A BOUT YOUR HOUSE

North Series 9

FANCOIL INTEGRATED COMBINATION HEAT AND DOMESTIC HOT WATER SYSTEMS

In the average home, space and hot water heating contribute the largest amounts to residential energy consumption. A traditional heating and hot water system relies on separate systems to heat the living spaces of a residence and the hot water used by the residents. This often requires both electrical and fuel input. These systems have considerable room for improvement, since the heating required is performed by two distinct systems operating independently of each other.

The cost of this energy, particularly in remote communities in the North, is very high (CMHC "Utility Costs in Northern Communities", 2002). One practical and highly effective solution to reduce these high energy costs is to replace older, non-efficient systems and appliances. By combining the household heating and domestic hot water heating requirements into one efficient system, such as a fancoil integrated combination heat and domestic hot water system, a number of redundancies can be eliminated, resulting in considerable savings. The cost of converting from a conventional oil furnace and electric hot water tank to a fancoil integrated combination system with an oil-fired hot water tank would likely be recovered within just a few years.

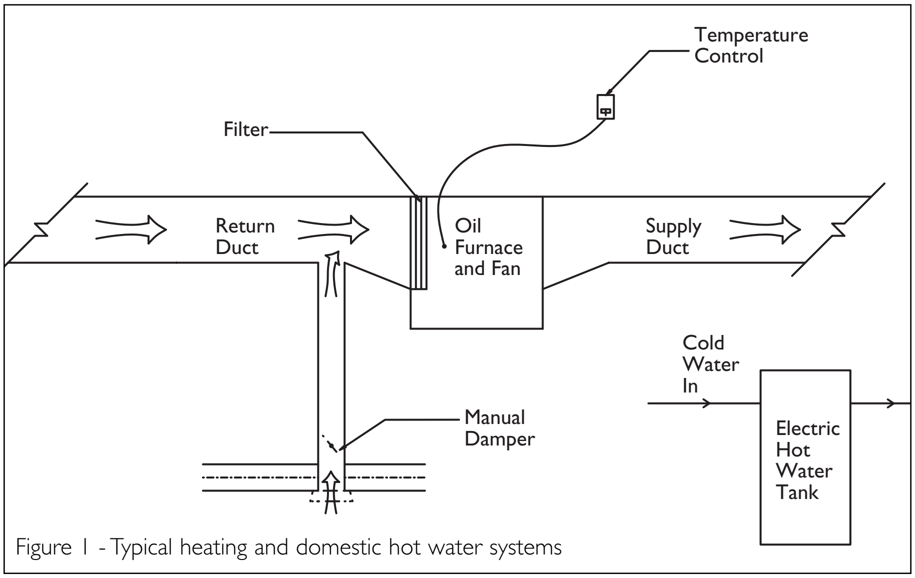

Figure 1 - Typical heating and domestic hot water systems

The Fancoil Integrated Combination System

There have been many successful installations of fancoil integrated combination heating and domestic hot water systems across the far North of Canada. A typical conversion is from a traditional oil furnace and electric hot water tank to an oil-fired domestic hot water tank with a forced-air heating

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system (an integrated combination system). Highly adaptable, the integrated combination system, even when installed as a conversion, is significantly more efficient.

A fancoil is simply a small appliance with a blower and hot water coil. Hot water from the hot water tank is circulated through the coil in the fancoil unit. Heat is transferred from the hot water to the air stream as air is forced over the coil, conditioning both fresh air and air from the return air plenum and distributing it to the house through the supply air plenum. Thus, both the air for space heating and the domestic hot water are heated by one appliance.

The heating system blower can also be installed with a manual switch or dial, located on the heating unit, which gives the user the option of having low-speed air circulated continuously throughout the house. A service disconnect switch allows the fancoil unit to be serviced without affecting hot water operation. Whether the low speed is on or off will not affect the normal operation of the heating system.

The fancoil integrated combination system is very versatile, and can easily be adapted to specific requirements, both in new construction and in renovation. The combination system easily lends itself to include ventilation systems as well as add-on cooling systems, such as air conditioning.

