Common Challenges

Selecting, Sizing VRF Systems

INTERVIEWS BY MARY KATE MCGOWAN, MANAGING EDITOR

Variable refrigerant flow (VRF) and ductless technologies are becoming more popular as they can support multiple applications in indoor spaces, and several features and innovations associated with this technology are now part of the building industry's new knowledge, said Fabio Clavijo, P.E., Fellow/Life Member ASHRAE, a Colombian design engineer.

This new knowledge could cause several challenges for design engineers, including during the selection and design process. To help, Clavijo and Dave Burggren, regional product portfolio director of Ductless Systems North America, Johnson Controls-Hitachi Air Conditioning, discuss a few common challenges engineers can face during the equipment selection process.

Selecting, Sizing VRF Systems

"Selecting and sizing VRF systems is a lot like doing so with other HVAC systems, where good engineering practices are the foundation for successful projects," said Burggren. He suggested starting by considering a climate's heating and cooling loads.

For example, when sizing and selecting a VRF system in Chicago, engineers may experience working on a respective building that requires 59,500 Btu/h (17.4 kW) of heating load in the winter and 41,250 Btu/h (12 kW) of cooling load in the summer due to the climate, he said. Since VRF provides primary heating and cooling, Burggren advised engineers to select a system that satisfies the larger of the two capacities.

"The opposite would be true for a far southern latitude, say Houston or Miami, where the cooling load would likely be the dominant of the two," he said.

However, engineers should consider if nominal conditions are realistically expected on the project. Nominal capacities are determined through the third-party tested performance of HVAC equipment at a prescribed set of conditions, via an AHRI standard, according to Burggren.

"In the case of heating, one should consider the derate in heating capacity experienced at ambient temperatures of the project site climate, not at the nominal ambient temperatures used in testing," he said.

Burggren added that refrigerant piping lengths similarly affect actual heating and cooling capacity. "We recommend the use of actual climate design conditions as well as built piping lengths and a manufacturer's VRF selection program with these inputs considered when selecting VRF equipment (outdoor units and indoor units) that meet the project capacity requirements," he said.

Connection ratio is another consideration during the selection and sizing process since it provides a ratio of the connected load of indoor units to that of outdoor units on a given VRF system, according to Burggren.

"VRF systems offer tremendous flexibility in terms of connection ratios allowed, a valued tool for skilled designers. However, one should fully understand the implications of connection ratios on a given project, and account for actual diversity of heating and cooling loads," he said.

Quick Tips and Lessons Learned

Burggren shared lessons learned he's observed sizing and selecting VRF and ductless technology.

Intended vs. actual space use. If a design calls for a reading room, with sedentary activity by a small number of occupants, the cooling and heating equipment selected should match. However, if the owner redesignates this space to a computer lab after construction is complete, users are likely to find the cooling for that space is not sufficient. In this case, a complete revision of calculations and HVAC requirement should be followed.

Consider part-load conditions. While we may select cooling capacity for the warmest anticipated day and similarly heating for the coldest day, more operating hours exist for both systems at milder, part-load conditions. Selecting heating and cooling systems (as in the case of VRF and ductless) that modulate capacity and fan speeds to precisely match the requirements of those part-load conditions will provide greater occupant comfort, less space humidity and higher energy efficiency.

Include the impact of ventilation air on heating and cooling loads. We must consider the effect of ventilation air that may be hot and humid in the summer and cold in the winter. Such ventilation minimum requirements should comply with the latest version of ANSI/ASHRAE Standard 62.1, *Ventilation for Acceptable Indoor Air Quality.*

Selection Software Concerns

VRF engineering software has emerged as a resource to help engineers understand, apply and select associated equipment units and components as well as simplify the selection process for control options, said Clavijo. Clavijo, who has reviewed several manufacturers' equipment

selection software (ESS), said that while the input data process is similar among the platforms, the oversimplification of data during that process can lead to challenges.

In several, Clavijo said design indoor conditions were the same as entering air conditions to the coil. "From the engineering standpoint, we know that mixed (return and outdoor) air conditions are different from actual comfort parameters. The greater the outdoor portion, the greater the difference between these figures will be," he said. "What we see across several VRF manufacturers' ESS is that there are no important differences between them in the feeding data process, although most of them treat comfort conditions as actual mixed air entering the cooling coil, which we know induces equipment selection errors leading to inaccurate equipment selection."

"Such oversimplification in the equipment selection process should be addressed through the ESS to separate such conditions favoring precise equipment selection based on actual air entering conditions," he continued.

Another ESS concern is the lack of altitude considerations that exist in several platforms, said Clavijo. Not addressing the altitude effect could lead engineers to undersize HVAC equipment at mid- through high-altitude sites ranging from 10% through 40% below required capacity, he said. "It is clear that each manufacturer's ESS should follow every design parameter applicable through software iterations and algorithms to reach consistency through selection of each piece of equipment," he said. "Leaving out altitude effect considerations, for example, as happens today through several manufacturers' ESS, introduces mistakes that should be avoided."

When selecting and sizing VRF and ductless systems, engineering fundamentals continue to be important, said Clavijo. "Cheaper solutions or a poor equipment selection processes can derail the objectives of a project causing unplanned costs, poor performance and high energy operation costs. When we consider improved projects and client satisfaction, a complete step-by-step engineering procedure is vital. Shortcuts are not acceptable!" he said. ■