Optimizing Coil Loop Energy Recovery Systems

"Optimizing Coil Loop Energy Recovery Systems" by Gene Nelson, P.E., Life Member ASHRAE, in November 2021's *ASHRAE Journal* provides comprehensive design requirements for an energy recovery system. A few thoughts:

1. In our area propylene glycol is demanded by the owners to provide a level of personnel safety and allow disposal through conventional drains; ethylene glycol is not allowed in conventional drains. This use of propylene glycol will probably be universally required in all HVAC systems in the future.

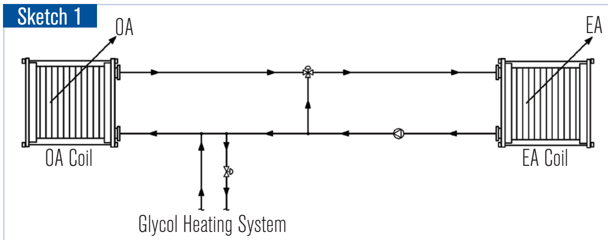
2. The design standard commonly used in our area for air-handling (AHU) units, whether roof mounted or indoors, is to use a 50% propylene glycol solution for all heating coils, whether energy recovery or traditional heating. The common design outside air temperature used is –35°F and farther north is –40°F.

3. Where multiple coil sections are used in a coil configuration, it needs to be emphasized the coil sections need to piped in reverse return to minimize the flow differences between coil sections, particularly when a variable frequency drive (VFD) is applied to the pump.

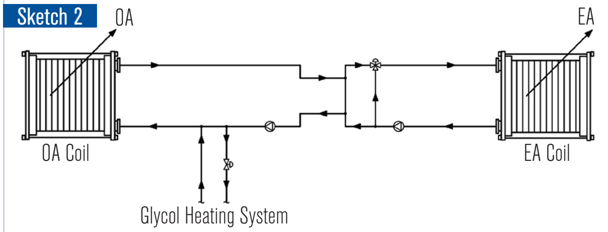
4. A quality coil manufacturer's selection program should be used; some very good programs are available that allow selections based on varying the tube size, tube thickness, circuiting, spacing of fins, fin size, fin type, pressure drop, etc., to maximize the effectiveness and minimize the overall pressure drop and flow requirements on the air and fluid side of the coils.

5. In Figure 3 of the article, a connection to the heating glycol system can be provided, as per Sketch 1, to assist in frost control and maximize the energy transfer at any time. Since glycol solutions are used in AHU units in this area, it is not a major issue to provide this additional connection. The essence of control is to have the three-way valve operate to at least at 95% i.e., full flow through both coils; if it drops lower than 95%, inject heat from the heating system to keep the valve to at least 95%. This ensures a consistent flow in both coil circuits.

Sketch 1



Sketch 2



In VAV systems the dynamics of performance will change, and this additional source of heat will assist in effective frost control and overall heat transfer at all volumes and outside air temperatures. The additional logic in the digital controller is not complex.

6. Per Sketch 2 an option is to add a second pump so each coil can be optimally selected. The coils may be of different physical sizes and the selected coils may have different pressure drop requirements to maximize the heat transfer and design airflow temperatures. Keeping constant flow in each coil eliminates laminar flow and optimizes the coil performance. As well there will not be an issue with variable flow in the individual coil selections in a coil with multiple sections.

The addition of a second pump is not a major additional cost compared to the overall total cost of the energy recovery system. With digital controls the addition of a heating injection valve only requires simple additional basic logic. The logic for control of the valves is the same as in point 5 of this letter. In addition, during unoccupied modes when there is no airflow, the coil in the outside air intake can be kept at a nominal temperature by running the pump in the outside air coil and managing the two-way valve.

The author states the glycol solution should not be more than 30%; based on a common supplier's chart, this only provides a nominal freezing temperature of about 10°F and a burst temperature of about –10°F. In our climate with a design of –35°F, this level of protection is insufficient.

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The Author Responds

Thank you for your additional insights on practical applications in extreme cold weather conditions. Using propylene glycol (PG) is safer but requires much higher flow rates than ethylene glycol (EG) solutions to maintain transitional flow. Designers need to educate owners/code authorities on risks/rewards of selecting the proper working fluid. Additional safeguards (double walled pipe in concealed areas and leak detection) may be required for safe use of EG.

The design standard of using 50% PG for freeze protection down to –40°F may be too conservative. Most glycol manufacturers' published data indicate burst protection concentrations of 36.6% for PG and 31.4% for EG at –50°F ambient conditions.

Using reverse return piping for multiple coils is a good provided that the costs of piping is not too excessive. Direct return piping can be used if the system is properly balanced using balancing valves.

I agree that some selection programs are better than others. Good selection programs have options to vary the construction parameters as suggested and provide good selection information such as tube velocity, heat transfer surface area, U-factor, log mean temperature difference and Reynolds numbers.

Sketches 1 and 2 offer an interesting idea to maintain the lowest possible fluid temperatures to avoid frost and maximize heat transfer in both supply and exhaust coils. Both options increase the supply coil's flow and Reynolds number. Don't use the supply coil to raise the supply temperature to design setpoint, as this will increase the fluid temperature to the exhaust coil and decrease the amount of energy recovered. A heating coil downstream of the supply energy recovery coil should still be used for both sketches.

My comment regarding limiting PG to 30% with a burst protection of –10°F is appropriate for most climates but not for –35°F design conditions as you stated. The comment was intended to point out that high concentrations of PG require tube velocities higher than 6 fps as shown in Table 2. I would recommend using the lowest concentration possible (35% EG or 40% PG) and limit tube velocities to 6 fps for these extreme cold conditions.

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