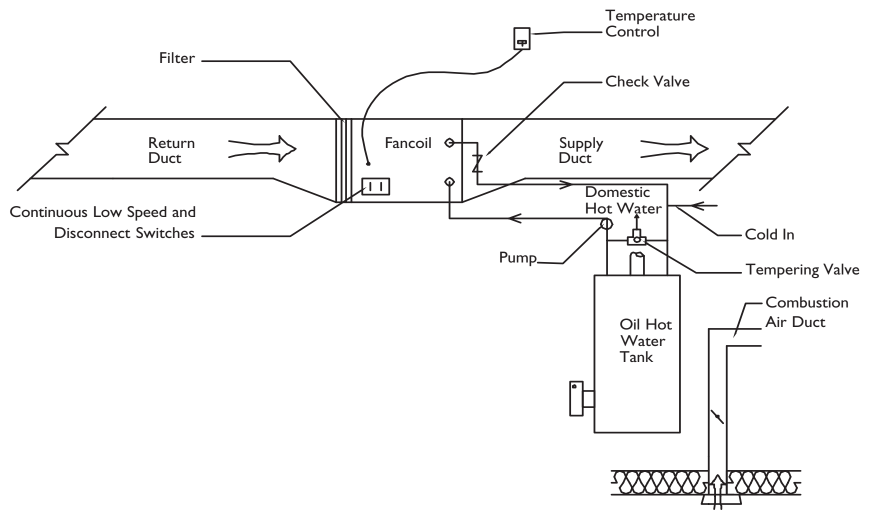

Figure 2 - Fancoil integrated combination heating and domestic hot water system

Non-Heat Recovery Humidity Controlled Ventilation

Further energy savings can be achieved by integrating mechanical ventilation into the heating system, improving interior air quality, controlling the amount of moisture in the air and supplying necessary combustion air for heating appliances. This creates a balanced system where the amount of fresh air being brought into the house equals the amount of stale or moist air being exhausted. Incoming air for ventilation and combustion is not dumped uncontrollably into the house: the required air intake is regulated and air can be tempered before being distributed throughout the house.

The main components of this integrated ventilation system are:

1. Dehumidistat – senses the humidity levels in the house. When the humidity exceeds a set point, the dehumidistat sends a signal to the rest of the system to begin ventilation.
2. Exhaust fan – removes stale air from the house via the return air plenum at a fixed rate set by the balancing damper. A backdraft damper is also installed with the exhaust fan to prevent unwanted leakage of exhaust air back into the house when the exhaust fan is off.
3. Normally-closed motorized fresh-air damper – opens up only on call for ventilation, allowing fresh air to enter the fresh air plenum for distribution throughout the house.
4. Fancoil blower – circulates heated and/or fresh air throughout the house. The blower provides the necessary vacuum in the return air plenum to draw fresh air into the heating and ventilation system.
5. Balancing dampers – allow the user to set the air flow rates, providing equal exhaust and fresh air intake, ensuring that the house is neither pressurized or de-pressurized.

Household ventilation is primarily controlled by the dehumidistat. With a call for ventilation the fancoil blower turns on, the exhaust fan comes on and the motorized damper opens, allowing for fresh air intake. The fresh air is then distributed throughout the house by the fancoil through the forced air system.

