Getting proper performance from your ductwork

Over the past two months, I have been presented with three scenarios that highlight the need for the HVAC industry in Canada to recalibrate our thinking on ductwork. Each issue shows that builders are on a path of continual improvement with respect to ever-more-energy-efficient, durable, safer, healthier and more comfortable homes, and as such, HVAC contractors will have to respond by adjusting the design, material selection and installation of the mechanicals – right down to something as seemingly simple as ductwork – to meet the ever-increasing expectations of homeowners.

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OVER & UNDER SIZED & PERFORMING

A large, but very good, production builder committed to building Energy Star-qualified homes called me to help resolve a comfort complaint in a two-storey 2,400 sq. ft. home.

Despite the fact that the home has an excellent, top-of-the-line three-stage, 95 per cent efficient furnace with a variable speed fan motor, and ductwork that has been sealed on all main plenum and branch line fittings in the basement level – in accordance with Energy Star requirements – the homeowner is very concerned about unequal temperatures between the first and second floor.

The homeowner's comment to me was that it just didn't seem right that in what is supposed to be an energy efficient home the second floor was almost "uninhabitably" cold on winter nights.

Indeed, the main floor thermostat was set at 22°C (72°F) and on the second floor it was a "frigid" (the homeowner's words) 19°C (67°F).

In days gone by, this might have seemed a frivolous, unrealistic complaint, but be reminded the more we talk about how comfortable, quiet and efficient new furnaces and new houses can be, the more homeowners will reasonably expect from us.

In this case, no amount of tweaking of balancing dampers and registers, thermostat locations or settings has solved the problem.

The root of the problem is that the furnace is oversized. An 80,000 BTUH input for an Energy Star home that, upon discovery, has a design heat-loss of just 43,000 BTUH. Adding to the problems is that the ductwork is oversized as well, and despite efforts to air seal the ducts, they still leak at a rate of nearly 20 per cent.

The furnace rarely goes to high fire, thus the fan seldom goes to high speed and very little air gets to the second floor.

A quick measurement off the top of the furnace showed that even when the furnace was at high fire, the static pressure was just 0.06" of water column when a typical duct sizing would assume at least 0.2" water column. There is not enough static pressure to get air movement throughout the system.

A well-intentioned designer and contractor, building safety margins into both equipment and duct sizes, have made it very difficult to find the right settings and balancing to meet the comfort expectations of this client.

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FLEXIBLE DUCT
AVOIDING DUCT SAG

I recently traveled to eastern Canada where I was reminded by ventilation contractors there that the selection of insulated flexible duct on HRV systems warranted updated thinking.

The vast majority of insulated ductwork sold in North America is used in heating and cooling systems where the ducts are in attics and crawlspaces.

The supply side of this ductwork is under positive pressure – if there is air leakage, it leaks out. In HRV systems, the supply side is under negative pressure. So any air leakage through the duct or vapour barrier liner pulls warm, moist air from the house into contact with the duct carrying cold outside air. This leads to condensation on the outer surface of the air carrying duct that then accumulates in the insulation layer until it sags and drips like a wet sock.

This presents long-term moisture and air quality problems that can be avoided by better material selection and more careful air sealing of flexible insulated duct.

Learn from the experts in Atlantic Canada. They have been installing far more HRVs for far longer than the rest of the country and specify a better class of insulated flexible duct to avoid this annoying problem.

Flexible duct is suitable for short lengths, and where air leakage isn't critical it is tested under standards as a "connector." It is usually made from a polyester laminated film that, due to the manufacturing process, can have pin holes in it and may delaminate if not installed properly.

The "good" stuff is usually made with a chlorinated polyethylene core permanently bonded to the coated steel wire. It has lower pressure drop, can't delaminate and has lower air leakage more suitable for a critical application of bringing in very cold ventilation air through the warm, moist environment of a house.

We think we have a solution by adding a second "averaging" thermostat on the second floor, adjusting the fan speed settings to get higher air flows at the lower firing rates and, where accessible, air sealing as many ducts, fittings and floor boots as possible.

The long-term solution is, of course, for designers and contractors to ask for better information on the characteristics of a home in order to save money by putting in smaller systems and smaller ductwork and reinvest the savings in more thorough duct sealing.

GORD'S LESSONS LEARNED

SIZE
- It can be beneficial to go back and review the duct sizing principles to ensure we have adequate pressure in the main ducts to drive air through the system.

SEAL
- Seal ducts, all ducts wherever possible. Fortunately we are seeing new developments in this area, with manufacturers of sheet metal ducts coming out with "self-sealing strategies – peel and stick tapes, gaskets and sealants already applied to joints.

HRVs
- Choosing a better quality insulated flexible duct to avoid warranty callbacks and long-term moisture problems might add $25 to a typical total installation cost, but it makes all the difference in ensuring healthy, durable ventilation systems.

PUTTING IT TO THE TEST

I was working with an excellent builder in Southwestern Ontario who is building homes that are about 20 per cent more efficient than Energy Star qualified homes. They too have experienced comfort issues on second floors, but more in summer because of large west-facing glass. They have been working very hard with their HVAC contractor to find cost-effective solutions. Specifically, they have been fitting proper-sized ducts into tight wall cavities to optimize space.

I advocated oval duct. The contractor pointed out that the "equivalent" oval sizes had less free area and thus would have higher pressure drop and lower air flow. He advocated three-by-ten rectangular duct. I countered that it would have higher air leakage because of the two longitudinal seams.

We engaged in a little challenge to see whose theory would win out. He mocked up three lengths of duct on his shop floor with fittings simulating a typical run to a second floor master bedroom. One was traditional six-inch diameter round; one was oval duct; and one was three-by-ten duct. Then we used a Duct Blaster (equipment used to measure duct leakage) to compare the three scenarios.

It turns out we were both right. The oval duct had higher pressure loss and delivered about 20 per cent less air at the same static as either of the other two. The three-by-ten had about 10 per cent higher air leakage, and thus its net flow to the register was lower than the six-inch round, but still higher than the oval duct. The oval duct had noticeably less air leakage, most likely because of the manufactured elbows and fittings have fewer pieces.

THE DUCT BLASTER