Proof: For superior energy efficiency

WATER BEATS VRF!

ASHRAE's Apples to Apples Comparison Proves **Hydronics Delivers** Superior Energy Efficiency over VRF

For years Variable Refrigerant Flow (VRF) manufacturers have been touting their systems' superior energy efficiency over hydronics without providing the supporting data. Then ASHRAE decided to showcase both systems in its Atlanta headquarters and meter their performance.

The results aren't what the VRF manufacturers wanted to see: Water Beats VRF!

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ASHRAE Building HVAC Study

An opportunity to compare apples to apples

The ASHRAE building HVAC retrofit

The ASHRAE Headquarters Renewal program serves as a prototype for the organization's Building Energy Quotient (Building EQ) labeling program on energy efficiency. In 2008 the Atlanta building went through an HVAC retrofit to upgrade its heating and cooling system. It was a unique opportunity to directly compare the performance of two different HVAC systems on its two floors. — Hydronics and VRV. A geothermal ground source heat pump system was installed to serve the second floor, and a VRF system with multiple zones was installed to serve the ground floor. Both systems use no backup heat and rely totally on the electric energy to the compressors to both heat and cool the building, affording an apples to apples comparison.

The data

ASHRAE's goal was to meter the two installed systems through several winters and summers, to see what the difference in energy consumption would be between the two systems. ASHRAE itself has offered no conclusions on the data but has put the information gained online for industry viewing. That data can be found at at http://images.ashrae.biz/renovation/ or you can snap the QR code above.

The data should be of particular interest to both sides of the HVAC system divide because VRF suppliers persist in making claims of superior energy efficiency without providing the supporting data the industry would like to see. From the VRF standpoint, the ASHRAE building energy study is a good test case to demonstrate their claim that a variable speed driven VRF system is more efficient than a constant volume or constant speed ground source heat pump system.

That has not been affirmed by the metered study, however. During the winter months in Atlanta, which of course is not a real high-heat climate compared to northern tier locales, the VRF system has an electrical energy consumption approaching three times the ground source heat pump system. On an annualized basis, the VRF system had an energy consumption 57% higher in 2010 than the hydronic system, 84% higher in 2011 and 61% higher in 2012.

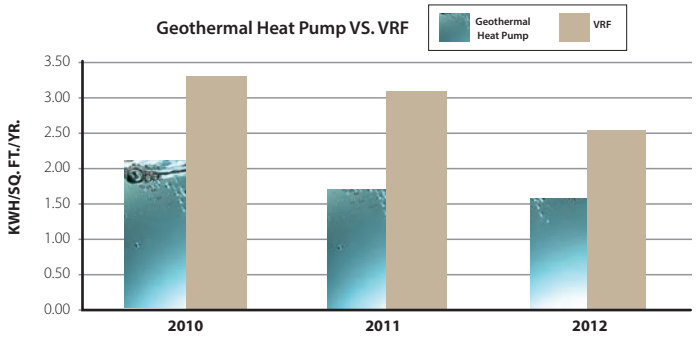
The VRF problem

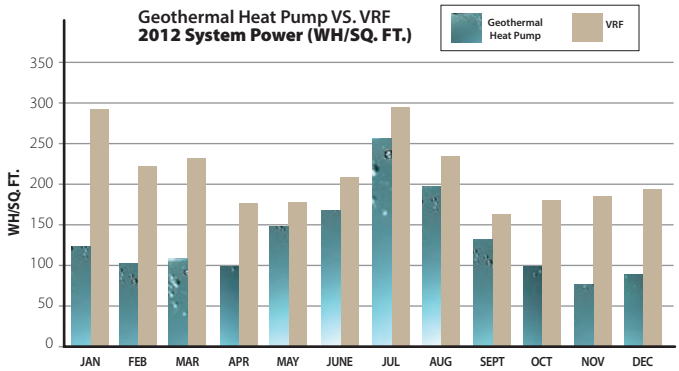
What's the problem for the VRF system in winter? VRF manufacturers claim that their system does not require backup heat. They claim that they can maintain constant heat output from their air-source heat pumps even as the ambient temperature decreases. In fact, though, capacity and efficiency of air-source heat pumps decrease with lower ambient temperatures, in accordance with the 1st and 2nd Laws of Thermodynamics. Yes, VRF air-source heat pumps put out a constant amount of heat; but to accomplish that they need additional energy, 1st Law, which they get through speeding up the compressors from 60 Hz up to as much as 120 Hz at low ambient temperatures. The compressor generates more heat because more fluid is being pumped, but that capacity is at the expense of efficiency, 2nd law, which drops even faster at higher RPMs than a typical air-source heat pump. The added heating energy comes from the compressor by virtue of the electricity to run it.

VRF system energy consumption was consistently higher than that of the Hydronic system.

The conclusion

One can think of it this way: if the efficiency of a VRF system increases because we can decrease the speed of the compressor, if we increase the speed of the compressor the efficiency is going to decrease. So the net effect is that in the heating mode, VRF systems are not efficient. In fact, they are very inefficient, and the ASHRAE headquarters' data clearly shows that. For the majority of the United States, which is heating dominated, this means that geothermal heat pump systems in particular will always outperform a VRF system.





Today's HVAC industry offers a number of choices when it comes to providing comfort air conditioning in large buildings.

Four reasons to choose a Hydronic System over VRF

1. Lower first costs

Hydronic chilled water systems have generally been regarded as costing more to install. But that's no longer true. Today's advanced hydronic systems include application of technologies like integrated and single pipe systems that dramatically reduce piping, along with the use of variable speed pumps and fans. These help bring the first costs of a chilled water system in line with a VRF system.

2. Easier to install and maintain

VRV-VRF systems involve lots of refrigerant pipe and use oil for compressor lubrication. Control of oil return is critical. So special care in installation is necessary to ensure that contaminants don't enter the system and damage the compressor. Then there's all the copper piping, refrigerant tubing and fabrication of brazed joints required. Proprietary VRF systems therefore require specialized technicians, and building owners are dependent on the manufacturer for the life of the system.

Chilled water systems are easier to install and maintain. Their piping runs don't require brazing or special soldering; plumbers and pipe installers can handle the job, and there's no oil or refrigerant to deal with.

3. Lower life cycle cost

The owner can expect to get significantly lower life cycle cost out of a hydronic system. A VRF system lives a much harder life and consumes more energy; especially in the winter. The compressor is installed in a complex field installed refrigerant system and it is forced to reject its heat to air. Most important is that the compressor spins faster in heating reducing the life of the bearings and compressor. Furthermore, it requires a very specialized mechanic. Compare this to a factory packaged water source heat pump unit. It is a much simpler system and has a proven track record of life expectancy well in excess of 20 years; twice that of DX systems. A water source heat pump system will consume much less energy, cost less to install, and live a much longer life.

4. More Energy Efficient

Energy efficiency claims by VRF manufacturers have been difficult to verify, and without actual test data in hand it's been difficult to determine the actual facts. The ASHRAE building comparative energy usage study shows that a VRF system is not as efficient as a geothermal system. In all cases, new variable speed hydronic chillers and heat pumps outperform variable speed VRF.

Hydronics Industry Alliance