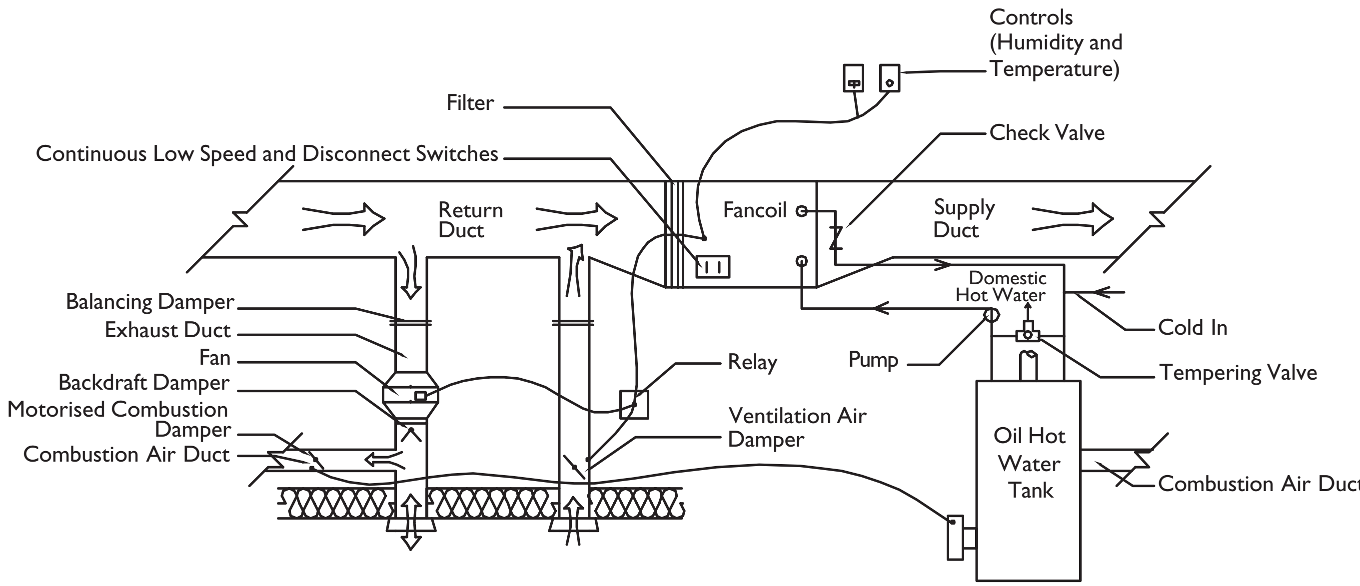

Figure 3 – Household ventilation and combustion air installed in combination with fancoil integrated heat and domestic hot water system
Source: Whitehorse Housing Authority. Taylor Street Row Houses Heating and Domestic Hotwater Conversion, 2000.

Installing a fancoil integrated heating and domestic hot water system during new construction provides even more benefits. A detailed heat loss calculation done room-by-room allows proper design of the entire heating system before installation, including appropriate sizing of the duct-work and fancoil unit. The result of proper layout and installation is a more efficient, quieter system, with more even temperatures throughout the house.

Benefits of the Fancoil Integrated Combination Heat and Domestic Hot Water System

There are a number of efficiencies inherent in the combined system that would enable the homeowner to recover the cost of the retrofit within just a few years:

1. Large amounts of heat can be lost when heating appliances start up and shut down repeatedly to adjust household temperatures, purging extra heat. These stand-by losses are reduced by running one heating appliance rather than two.
2. Savings are generated not only by using a more efficient system, but also by the type of energy required to operate the system. In the North, electrical input is often at least three times the cost of the same amount of oil input (CMHC "Utility Costs of Northern Communities", 2002). The elimination of the electricity-dependant hot water tank results in significant savings.
3. Because of the limitations of furnace sizes readily available on the market, furnaces tend to be far over-sized for the amount of space they are required to heat. This is especially true for small houses. Over-sized furnaces have very short and frequent cycles, resulting in large stand-by heat losses. Fancoil integrated combination systems have a modulated output, enabling them to put out only as much heat as is needed to meet demand.
4. Fancoil combination systems can be designed and installed to create a number of zones by running multiple, smaller fancoils from one hot water tank, allowing variable heating demands in the house to be met.

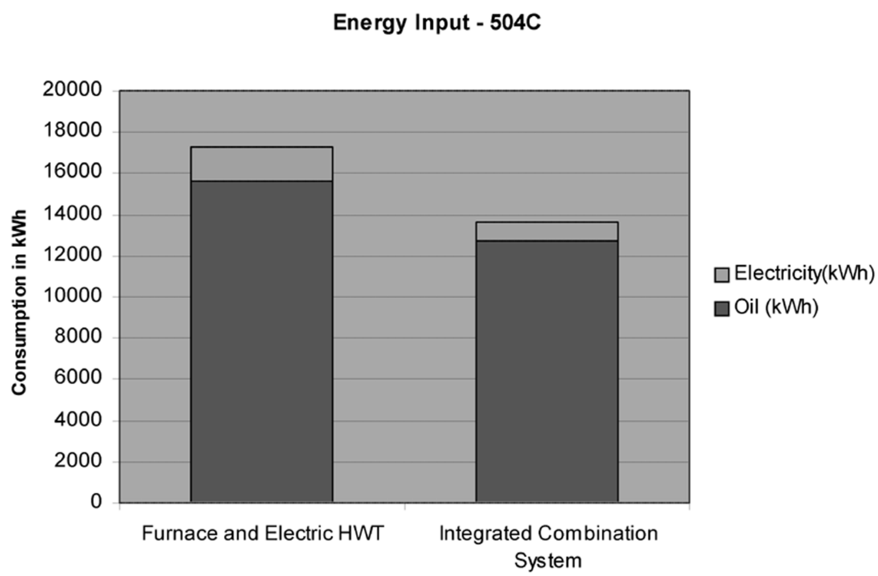

Figure 4 – Household Energy Input Before and After Conversion to Fancoil Integrated Combination Heat and Domestic Hot Water System

