

# Reducing Costs of Affordable Housing

## TWO-PIPE FAN COIL SYSTEMS

### Introduction

Affordable housing projects require heating and cooling systems that are reliable, easy to maintain and service, economically feasible and efficient. Two-pipe fan coils are a proven technology that offers a good choice for affordable energy-efficient design.

### Description

A fan coil consists of a combination heating/cooling coil, a fan and an air filter—all within one well-engineered package. It is generally controlled by a room thermostat. During the heating season, hot water is provided to the fan coil from a central boiler. The hot water flows through the coil and delivers heat to the air that is being drawn through the fan coil unit. The warmed air is then delivered back into the apartment. During the cooling season, chilled water can be provided to the fan coil unit from a chilled water plant—if provided.

Fan coils can be two-pipe or four-pipe. Two-pipe fan coils, the less expensive of the two types, are connected to a supply water line and a return water line. The water temperature in the two-pipe system is controlled by a boiler during the winter and a chiller during the summer—if air conditioning is provided to the building. Two-pipe systems operate in either heating mode or cooling mode—not both.

Four-pipe fan coils are connected to both hot water supply and return pipes and chilled water supply and return pipes. Four-pipe systems allow for simultaneous heating and cooling in the building—a feature common in condominium buildings, where different dwelling units may have different heating and cooling needs. Because of the greater number of pipe connections and more piping required for the two distribution systems, four-pipe systems are more expensive than two-pipe systems.

Fan coils are available in different configurations. Horizontal units can be located in ceiling spaces and are more common in hotel/motel buildings. Vertical units are more common in apartment buildings, as they can be easily stacked on top of one another floor by floor, simplifying the distribution piping system and connections. A vertical-style fan coil unit is shown in figure 1.



Credit: Enermodal Engineering

**Figure 1** Installed vertical fan coil

The unit is contained in the enclosure in the corner. The front panel permits access for maintenance. Supply air grilles can be seen immediately above the unit. There are distribution ducts located in the drywalled chases leading to and from the unit at ceiling level.

## Fan options

Fan coils are traditionally equipped with multiple-speed fans, driven by direct drive, permanent split capacitor (PSC) motors. A centrally mounted thermostat allows the occupant to select the temperature setting for the room, the speed of the fan and the operational mode (continuous fan operation or fan cycling on and off with calls for heating/cooling). Brushless direct current (DC) motors have become popular in fan coils, as they are much more energy-efficient than PSC motors, use much less electricity and reduce operating costs. They also allow for infinite fan speeds to be selected to suit the particular application.

Manufacturers may charge extra for fan coils equipped with DC motors. However, this additional cost may be offset by operating cost savings.

## Control valve options

Traditionally, fan coils were provided with three-way valves (or no valves at all). Heating and cooling water would either flow through the coil if there was a demand for space conditioning or be diverted back to the return water piping and the central plant.

Two-way valves can be installed instead of the three-way valves, which allow water flow through the unit to be stopped completely when heating or cooling is not required. Central pumps can be equipped with variable-speed drives controlled by a differential pressure sensor in the system that monitors the demand at all times. This allows the pump to modulate its speed of operation in accordance with the number of fan coils requiring heating or cooling.

## Application

Vertical fan coils are well suited for multi-unit residential buildings, particularly where a single fan coil can provide space conditioning to modestly sized units with little to no ductwork. They offer air-conditioning capacity that can reduce the problems associated with occupants installing their own window-mounted air conditioners (damage to windows, higher electricity consumption and costs, overhead hazard to those on the ground below, noise, water spillage, etc.).

Even if air conditioning is not included in the construction of new affordable housing projects, the installation of two-pipe fan coils makes it easier to accommodate at some point in the future should needs change.

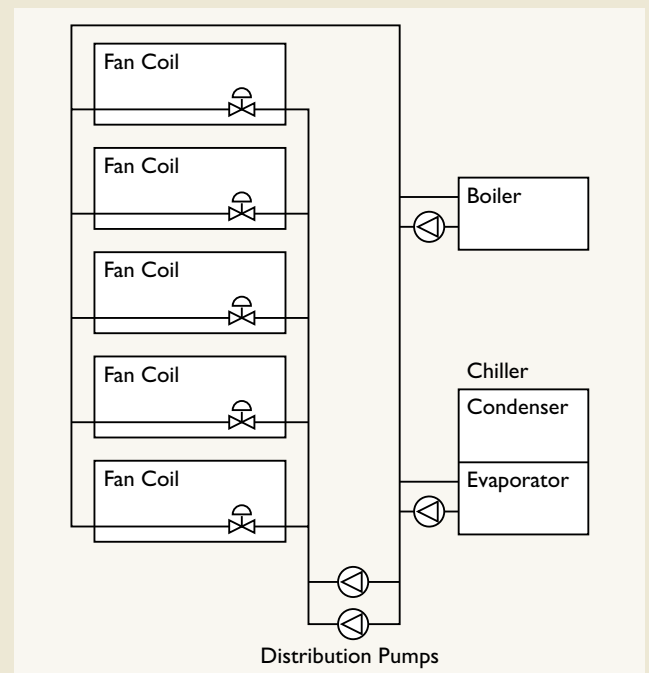
Eden Park Towers (Block 49 is shown in figure 2) is composed of three 13-storey residential buildings with a total of 430 dwelling units. Each of the units in the apartment buildings contains a two-pipe fan coil for space heating and cooling.

