Q Lofts – It's All in the Envelope

When Darcy O'Connell of DOC Engineering mentioned that he was designing an in-floor system that would provide not only heating but cooling also, they said it could not be done. His colleagues in the engineering and construction field thought he was crazy, "In Halifax? In this climate? Don't you realize how humid it is? You will have condensation everywhere." His response was, "Yes, it is very humid, but that is outdoors." The reason it is possible to have in-floor cooling as well as other innovative HVAC systems at Q Lofts is because it is built right. The building envelop is so well insulated and so tight that the outdoors stays out and the indoors defines "built environment".

Q Lofts is a multiunit residential condominium constructed by Polycorp, located in the north end of Halifax. The three floors house 72 apartments. Even though there are 3 floors, each floor is 2 stories high giving the one bedroom loft apartments an open and spacious feel. The penthouse offers a lounge, gym and terrace.

A dedicated team of designers and builders work for Polycorp with the understanding that care and precision must be taken with each detail. The team understands that heat transfer happens in three dimensions. Every detail like attaching balconies or installing windows, was carefully designed to minimize thermal bridging. During construction, windows were installed in one apartment and then they were tested for air leakage. An issue was detected and corrected prior to installing windows in the rest of the building. It is because of the envelop construction, the convenient urban location, and the unique HVAC and plumbing systems that Qloft has been awarded Platinum by Leed for Homes®.

Figure 1 – ICF Construction at Q Lofts
(Polycorp, 2013)

Details of the building thermal envelope include an insulated concrete form (ICF) construction with an extra 50mm (2in) polystyrene insert. The windows and patio doors are triple glazed low solar gain with thermally broken frames. The cavities between the glass is filled with argon which further increases the insulating value. The glazing is selective which as shown in Figure 2 means in the summer it reflects the infrared heat from the sun back to the outdoors while letting in a high percentage of the visible light. During the winter, the glass reflects heat back into the building. The balconies are designed such that they

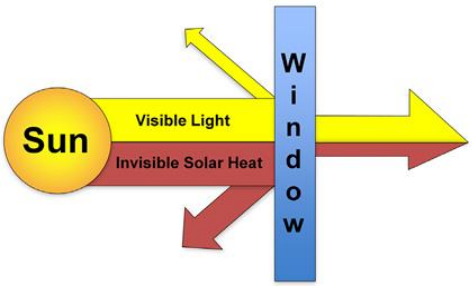

Figure 2 – Selective Windows in the Summer
(Lawrence Berkeley National Laboratory, 2013)

provide external shading for the windows below during the summer but will not block the sun during the winter when the sun is lower in the sky.

Figure 3 – Well placed windows
(Polycorp, 2013)

While the modern trend in architecture is to build glass houses, Polycorp has elected to create beautiful sunlit interior spaces by using an open floor plan and strategically placed windows. Even though the windows are extremely energy efficient their overall insulating value is less than one quarter of the insulated value of the walls. Windows are also the most expensive component of a building envelop. The most cost effective method to construct a building with low energy consumption is with an envelope that has well insulated walls and roofs; is tight and has extremely low levels of unwanted air leakage; is devoid of thermal bridges; and has well placed windows that do not limit the natural light.

Mr. O'Connell is the mechanical engineer for the project and he designed the HVAC and plumbing systems for Qloft. The unique details of the systems are described in this article and they include:

- Radiant in-floor heating and cooling
- Air-to-water heat pumps that provide most of the heating and all of the cooling
- Domestic hot water pre-heating using air-to-water heat pumps
- Ventilation using variable speed fans with electronically commutated motors (ECM); an enthalpy recovery ventilator (ERV); and a cooling coil that dehumidifies air for summer operation
- Rainwater harvesting for flushing toilets

In-floor Heating and Cooling

The benefits of radiant in-floor heating are well known and well documented. The water that flows through the piping in the floor is at a lower temperature than traditional hydronic heating systems and therefor the system is well suited to a heat pump application. Because the water temperature is lower, the system has a higher energy efficiency than other heating systems. The warmed concrete floor radiates heat and there is little stratification of the air is the room. Limited stratification is particularly important in Q Lofts where the living area in the apartments is two storeys high. Radiant in-floor heating provides the most comfortable indoor environment during the heating season.

