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VRF NATURAL GAS HEAT PUMP SYSTEM

YANMAR is making Variable Refrigerant Flow technology greener with natural gas.

By Julia Stone



YANMAR's new EVO//CENTER incorporates a VRF system, which considerably reduced building operating costs.

YANMAR AT A GLANCE

- ⇒ Efficient zone controls and heat recovery technology
- ⇒ Reduced electrical energy consumption
- ⇒ Easy automation integration and remote monitoring capabilities

YANMAR began manufacturing Variable Refrigerant Flow (VRF) systems in 1987, but the company has been producing reliable, compact diesel engines for more than a century. Their VRF heat pump features powerful heating and cooling capabilities while relying on minimal electricity. The natural gas-powered engine is what sets this system apart when it comes to all things green—natural gas emits less harmful greenhouse gases than coal: 80% less NO_x, 100% less SO_x, and 35% less CO₂.

"We're not using electricity to drive the compressors, so the energy reduction is immense," says **Eddie Caton**, regional sales and service manager at YANMAR America. On top of energy savings, YANMAR's VRF system also provides lower operating costs, increased comfort, and cutting-edge control integration. As a flexible way to provide indoor comfort, YANMAR's natural gas heat pump VRF system has been implemented in schools, office buildings, restaurants, and multi-family complexes.

Natural Gas vs. Electricity

Caton says one of the greatest benefits of using natural gas is the fact that it's greener. "We have an abundance of natural gas here in

the United States," he says. "It's greener than burning coal to make electricity, and we don't have that same transmission loss."

For the most part, conventional VRF systems use electrical power for outdoor units, but YANMAR favors natural gas. The energy savings of using natural gas are based on the spark spread, or the gap between the electricity cost and the cost for natural gas—the higher that differential is, the more savings you're going to get by using natural gas. "The spark spread between the natural gas rate and the electric rate is very high because the majority of areas have a lower rate for natural gas, so the customer would be able to save energy, as well as benefit from economic savings," says **Mike Mehrvarz**, engineering manager at YANMAR America.

Miles Johnson, mechanical designer at **Croft & Associates**, was the architect and designer for YANMAR's new **EVO//CENTER**, which opened in November 2017. Johnson says the primary benefit of YANMAR's VRF is that it uses natural gas instead of electricity, which provides cost savings and increased energy efficiency. "Gas-fired heat pumps offer a very economically viable solution to minimizing the carbon footprint of a building," he says. "VRF tends to use significantly less energy than comparable HVAC systems. Whenever you can combine that with a gas-generated power then the benefits tend to stack up pretty nicely."

Zone Control & Comfort

Unlike conventional HVAC systems, YANMAR's multi-zone VRF system gives you total control over your indoor environment. Every room, or zone, can have its own indoor unit and thermostat. In addition, you can turn off heating and cooling in unoccupied rooms or floors to cut down on your energy usage. The advanced zoning capabilities are especially helpful during renovations because the system allows each floor to be occupied upon completion while construction work continues in other areas. "Instead of your HVAC central system dumping the cooling or heating to the whole building, you would be able to control which zone requires cooling or heating, or even provide heating and cooling simultaneously," Mehrvarz says.

Adding to your indoor comfort, YANMAR's VRF units are also much quieter because of sound-dampening materials installed on the panels. "Sound is just about nonexistent," Caton says. Traditional rooftop units usually run at 90 decibels, while YANMAR's outdoor units run at between 54 and 58 decibels.

YANMAR also offers solutions for just about any air flow, air direction, or capacity requirement for cooling and heating.

Economic Savings

The cost of operating the compressor in gas-powered outdoor units is 1/10 the energy cost of a traditional electric VRF system—that's because YANMAR's natural gas VRF units only require 750 watts per hour to operate. Depending on local utility costs, YANMAR's VRF system can decrease energy spending by 30 to 70%. When YANMAR replaces electric VRF systems with natural gas VRF systems, building owners quickly see the benefits, Mehrvarz says.

Also, because their VRF systems are durable, this cuts down on the overall life cycle cost. "We have seen that our system can reach a maximum of 90,000 hours of operation, which is equivalent to 10 to 15 years," Mehrvarz says.

YANMAR has also developed a ROI Analysis tool, which can help you decide if YANMAR is the right choice for your project budget. The tool shows the amount of financial savings you can expect, as well as the estimated

payback period. It also provides the internal rate of return and an annual cash flow projection.

When Croft analyzed YANMAR's VRF systems for the new EVO//CENTER, Johnson and his team conducted cost comparisons and evaluations. They were able to save on project costs by using VRF where a standard variable air volume (VAV) system would not have been as cost-effective—in fact, they ended up using YANMAR's VRF system for more than 75% of the HVAC units for the building.

Energy Efficiency

YANMAR's engineering team is in the process of collaborating with ASHRAE to study how to calculate the actual efficiency of their natural gas VRF system. "There is no official EER efficiency standard for our system because this type of equipment is new in the United States, but our unit is 90% efficient overall," Mehrvarz says.

As far as heat exchange efficiency, YANMAR is leading the pack. Their VRF system operates well during cold periods by using waste heat to boost the amount of heating for the building. Their system captures the waste heat from the gas-powered engine and returns it into the refrigerant line through the use of a plate heat exchanger. "A typical heat

but we don't need those," Caton says. "We have a plate heat exchanger, which transfers heat back to the refrigerant. So, our recovery time and operating temperatures are a lot lower than typical competitors."

System Integration

Control integration is simple with YANMAR's VRF system. "Because we partner with **Daikin**, all of our controls are Daikin controls," Mehrvarz says. "We're able to provide control for the HVAC system, as well as integration with any building management system using our open protocol with a BACnet or LonWorks interface."

YANMAR's remote monitoring control helps with troubleshooting and preventative maintenance. It can connect to multiple outdoor units, and if any errors are detected, the system will send emails to YANMAR's service staff, so they can address the issue before the customer even realizes something is wrong, Mehrvarz says. The remote monitoring control allows YANMAR to oversee system performance, such as the level of coolant, hours of operations, and the engine's RPM and temperature.

Easy Installation & Maintenance

It's quite easy to install YANMAR's VRF system. All you need to do is maintain a flat

concrete surface on the ground or the roof and bolt down the unit. "There's very small wiring required for the unit since the only electrical requirement for the VRF to be able to operate is about 0.8 kilowatts—not even 1 kilowatt," Mehrvarz says. You don't need a large cable for the unit, just a gas hook-up. Electric VRF systems require more kilowatts to run, and therefore a larger cable. There is also no need to expand building electrical infrastructure since YANMAR's product only requires single phase power supply.

Maintenance is required every 10,000 hours, which means the first call for maintenance typically isn't for two to three years. Caton says the maintenance check consists of changing the spark plugs, motor oil, air filter, oil filter, and compressor belt. They also do a general inspection of your system, including checking your system's coolant levels and making sure the gap on the valves are still within specifications.

"One of the benefits of monitoring your system remotely is that we will be able to see hours of operation," Mehrvarz says. When a unit has close to 10,000 hours of operation, YANMAR will contact the customer to remind them about their first maintenance check and schedule when to send their maintenance team. ●

The Future of VRF

Croft & Associates Mechanical Designer **Miles Johnson** has been using Variable Refrigerant Flow (VRF) systems in his projects for more than 10 years, and he plans to continue implementing the technology. "The overwhelming response to VRF at this point is that the building owners like the reduced maintenance, simpler system, increased comfort, increased control, and reduced utility bills," Johnson says. "The more I hear about all of the benefits the owners are getting, the more it makes me want to use VRF in my future projects."