

By-pass Blending Station-An Innovative Secondary In-Build Pump System for District Heating and Cooling Systems

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Since 1984, district heating and cooling has made a comeback the United States. Many new district heating and cooling systems have been established and existing systems have been expanded in recent years. Industry and government agree that cooling, heating, and power (CHP) systems are critical components of the future electric grid. It has been recently projected that eight gigawatts will be installed in the states by 2020. Many more existing and new buildings are likely to receive chilled water and/or hot water from future district systems

The construction costs of pipe systems and the pump energy costs are significant for district heating and cooling systems. As a result, these systems require a large temperature difference between supply and return, as well as constant return water temperature under all load conditions, to minimize the initial construction and operation costs. The chilled water return temperature is typically designed 17°F (9.4°C) higher than the supply water temperature. However, the cooling coils in air-handling units (AHUs) are often designed to increase the supply water temperature by 10°F (5.6°C) or 12°F (6.7°C). When the district chilled water is directly supplied to the cooling coil, the building return water temperature is often significantly lower than the value required by the district plant. To maintain the district system required return water temperature, the district water has to be mixed with the building return water before being sent to the building systems.

Even when the building end users are designed with the same temperature rise or drop as the district systems, mixing of the primary water and the building return water may also be required to maintain the constant return water temperature under partial load conditions. Under partial load conditions, the entering and leaving coil air conditions vary with building load, outside air condition, outside air requirement, entering water conditions, and coil heat transfer characteristics. For variable water flow systems, both

the entering water temperature and water flow rate are often required to be modulated according to actual air conditions and heat transfer principles to maintain constant return water temperature. For constant water flow system, the entering water temperature must be modulated.

To ensure constant return water temperature, it has been recommended to use secondary in-build pump system for district heating and cooling systems.. A building circulation pump is installed to draw water from the district supply line. A by-pass is installed to connect the building return back to the building pump suction side. This design has two drawbacks: (1) the pump design flow must be the same as the total building flow although the return water flow for mixing is much less than the total water flow, and (2) the pump will have to provide the entire head required by the water circulation in the building loop, although the primary loop may have the required differential pressure available.

It has been mentioned that “in some cases, the pressure of the distribution system may cause flow through the in-building system without in-building pumping.” However, there has been no rejection of in-build pump systems even when the district systems have sufficient pump head for in-building systems. Indeed, eliminating in-build pumping will not result in maintaining constant return water temperature under partial load conditions, and may result in significant low return temperature penalty for building owners. Based on scientific observations, in-build pumps are used regardless of the available district pump head at the building entrances. In many cases, retrofits have been performed to reduce the building entrance pipe sizes to overcome “excessive” district system pressure heads.

An innovative secondary in-build pump system called the By-pass blending station (BBS) has been developed to reduce building pump energy consumption and maintain the desired return water temperatures in district heating and cooling systems where systems provide sufficient pump head for in-building water circulation. The BBS can be used in both constant and variable flow secondary systems. Research has found that the BBS has lower initial cost than the in-build secondary pump system, and the BBS system annual

pump energy consumption is often less than half of the in-build secondary pump system. The BBS only applies to cases where the primary distribution systems provide sufficient pump head for in-building circulation, typically found in commercial district cooling and heating systems.