While in-floor heating works well in our Canadian maritime climate, in-floor cooling presents many potential problems. For example, will the occupants feel comfortable with a cold floor? At Q Lofts, the temperature of the floor is set at approximately 21°C (70°F) which is very close to the desired air temperature of the room. The cooling is effective because the building envelope is so well constructed. Most of the cooling required in the apartments does not result from the outdoor temperature, humidity

or from solar heat gain. Most of the cooling is required because of the heat gains from within the apartments from cooking, lighting, and electronics. This cooling system may not work in a building with huge windows and excessive solar heat gain.

Figure 4 – Installation of In-Floor heating and Cooling at Q Lofts
(Polycorp, 2013)

Condensation is the biggest concern with a chilled floor. If the temperature of the floor is colder than the dew point of the air in the room, then condensation will form on the floor in the same manner that dew forms on grass. Any one who has experienced their glasses fogging when they step into a heated building during the cold winter has experienced the phenomena of condensation on a cold surface. To ensure that condensation will not form on the chilled floor, Mr. O'Connell has employed several design strategies:

- Dehumified ventilation air
- Multiple temperature zones in each apartment
- Controls to shut down the cooling if the floor is approaching the dew point temperature
- Controls to shut down the cooling if windows or doors are opened

Again, the most important building feature is the tight construction which blocks the warm humid maritime air from getting indoors.

Outdoor ventilation air is introduced into the apartments to meet the requirements ASHRAE Standard 62. It is supplied through a central ventilation system that dehumidifies the air by passing it over a cold cooling coil and allowing the moisture to condense before it is supplied to the apartments. In addition to the dehumidification coil, the centralized ventilation system utilizes an ERV which exchanges heat from the air exhausted from the building to the outdoor air supplied to the building. In the winter, it provides free heating and in the summer, it precools the air before it passes over the dehumidification coil. To further save energy, the fans in the ventilation system are powered by variable speed ECM motors which match the air needed to the system requirements.

A sensor is installed in the slab measures the surface temperature of the chilled floor. At the same time, a dewstat measures the air temperature and moisture content. The dewstat calculates the dew point temperature of the air and compares it to the surface temperature of the floor. The dewstat will shut down the flow of chilled water to the floor when the temperature of the floor is within 3°C (5°F) of the dew point. To further reduce the risk of condensation, the small loft apartments have three separate zones so that the dew point temperature is measured in three distinct areas of the apartment. Also, sensors will shut down the apartment cooling system should the occupants decide to open the patio doors or windows.

Air-to-Water Heat Pumps

Six air-to-water heat pumps with buffer tanks provide much of the heating and all of the cooling for the building. Q Lofts is so energy efficient that both the heating and cooling loads are very low. These modern heat-pumps can provide heat even when the outdoor temperature drops to -8°C (17°F). In Halifax, it may get that cold a few days each year. Supplementary heat is provided with electric boilers. If during the heating season the heat pumps produce excess heat, it is diverted to the plumbing system to preheat the domestic hot water.

During the cooling season, four of the heat-pumps produce chilled water for cooling. Very cold water flows through the cooling coil to dehumidify the incoming ventilation air. A three-way mixing valve provides less cold water for the in-floor cooling. The two remaining heat pumps operate in heating mode during the summer to provide domestic hot water to the building. When necessary, the temperature of the domestic hot water is boosted by the electric boilers. Often the heat pumps can heat the domestic water to the temperature required for use without supplementary heat.

Rain-Water Harvesting

Rather than sending storm water to the city system, an underground cistern has been installed to collect rain water. The water supplies to the toilets have been piped separately and when the system is complete, the rainwater will be pumped through that piping to flush the toilets rather than wasting Halifax city resources by flushing very expense potable water. It is necessary to treat the rain water to eliminate growth of bacteria but the cost is very low as compared with potable water.

In addition to rain-water harvesting, Q Lofts have water conserving plumbing fixtures including dual flush toilets and low flow showers and sinks.

Conclusion

Halifax has a temperate climate when compared to most of Canada making it an excellent location to use the modern air-to-water heat pumps. At Q Lofts, they operate all year to provide heating at a greatly reduced cost; to provide cooling; and to provide domestic hot water during the summer. The most efficient method of heating is with radiant in-floor heating which uses water at a lower temperature than traditional hydronic systems. Combining in-floor heating with air-to-water heat pumps further extends the usefulness of the heat pumps. Providing in-floor cooling using the heat pumps is unique to Q Lofts. It is the quality of the construction and modern controls that make this unique design successful. The building is well designed and constructed with meticulous attention paid to reducing thermal bridging and air leakage. The long-term benefit to the owners will be reduced energy consumption and lower utility costs in a beautiful and thermally comfortable living space.

References

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