Thermenex-In-A-Box system at the NexSource Centre, Sylvan Lake, AB.

Turn Up The Heat

A focus on Passive House is changing the world of mechanical and HVAC systems

by **NATALIE BRUCKNER-MENCHELLI**

It has been well documented that mechanical systems providing indoor environmental control and domestic hot water functions generally represent the largest consumer of energy in Canadian high-rise multi-unit residential buildings.

However, as government, owners and end users shine a spotlight on the sector, leaders in the field have taken it upon themselves to drive mechanical and HVAC systems towards a more sustainable future and are participating in R&D efforts to ensure buildings are optimized and can actually achieve the energy goals of not just today, but 30 years from now.

"New buildings are becoming more and more energy efficient based on municipal policies and regulations, however this only accounts for a minor percentage reduction of the overall energy consumption. Existing buildings designed and constructed are not subjected to the same rigid energy requirements," says Vancouver-based engineer Gideon Loh from Norman Disney & Young (NDY).

However, Loh adds that between the lack of incentives to upgrade existing buildings to improve energy performance and municipal policies, and regulations to meet energy standards, reduction of energy consumption is not a high priority of building owners.

Over the past 12 months Loh says modifications to the local/municipal code to meet benchmark energy targets and ultimately achieve significant reductions in carbon emissions has resulted in a greater focus on the integration of individual mechanical systems (such as space cooling/heating, domestic hot water and sewage waste) to share "waste" heat.

Examples of this include the extraction of the heat generated from electrical motors, transformers, elevator machine rooms and electrical rooms to preheat domestic hot water. For one project, the heat extracted from the sewage waste generates 85 percent of the domestic hot water requirements, thus reducing natural gas consumption and carbon emissions.

In addition, there is increasing focus on the utilization of excess heat from cooling plants to preheat domestic hot water prior to discharge to a cooling tower, as well as the use of ocean sea water to extract or reject heat based on building requirements.

Measuring and managing energy consumption is key, says Loh: "The design and installation of the most advanced system does not equal an efficient building. Metering is a means to determine the actual performance of the building based on the occupant demand," he explains. "The biggest influence I see on the mechanical/HVAC sector will be the modification to the operation of the systems to meet the occupant demand based on peak and non-peak requirements during different seasons."

Over at Williams Engineering Canada Inc., the highly skilled team of mechanical engineering specialists are constantly optimizing key strategies in an effort to maximize efficiencies and minimize wasted energy, and are investing in new technologies and education to take the sector towards a lean and sustainable future.

"The City of Vancouver's Zero Emissions Building Plan has a new green building policy to achieve zero emissions for new buildings by 2030. This is driving the building industry to revisit conventional ways and be creative to meet those goals," explains James Y. P. Lee, regional director at Williams Engineering.

PHOTOGRAPHY COURTESY THERMENEX

One way to achieve this is through heat recovery ventilators (HRVs) that use a heat recovery ventilator, heat exchanger, air exchanger, or air-to-air heat exchanger that employs a cross flow or counter-flow heat exchanger between the inbound and outbound air flow.

"The City of Vancouver is at the forefront of this movement," explains Peter Kuo, mechanical team lead at Williams. "HRVs offer improved efficiency and superior ventilation, and are the shortest path to meeting new Code requirements. But they have to be installed properly."

Williams is currently working on a groundbreaking new project in Vancouver due to be completed by 2022. The project will feature a 45- and 50-storey building and consist of HRVs, as well as a number of other new technologies to meet many stringent targets set by the City (such as Green Building Policy for Rezoning, General Policy for Higher Buildings and City of Vancouver Neighbourhood Energy Interpretation Guide for Rezonings).

"The building will demonstrate leadership in sustainability, and we are using mechanical systems to help achieve those targets," says Lee. "In addition, the underground parkade has a ventilation tunnel using a concrete wall on one side with a cavity behind that has a metre space in between. The air drawn from the outside into the tunnel will be preheated and pre-cooled prior to entering into the building ventilation system. This mimics a geoexchange system as we use the ground temperature, and is quite a unique and simple way to take advantage of relatively consistent ground temperature throughout the year."

