Tackling The Challenge Of Sizing Today’s Heat Pumps

BY DOUG PRIESTLEY AND GREG BRUNTS

Photos courtesy of Maytag, a heat division of Nortek Global HVAC and ChargeCalculator.com

Air-to-air heat pumps comprise an estimated 35% of the residential HVAC market share today, but questions remain whether contractors who are installing them are sizing them properly.

The heat pump selected by a contractor might be sufficient, however subpar indoor air comfort and energy efficiency—due to the wrong size—might lead to an unhappy customer. For example, sizing strictly for heat load can result in uncomfortable high humidity levels in summer months.

Sizing heat pumps of any brand is challenging because of the many unknown variables regarding building material thermal characteristics, local climate and existing conditions. The Air Conditioning Contractors of America (ACCA), Arlington, Va., offers its Manual J-Residential Load Calculation to navigate through those variables. Manual J helps the contractor determine residential heating and cooling loads that affect the heat pump sizing. The manual’s calculation accounts for thermal characteristics of the walls, ceilings, floors, doors and windows. It also requires data inputs for the geographic location, sun orientation, appliances, lighting, building envelope integrity and other factors. It’s a very sophisticated sizing guide that even includes factors, such as the amount of heat and humidity generated by residential occupants.

While Manual J calculations take time, the guide’s sophistication should dispel the old-school notion that a heat pump can be sized simply by the residence’s square-footage.

One retrofit sizing mistake is assuming the new heat pump should be the same size as a residence’s previous heat pump or air conditioning system. This assumption can result in a poor application because the original equipment might have been improperly sized. Asking the homeowner about previous air-comfort performance might also surface insufficiencies related to a poor sizing or inadequate ductwork. Other load-
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altering factors might be the addition of more energy efficient windows, insulation, new construction square footage or other modifications since the last HVAC system was sized and installed.

Another sizing mistake is not reviewing the ductwork design, which can be addressed to ACCA’s Manual D—Residential Duct Design.

While it might require more time, consulting ACCA’s Manual S—Residential Equipment Selection, in addition to Manual J, can also avoid heat pump sizing pitfalls.

Dual fuel considerations
Heat pump technology can typically provide sufficient reverse cycle heating on its own and still extract heat from ambient air, even when temperatures drop to as low as 0°F. However, as the ambient outdoor temperature drops below freezing, onboard electrical elements typically provide supplementary heating. Consequently, dual fuel options are typically used in colder climates as more economic solutions to supplementary electrical heating.

Therefore, heat pumps in northern climates might best be sized with considerations for natural gas furnace backups. Retrofit projects may already have a furnace in place; however, new construction projects might require specifying a dual fuel appliance. Regardless, supplemental dual fuel appliances should be sized to heat the entire structure. This eliminates the danger of a plumbing pipe freezing if the heat pump fails during extreme low temperatures. In rural areas, propane-fired appliances might be an economic solution compared to operating electric elements in the heat pump, depending on the efficiency of the gas furnace.

Heat pumps are still more energy efficient than most alternatives and the proof is that some utility companies offer significant rebates. Rebates range from $200 to $1,500 or more, depending on the utility and region, to incentivize efficiency upgrades and reducing carbon footprints.

While most small and medium residential heat pumps in the south have 5kW electric heating elements, midwestern heat pumps may require a 12 to 15kW or larger electric heating. Far north areas such as Buffalo, NY, and Minneapolis, MN, may require 17-30kW heating elements, depending upon the...
structure's size. Therefore, heating elements introduce yet another sizing selection challenge for the contractor.

A rule-of-thumb that heat pumps should be sized from 1/2 to one-ton larger to handle heating loads is no longer a good practice. Instead, it's better to size it to the total cooling load, especially since the advent of two-stage cooling and two-stage heating. The first stage can economically optimize temperature, comfort and humidity for the majority of environmental needs, while the second stage activates for extreme weather events.

Inverters, which already command a growing 10-15% market share in split system heat pump sales, have positively helped sizing by offering ton increments of one, rather than half-sizes. A sizing calculation that results in a 2-1/2-ton choice, for example, would be better sized up to 3-ton, rather than down to 2-ton. It will offer more heat pump heating capacity, while also offering controllable cooling without sacrificing humidity control.

**Ductwork corrections**

In retrofits, it's likely that ductwork corrections will need to be made. For example, an older home that was with a furnace only, will probably need duct modification for cooling.

Interestingly, many heat pump manufacturers report that customer support calls are often due to ductwork improprieties, rather than heat pump malfunctions. ACCA's *Manual D* is invaluable for calculating ductwork factors, such as static pressure drops, ductwork sizing, branch runs, registers, return duct and grills. Most contractors don't perform a *Manual D* review because it could price them out of a bid.

However, ductwork often requires modifications, such as adding a duct branch or changing plenum size, main supply duct modifications and return connections. The efficiency requirements for contractors today are more stringent than ever. Older equipment can operate with subpar airflow, but none of today's high technology brands will tolerate it. Not

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**Using a Charge Calculator**

Service technicians can use several programs to help them calculate heat pump sizes. A new, free software program called Charge Calculator is one, and it will assure a heat pump is charged within a tolerance of ± 2 ounces. It's designed exclusively for microchannel coil systems. However, there is an allowance for systems mixing microchannel and fin/tube coils. When used in the cooling mode, the calculator can assist the technician in charging microchannel systems.

The calculator is for a technician who is unsure of the existing charge in an unfamiliar heat pump. It's also invaluable for verifying a charge in a newly installed unit, retrofit or leaking system that was recently repaired.

It can also expedite troubleshooting issues, such as thermostatic expansion valve malfunctions or other restrictive flow issues. The calculator will help identifying skewed superheat and sub-cooling numbers and help find refrigerant restriction positions.

A heat pump should always be charged in the cooling mode and not the heating mode. Also, airflow should be verified by checking static pressure and blower speed, based on the manufacturer's chart recommendations, before charging.

Fifteen to 20 years ago, a technician could set heating speeds low and cooling speeds high for airflow verification, but that's no longer valid with today's brands of equipment. If passed by the U.S. Department of Energy next year, the proposed mandate for electronically commutated motors (ECM) on all heat pump brands will make airflow verification more complex. ECM motors have the capacity to run at over a dozen different speeds.
Checking or modifying poor airflow ductwork is a disservice to the customer in a retrofit heat pump project. For example, a customer that pays for a 16 SEER unit isn’t getting that efficiency if the ductwork doesn’t perform properly. Also, there’s no guarantee that the last contractor installed the ductwork properly. It’s also a sure bet that an older home’s ductwork is most likely not sealed up to current International Mechanical Code requirements.

**Charging errors**

While not a sizing consideration, another common mistake made with heat pumps is charging in the heating mode. All heat pumps, regardless of the brand, are overcharged while running in the heating mode, which reverses the refrigerant flow and functions of the condenser and evaporator. Now that the condenser is smaller than the evaporator in the heating mode, there is more refrigerant than what’s needed and a portion of the refrigerant is stored within the refrigerant circuit. It’s difficult to measure the excess refrigerant, thus there may not be sufficient refrigerant when the unit returns to cooling mode. When temperatures are below 60 degrees, it’s a good safeguard to weigh the amount of refrigerant for charging. (See Sidebar—Using a Charge Calculator).

While an air-to-air heat pump is an excellent alternative to conventional air conditioners, its diverse ability to also supply heat requires a careful sizing regimen that should be faithfully followed to provide customers with optimum indoor air comfort and energy efficiency.

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