Based on the Taylor Street Row House (Unit 504C) conversion to a fancoil integrated combination heat and domestic hot water system. The illustrated energy savings are based on a similar 4 month period prior to and following the conversion (October to January 1999-2000, 2000-2001), and correspond to savings of $82.58 for electricity and $131.12 for oil, totaling $213.

5. There is the potential in this type of system to temper cold, outside air before bringing it into the ductwork.
6. There is an increased availability of domestic hot water.
7. Available floor space is also increased. The fancoil unit tucks into the ductwork at the ceiling level, freeing up the space required for a furnace in a traditional heating and hot water system.
8. With a single heating appliance, not only are operating costs reduced, but there is a decrease in cost for operation and maintenance as well.

There are times when converting to or installing a fancoil integrated heating and domestic hot water system is not advisable.

- First, since water is critical to the functioning of the entire system, the quality of the water is important. Poor water quality may cause the hot water tank to silt up or corrode.
- Second, if there is a chance of running out of water, as is often a risk in northern communities where water is supplied by truck, the system must be designed carefully to prevent the space heating loop from losing water pressure. This could cause the heating system to fail. To prevent the pump from air-locking (which occurs when an air pocket enters the suction pipe, disabling the flow of water), the circulating pump should be located as low as possible in the system where it will not run dry.
- Third, if the residence is susceptible to freeze-ups due to long periods of absence, power failure, lack of fuel, poor ventilation air dampers, etc., a water-based fancoil system is not recommended. In these situations, a glycol-based system would be more suitable, in which glycol is used in the closed heating loop that travels from the hot water tank to the fancoil unit rather than water.
- Fourth, access to expert installation is mandatory as the motorized dampers must seal tightly and the ducts carrying cold air must be properly tied into the vapour barrier, sealed and insulated to prevent condensation or failure will occur.
- Most importantly, like most advanced systems, the expertise to properly design, balance and maintain the system must be available.

Conclusions

In order to compare the total energy input and efficiency of the combination system versus the "conventional" system, the total energy consumption must be calculated for each. This means that the energy consumption of the fancoil integrated combination system is compared to the combined energy consumption of the heating system plus that of the hot water system in a conventional heat and domestic hot water system.

Preliminary data collection and analysis shows that the integrated combination system consistently uses less total energy than a traditional forced air furnace and hot water tank. In many instances, the entire heating, domestic hot water and ventilation of the fancoil integrated system is less expensive to operate than the oil furnace heating system alone. While more testing and analysis are being done to determine more accurately what the exact differences are, when comparing costs and efficiencies of all systems (heating, hot water and ventilation), the results are, at the very least, comparable, and it is always less expensive to run the combination system than the conventional oil furnace and separate electric hot water system.

Notes

A six-plex row-housing unit in Whitehorse was converted from a traditional oil furnace and electric hot water system to a fancoil integrated heat and domestic hot water system in April 2000. Electrical, fuel and weather data were collected and analyzed for a year before and after the conversion (1999-2001) to measure the real effect of the conversion and the savings generated. Data collection, monitoring and analysis of the Taylor Street Row House conversion to a fancoil integrated combination heat and domestic hot water system was done by Juergen Korn of the Yukon Housing Corporation.

In each unit, a continuous ventilation and combustion air system was added to the integrated combination heating system. The inclusion of ventilation makes the operation of the fancoil system slightly more costly than a system without integrated ventilation. A heat recovery ventilation system (HRV) would have been a more efficient choice for the ventilation system, resulting in even lower operating costs. As well, the new water tanks that were used in these units were not the most efficient on the market. A more efficient tank would increase both the efficiency and savings of operating the combined heating and domestic hot water system even more.

The cost to retrofit the oil-furnace and electric hot water system to a fancoil integrated combination system was about $4500/unit (2000 cost) (Juergen Korn, "Row House Combo Heating System Components and Costs", 2000).

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