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Dual Temperature Systems / 2-PIPE vs. 4-PIPE What They Are, Challenges, and Optimization Opportunities

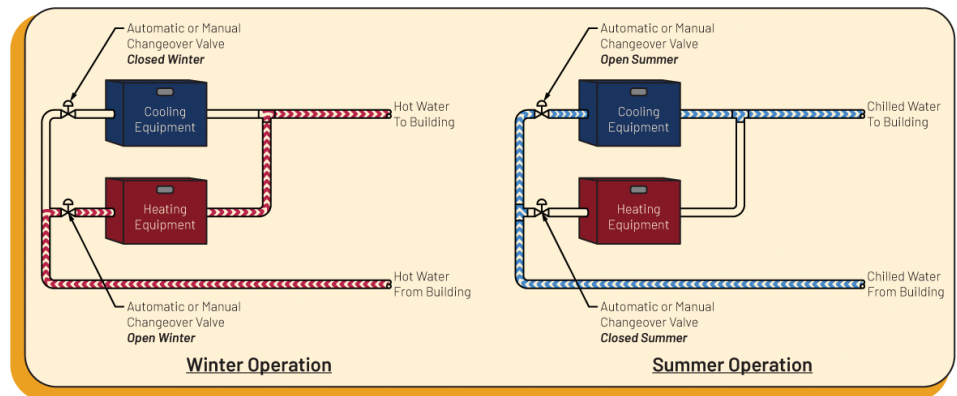
It is common for large buildings to circulate water through a building to distribute heating and cooling energy as water has the capacity to store and transport energy while using a minimal amount of space. Systems that use water to distribute heating and / or cooling energy are referred to as hydronic systems. Hydronic systems are quite common throughout large buildings and campuses as they are an efficient and cost effective way to provide centralized heating and cooling at scale.

A typical residential unit within a high-rise condominium may use a fan coil unit to provide heating and cooling to the space. A typical fan coil unit may include a blower, a hydronic heating coil, and a hydronic cooling coil. A fan coil unit with separate heating and cooling coils is served by four (4) pipes to deliver the hot water and chilled water (hot water supply, hot water return, chilled water supply, and chilled water return).

Having separate piping systems for heating and cooling does provide more flexibility at the room level (the occupant can decide whether they want heating or cooling). However, installing another pair of pipes, installing fan coil units and other ventilation equipment with more than one (1) coil to transport thermal energy can require millions of dollars of additional development investment and can occupy otherwise useable space throughout the building. Dual temperature systems utilize only two (2) pipes to deliver both heating and cooling energy from centralized pumping systems within the building.

In dual temperature systems, central valves and equipment are adjusted to send hot water or

2-Pipe System ↘



chilled water through the hydronic distribution piping. This arrangement requires that the decision to make heating or cooling available is made by the entire building as a whole in lieu of being made by the individual occupants.

Although dual temperature systems have some limitations, there are some notable benefits.

Dual temperature systems provide significant maintenance and future replacement cost savings (a typical line item in reserve studies) as only one coil is typically required for all heating and air conditioning equipment and the amount of piping required for heating and cooling is reduced by nearly 50%. Lastly, there are typically ongoing energy savings resulting from the system being unable to switch immediately to heating or cooling, as the heating and cooling equipment does not have to operate year round. This allows the thermal energy

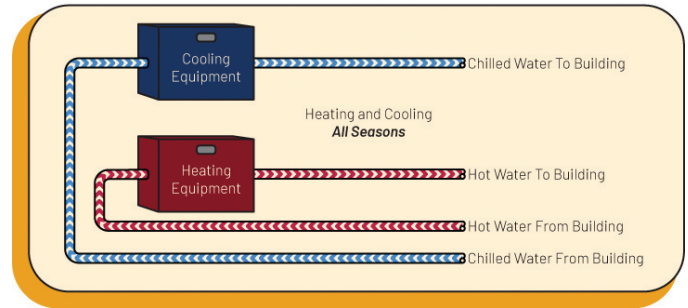
stored within the building structure to partially offset heating and cooling needs during outdoor air temperature fluctuations. For the reasons mentioned above, dual temperature systems have been a common system choice for owners and engineers over the past 50+ years as they have strived to balance comfort needs and construction budgets.