The two-pipe system at Eden Park was configured as shown in figure 3 with multiple boilers and multiple distribution piping risers serving the fan coils throughout each of the buildings.



Credit: Enermodal Engineering

Figure 2 Eden Park Towers, Block 49



Credit: Enermodal Engineering

Figure 3 Two-pipe system schematic

## Typical multi-unit installation

Fan coils are typically installed in configurations similar to figure 3. Boilers control the loop temperature to the heating setpoint in the winter and, if air conditioning is included, the chiller controls the loop temperature to the cooling setpoint in the summer. Variable-speed distribution pumps modulate in speed to maintain the differential pressure between the supply and return piping.

Typically, the cooling requirement of an apartment dictates the size of the coil within a two-pipe fan coil. Much smaller coil sizes are required for heating. If the fan coils are sized for air conditioning, the oversized heating coils allow the heating supply water temperature to be lower than that of conventional heating systems, thereby increasing boiler efficiency.

Large coil sizes also allow the design water temperature drop through the coils to be increased. This reduces the required water flow through the coils in heating mode, saving pumping power.

## Benefits and considerations

The two-pipe fan coil system has many benefits. The fan coil units are relatively simple, with few parts requiring maintenance. Filter replacements, as well as blower or coil replacements, are easily conducted through the front access panel. Many companies manufacture fan coils, which helps to ensure that costs are competitive. The units are easily adapted to different types of central plants, as well as district energy systems and renewable sources of heat, such as solar. Since the units are located directly in the spaces that they serve, ductwork and installation costs can be minimized. Fan coil units are often provided with supply and return pipe risers connected, simplifying the distribution piping installation.

Another advantage of two-pipe systems is that air conditioning can be provided to the building, either at the time the building is constructed or at some point in the future. The capacity to add air conditioning helps to overcome the need for occupants to add window air conditioners with, or without, the permission of the property management. It also provides a measure of flexibility to the building should air conditioning be required to provide healthier indoor environments to those in need (for example, seniors).

The main disadvantage of the two-pipe fan coil system is the fact that, at any given time, only heating (or cooling) is available to all units, since a single supply and return riser serves each dwelling unit. The building operator must decide when to switch the entire system from heating to cooling taking into consideration the simultaneous need for heating and cooling during the spring and fall periods.

Another consideration with two-pipe fan coil systems is that they are located in the living space. If not carefully designed and installed, complaints due to airflow noise could occur. Additionally, property damage due to water spillage from a broken coil, faulty fittings or blocked drain pan can occur. Two-pipe fan coils should be inspected annually or at the minimum intervals recommended by the manufacturer.

## Costs

### Initial requirements and cost

Costs for a typical vertical two-pipe fan coil unit complete with supply/return piping risers attached, supply and return grilles (no extended ducting), a space thermostat and a DC blower motor can be approximately \$1,200 per unit. This does not include the central boiler or main distribution pipe system.

## Implementation considerations

### Floor space

The floor space for each dwelling unit must be planned to include the footprint of the fan coil unit(s). As the least expensive installation requires the fan coils to be vertically stacked from floor to floor, this can reduce floor plan options. Fan coils are least visually intrusive when designed into service spaces that are flush with room walls. If ductwork is required to heat adjacent rooms, chases will be required to contain the supply and return ducts.

### Building envelope

When a two-pipe fan coil system is planned, steps should be taken to reduce simultaneous heating and cooling demands in different apartments. This can be accomplished by reducing the amount of window area in the building, adding reflective films to the window panes, providing shading devices and designing and constructing a well-insulated, airtight building envelope.



## Life expectancy

The typical life expectancy of a two-pipe fan coil is 30 to 35 years. During this period, fan motors or valve actuators may have to be replaced; however, all components are easily accessed through the front panel and tend to be common, readily available parts.

This technology has been utilized for decades and is well proven to be a simple, reliable system. Advances in motor technology (for example, DC motors), variable-speed pumping and boiler technology continue to reduce the energy consumption of two-pipe systems.



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