

Pros and Cons of Variable Refrigerant Flow Systems

By Alex Tompsidis

As a system, Variable Refrigerant Flow (VRF) has a lot to offer in terms of efficiency, running costs, flexibility in use, and control. As with any system, it suits some buildings, applications, and climates better than others.

A VRF air conditioning system is a particular type of heat pump air conditioning system in which *one* outdoor unit can be connected to *multiple* indoor units. Each indoor unit is individually controllable by its user and a variety of unit styles can be mixed and matched to suit individual tenancy requirements (e.g. high wall units, cassettes, and ducted units).

The outdoor unit can be made up of a number of modules to create the required capacity. The compressors can be operated at varying speeds, so the VRF units work at only the rate needed to meet the prevailing heating or cooling requirements, considerably enhancing their efficiency.

This narrative mainly applies to the Mitsubishi “City” series, though other brands such as LG, Sanyo, and Daikin have similar pros and cons.

The Mitsubishi City Multi R2 Heat Pump System is able to pull heat from one exposure and move it to another exposure, significantly increasing efficiency. It is a true heat pump system. The system has been used in many assisted living and senior residence facilities throughout our area and the country.

System Features (Pros)

VRF systems offer a number of benefits to designers, installers, and end-users. While it is best to peruse the manufacturer’s literature for a full list of benefits, a few of the common features include:

- State-of-the-Art HVAC system utilizing the most technological and energy-efficient devices in our industry
- One outdoor unit for multiple indoor units, saving space and installation costs while also improving the building’s external appearance
- Less electrical connections versus split systems
- A commercial-grade system
- All systems need to be completely engineered and laid out properly
- The ability to use long pipe runs, so the outdoor units can be located in “out of the way” places (i.e. places where architects and owners cannot see them)
- Typically very quiet outdoor units
- Very quiet indoor fan coils
- Sophisticated control, offering modulated heating and cooling for better comfort
- Very high-efficiency heating
- Simultaneous heating and cooling (year-round), offering even higher efficiencies
- Ozone-friendly refrigerants

- No requirement for gas piping, flues, and combustion air intakes within units
- No requirement for outdoor wall-mounted grille as with a Magic Pack or PTAC-type system
- Metering/usage capabilities within the software so that individual tenants can be charged for their particular usage
- Interface capabilities to Bacnet or Lon protocols

Of the above, it is the energy efficiency argument that is most often promoted as the compelling reason to use VRF.

System Issues (Cons)

Many VRF systems provide relatively trouble-free operation with normal maintenance costs. Full life expectancies in our climate are yet to be determined, as there are relatively few systems that are over 12-years-old to date. We anticipate life cycles around 25 years with proper maintenance. (This may be a conservative number.)

Worldwide, there have been several installations and thus some installation problems. Many of the issues encountered have root causes stemming from poor installation or poor maintenance practices. We would stress the importance of following “best practice” refrigeration industry standards for the design, installation, maintenance, and commissioning of these systems.

A few of the issues, or possible issues, with using VRF technology are as follows:

- Not a good application with systems that require high outside air requirements
- Not a good application for systems used in a lab or hospital environment
- Obsolescence. VRF technology continues to develop rapidly with respect to control systems and the adoption of new technology, particularly technology to extract as much heat as possible in colder climates. The City R2 system discussed here is the latest technology from Mitsubishi and uses two pipes (in lieu of three) along with the Mitsubishi BC controller. (Please watch the VRF video here: https://www.youtube.com/watch?v=-_2Xp5xDXYM.)
- Quality of installation. The spidery nature of VRF pipework, and specific installation requirements (which can vary between different manufacturers), makes the standard of the initial installation a crucial factor in the life expectancy of a VRF system. These are complex refrigeration systems that may have thousands of feet of pipework, hundreds of brazed joints, and hundreds of connecting joints, creating many opportunities for leakage. VRF systems require the same level of care and attention to detail as allocated to large chillers or industrial refrigeration systems. Linesets/Pipework must be supplied to the site cleaned and capped and must remain capped as long as possible. As soon as the installation of a section of pipe has been completed, it should be sealed again to minimize the entry of moisture. The air inside the pipe must be totally replaced by nitrogen during brazing; otherwise a layer of carbon will form on the inner surface of the pipe. Then, once the system is operating, carbon flakes will progressively be released and carried to filters, restricting the refrigerant flow. Special tools and techniques are needed to tighten flare joints to correctly minimize the risk of leakage. Isolation valves with service ports

should be fitted to the branch lines for each indoor unit, so that the unit may be repaired or moved without having to decommission and re-evacuate the whole system.

- The 2 figures below show a very poor standard of installation. If your installation looks like this, it is hard to imagine much care has been taken, or the required attention to detail has been provided, to avoid future problems.



Figure 1



Figure 2

- Below, figures 3 and 4 illustrate a good quality installation completed under proper supervision. Your final AT Mechanical installation will look like this...or BETTER.



Figure 3



Figure 4

- The Mitsu R2 system uses significantly fewer joints, and less connections equal better system operation and reliability.
- Quality of Commissioning. Completed systems must be thoroughly pressure tested, preferably before joints are insulated, to identify leaks. Of course, the leaks must then be

fixed, which may involve re-purging the lines with nitrogen and/or re-assembling flared joints. The systems must then be thoroughly evacuated to remove all air and moisture. Evacuation can also identify leaks that do not show up during pressure testing. Evacuation may take several days, especially if the system is large or contains a significant amount of moisture. The vacuum pumps must be connected to the system via copper tubing, rather than a refrigerant hose, with a non-return valve to prevent back-flow into the system. The oil in the vacuum pump must be changed when hot just prior to evacuation to minimize its moisture content.

- Troubleshooting and Maintenance. Location and detection of refrigerant leaks can be very difficult with VRF systems. Some factors contributing to this are that the systems tend to be quite large, so it can take weeks or months for a slow refrigerant leak to become apparent.
- Physical leak detection is difficult as the refrigerant pipes are insulated and is even harder where they are run in inaccessible or difficult to access spaces. Also, leaks on internal parts of equipment, such as indoor units, can be difficult to locate without disassembly.
- If a leak has occurred, it is almost impossible to determine how much refrigerant has been lost.

With the City R2 Series design and with our proper brazing and installation techniques, the only places where mechanical and leak issues can occur are at the roof-mounted heat pumps and the BC controllers. (The only moving part in the fan coil in the unit is the blower.) With isolation valves included at the BC controllers, isolating and fixing a problem is easier than with other systems.

AT Mechanical is a certified Mitsubishi Installer. We take great care to ensure a professional installation and commissioning per Manufacturer's requirements and specifications and best refrigerant piping practices. Please call AT Mechanical to identify your VRF system needs.