Challenges

Although dual temperature systems provide benefits including reductions in installation cost, energy consumption, and pipe space requirements, dual temperature systems do have some unique challenges.

Since a dual temperature system can only be in heating or cooling at any given time, optimized comfort control may be temporarily unavailable when desired. Meeting the comfort demands of all

4-Pipe System ↘



occupants can be particularly challenging during the shoulder season when the outdoor air temperatures swing between warm and cool weather over the course of a short period. It is common to have cooling requests from one side of a building due to solar exposure, while the opposite side (often the north side) is in the shade and is requesting heating. Additionally, when the system is changing between heating and cooling modes, the system is often temporarily unavailable to provide useful space conditioning. The length of time required to changeover a building is unique to each building and is determined over time through trial and error by building engineering staff and the mechanical service contractors. Typically, on a transition from heating to cooling, the dual temperature system is passively cooled by circulating water with the heat source shut off. As outdoor air temperatures rise, the passive cooling within the dual temperature loop takes an increasing amount of time. Typically, the reverse is true on a transition from cooling to heating. The dual temperature loop is typically warmed to a neutral water temperature by shutting down the cooling source and circulating water through the building.

Lastly, the changeover process has risks associated with it. It is possible to perform the changeover process too quickly, resulting in equipment damage and costly repairs. For example, it is critical that the dual temperature loop is sufficiently cooled prior to flowing water through cooling equipment. If the water is too warm, the refrigerant within a chiller can over pressurize and be released. If the temperature of the dual temperature loop is too cool, the thermal shock can damage some boiler models. Additionally, for some buildings, there are known risks of leaks when the piping expands or contracts too quickly.

These risks are mitigated by knowledgeable building engineering staff, knowledgeable service contractors, and proper training on the system. As the building engineers are most familiar with the unique changeover risks associated with the building, it is critical that building ownership and management respects the decision of the building engineer regarding when it is appropriate to change over the building between heating and cooling operation to avoid costly repairs.

Dual Temperature System Changeover Control Types

There are three main types of dual temperature control types: fully manual, manual with BAS assist, and fully automatic.

The first and most common control type for dual temperature systems is “Fully Manual”. A dual temperature system that is fully manual has valves and / or pumps used for the changeover process that are only operated by hand. A building engineer for this type of system monitors weather and upcoming forecasts to predict the need to change the building over. Changeover expectations do vary from building to building. Some buildings will typically only changeover twice per year (late spring and late fall). While other buildings do have more frequent changeovers during shoulder season months.

The 2nd control type for dual temperature systems is “Manual with BAS Assist”. This control method still relies on the building engineer to make the decision when to switch over the building. However, the main advantage here is that it is possible for the building engineer to make remote adjustments. This can become beneficial for some buildings where the changeover period extends past normal business hours.

The 3rd and final control type for dual temperature systems is “Fully Automatic”. A “Fully Automatic” dual temperature system automatically monitors weather conditions and makes decisions regarding whether to switch the building to heating or cooling without user input. Although a “Fully Automatic” dual temperature system can prevent issues that could result from user error, a “Fully Automatic” system must be thoughtfully designed and thoroughly tested to mitigate the potential issues discussed earlier in this article.

Optimization Opportunities

Whenever planning for future mechanical upgrades it is important to understand the existing mechanical systems that are in place and the impact they have on future decision making.

Converting a system from dual temperature to (4) four pipe may be desired in some situations to provide more individualized control. Some buildings may desire to convert the dual temperature system from “Fully Manual” control to “Manual with BAS Assist” or “Fully Automatic” as mentioned earlier. For some buildings, the changeover process is much longer than they would like it to be

and building ownership may desire to reduce changeover time. The feasibility of the possible upgrades referenced above can be evaluated by a qualified engineering professional.

Summary

Dual temperature systems are common with their own unique benefits and drawbacks. It is important for property managers to understand the limitations of dual temperature systems so that comfort expectations can be properly communicated to building occupants. It is also important for ownership and management to respect the building engineer’s decision regarding how often and how quickly to changeover the system between heating and cooling. Due to the economics and practicality associated with dual temperature systems, it is anticipated that the use of dual temperature systems will continue far into the future as new technologies emerge. 🍃

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