known to put more pressure on equipments and can with no trouble make the service calls more urgent. Most of the HVAC technicians are usually known to work on the roofs or in move slowly spaces in cold and hot conditions. Definitely, your HVAC business will always come across seasonal lows and highs hence,

you will always need to manage your funds in order to take advantage of the time and flush times.

Costs

The HVAC companies require invest in top class and particular equipments such as vans or tacks that will help in carrying the equipments and software for carrying out diagnostic testing and managing equipment controls. However, this will take you some steep funds in order to get started. As the business owner, you will also be responsible for the medical insurance, workers compensation insurance, payroll taxes and liability insurance which will add up to some major costs.

VI. PRECAUTION

During Installation of VRV system, some safety measure action need to be considered as listed below:

a) The system shall be planned by a competent, experienced professional air conditioning engineer.
b) Use a supplier-approved qualified installer.
c) Use corrosion-treated outdoor units, to make the most of their life.
d) Make sure isolating valves with service-ports are fitted for every indoor unit.
e) Make sure all brazing is done using nitrogen purging and at least some joints are witnessed.
f) Make sure pipe work pressure tests are undertaken in accordance with the manufacturer's recommendations and are witnessed.
g) Make sure proper system evacuations are undertake to remove all moisture and are witnessed.
h) The system shall be commissioned by a supplier-approvedagent.
i) During installation double check your equipment.
j) On daily basis you are likely to encounter a range of chemicals that can pose a serious threat to your health. You should familiarize yourself with it or ask an expert before handling it. It's better to be safe than sorry.

Pressure testing is frequently absent or carried out lower than recommended levels due to time constraint. Pressure testing pipe work and joints stresses the metals in dissimilar directions than achieved by system evacuation procedures. Proper triple evacuation procedures must be followed and will preferably be left until a specific level of vacuum is attained slightly than by time alone. Enough time must be allowed, particularly in cold weather for all of the moisture to be drawn out of a system. There is no short-cut to this process. It will take as long as it takes and on a vast system, it could sit under vacuum for 3-5 days before suitable results are achieved. If a system requires repairs such as a compressor replacement or alteration work such as relocation of an indoor unit, all of the measures linking to a new installation must be followed.

VII. CONCLUSION

VRV system requires the same level of care and awareness to detail as afforded to large chillers or industrial refrigeration systems. As a conclusion, poor workmanship during installation process and cause of a mechanical or more specifically a compressor failure is lack of oil at the compressor, usually caused by sludge and blocked strainers and oil-ways within the outdoor unit in Sarda Tiles building. Hence, site Engineer has worked out with service contractor to identify the main problem and leaking area before proceed with repair and commissioning activities. One of the major repair activities done was replacing

the piping especially at joint area and some mechanical parts, like refinite, compressor, etc.

VIII. ACKNOWLEDGEMENTS

Thanks to all the contributors, especially to site Engineer, Contractor, staff and our project Guide whose gave the authors fully support and guidance to complete this paper.

IV. REFERENCES

[1]. Brochure: Daikin AC(Americas) Inc, (2013), VRV III, Daikin Industries Limited., United States, pp.4-5.
[2]. HVAC design and drafting on international project, Electro Mechanical Pvt. Ltd. http://www.kgmech.com
[3]. William Goetzler, ASHRAE Member, ASHRAE journal, April 2007.
[4]. Refrigeration and air conditioning by R.S.Khurmi , J.K Gupta.
[5]. Refrigeration and air conditioning by P.S.DESAI
[6]. Paper: Rajshahi University of engineering & tech. Information paper – Heating, Ventilation and Air Conditioning (HVAC) Systems, Md Sadiqul Hasan Talukder. http://iosrjournals.org
[7]. Book: Brian Thornton, Anne Wagner, (2012), Variable Refrigerant Flow Systems, General Services Administration, United States, 15-18.
[8]. http://www.daikinac.com
[9]. http://www.ashrae.in

Cite this article as :
Sh