Kuo adds that Vancouver's plan for all new city-owned and Vancouver Affordable Housing Agency projects to be built to certified Passive House standards is also having an impact on the sector. Heat recovery from the waste water, such as the bathroom and kitchen sewer heat recovery, is becoming more common. Passive House buildings must have an annual heating and cooling demand of not more than 15 kilowatt hours per square metre of building (15 kWh/m^2) per year, and total primary energy (calculated as source energy, not metered energy at the building) must not exceed 120 kWh/m^2 per year. Passive House buildings typically require a mechanical ventilation system with HRV to run 24 hours a day.

This leap to Passive House standards means that conventional heating systems design needs to evolve, and buildings can be heated with considerably minimal amounts of heat input with the ventilation air distribution system or other low energy input systems.

Kuo adds that technologies are evolving every year and he expects to see other alternative energy sources such as solar energy having a greater influence on mechanical and HVAC systems in the near future.

B.C.-based Thermenex, which uses patented technology to fabricate thermal energy plants for HVAC systems in large buildings, has always taken a holistic approach to building reclaim.

"As an industry we need to understand that every heating system is a cooling system and vice versa. When you cool a building, you are heating the outside. The traditional design approach focuses on one side of thermal exchange, but we believe the future is optimizing both sides of energy exchange for every system," says Jeff Weston from Thermenex. "Every HVAC engineer can design a boiler system to heat a building, but how many think about designing a building to cool a boiler?" The Thermenex system has been shown to reduce greenhouse gas emissions (GHG) by as much as 93 percent, and energy cost savings up to 59 percent.

Weston adds that the biggest challenge facing the sector is change. "The problem is consulting engineers are not incentivized to change as change comes with risk and they are not paid to take risks. As engineers we have a desire to innovate, but you can't progress with a system that penalizes the innovator."

A collaborative consulting engineer is critical to successful Thermenex solutions. "We have learned some hard lessons and now deliver our technology in a manner that allows engineers to be as creative as they wish and we take the risk," says Weston. Thermenex experts inspect every installation to ensure it is done correctly and then monitor and operate for a minimum of two years.

While Weston says that Passive House is a positive direction to be moving toward, he adds, "I don't believe large buildings are able to be totally passive when it comes to solutions as they need some active component to the mechanical system." He sees a future instead where thermal energy is shared among buildings. "All the buildings within an area will eventually share energy with each other and excess energy will be stored. It will be a closed energy circuit free from carbon emissions and we will have the passive/aggressive technology to manage the energy."

PHOTOGRAPHY COURTESY AQUA-TECH

Lochinvar Hydronic heating system at the YMCA, St. John, NB.

For now Thermenex continues heavily investing in R&D and monitoring the operation of its systems to better understand how to further improve performance. "We are rare in that we get to operate our systems and learn from each and every project we work on. We are building our fourth TIAB [Thermenex-In-A-Box] system for UBC and each time we improve on our past results."

Another technology that continues to gain momentum is the large commercial Condensing Fire Tube Hot Water Heating Boiler. The Lochinvar boiler product line – one of the top spec brands in Canada when it comes to hydronic heating – has been at the forefront of developing this technology in North America.

The popularity of hydronic heating systems has exploded here in Canada due to its versatility, energy efficiency and comfort.

"Over the past three years, with the advent of the larger Btu size products, demand for large Btu fire tube condensing technology has escalated as Lochinvar products now reach six million Btu," says Darryl Singleton at Aqua-Tech, the Canadian distributor of Lochinvar.

With Lochinvar Knight and FTXL product lines, the condensing fire tube technology now ranges from 55,000 Btu to six million. Hot water boiler systems and components ensure better heating and efficient solutions. With the advent of new control technologies, more efficient and effective maintenance programs can be created with CON X US Remote Connectivity (yes, there is an app for that) and Smart System Boiler operating control.

On a retrofit project at an apartment complex in Cranbrook, B.C., a high-efficiency condensing Lochinvar Knight system proved to deliver 30 to 35 percent yearly energy savings, with some months exceeding a 50 percent reduction over previous years. Each of the 16 to 24 unit multi-family apartment buildings has two 285,000 Btu/hr Knight Boilers and a single 119-gallon Squire Indirect Water Heater.

At the 55,000-square-foot Fairville Farms in Alberta the boiler room is comprised of three primary space heating boilers: Lochinvar's Knight Wall Mount units with individual inputs of 400,000 Btu/hr and 95 percent AFUE efficiency, along with an additional Knight Wall Mount boiler for space heating and hot water for the truck wash.

Singleton concludes that this is an exciting time for the industry as technologies continue to mature with high-efficiency combustion products. **A**