Coil loop for exhaust-air energy recovery

TIP

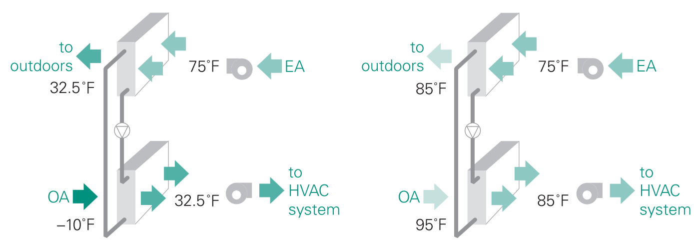
Devices (including total-energy wheels and heat pipes) other than the coil loop described here can exchange sensible and/or latent heat for energy recovery.

An exhaust-air energy-recovery system can reduce utility costs by capturing and using energy that would normally be lost to the exhaust air stream.

A coil loop can be applied either to the primary supply-air system or to independent systems such as the dedicated ventilation system that serves a laboratory. The effectiveness of the coil loop typically ranges from 45 percent to 60 percent for recovering sensible heat.

Figure 4–2 illustrates how the coil loop works. During the heating season (Inset A), heat extracted from the exhaust air stream (EA) warms the air brought into the building. Operation of the coil loop is limited to prevent the supply-air temperature from exceeding the cooling set point. (This condition is most likely to occur on mild days during the spring and fall.) Preconditioning the outdoor air (OA) in this manner reduces the heating load, which in turn reduces the energy consumption of the HVAC system.

Figure 4–2 Operating modes for coil-loop energy recovery



$$\text{efficiency} = \frac{32.5 - -10}{75 - -10} = 50\%$$

Inset A • winter operation

$$\text{efficiency} = \frac{95 - 85}{95 - 75} = 50\%$$

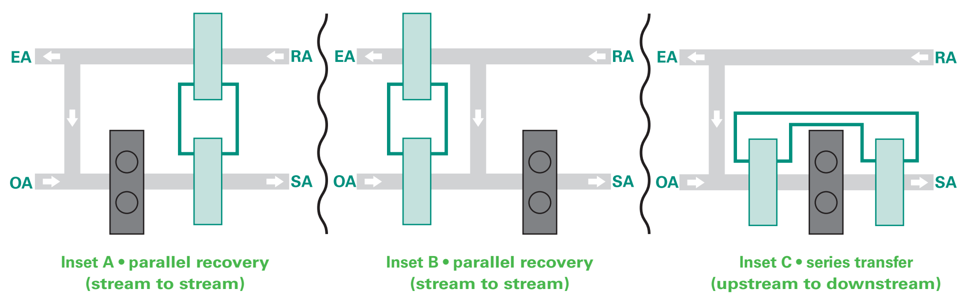
Inset B • summer operation

Coil-loop operation reverses during the cooling season (Inset B). Sensible heat is extracted from the air brought into the building and is rejected to the cooler and drier exhaust air stream. This time, preconditioning by the coil loop reduces the cooling load and, in turn, the energy consumption of the HVAC system.

A coil loop—also called a *coil runaround loop*—consists of two or more finned-tube coils that are piped together in a closed loop. A small pump circulates the working fluid (usually a solution of inhibited glycol and water) through the two coils. An expansion tank and a means for modulating capacity, either a three-way mixing valve or a variable-frequency drive on the pump, complete this energy-recovery device.

Figure 4–3, and Figure 4–4 on page 4–10, show the typical arrangements for sensible-heat recovery in mixed-air and dedicated ventilation systems. In Figure 4–3, which shows mixed-air systems, sensible-heat recovery can be used to reheat the dehumidified supply air for independent control of both temperature and humidity (Insets A and C), or to precondition the outdoor air (Insets B and C).

Figure 4–3 Mixed-air arrangements



In Figure 4–4 on page 4–10, which shows dedicated ventilation systems, sensible-heat recovery is often used to reheat the dehumidified outdoor air (Insets A and C), or to precondition the outdoor air (Insets B and C). Insets A and C are typically used with systems that deliver dehumidified outdoor air at a *neutral* dry-bulb temperature.

Each of the arrangements in Figure 4–3 and Figure 4–4 can be modeled using TRACE 700. However, only the arrangement shown in Figure 4–4, Inset C, will be covered in this discussion of coil-loop energy recovery. For arrangements other than this one, select the appropriate energy-recovery configuration (similar to step 2 in this example) and refer to the following:

Figure 4–4 Dedicated ventilation arrangements

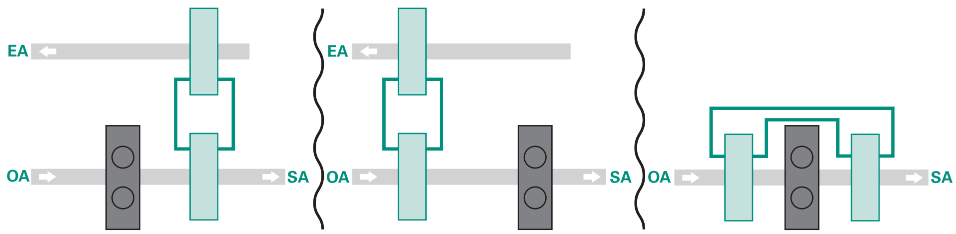


Figure 4–3:

- for *Inset A*, refer to steps 1 through 6 in "Fixed-plate heat exchanger" on page 4–21
- for *Inset B*, refer to steps 1 through 6 in "Total-energy (enthalpy) wheel" on page 4–15
- for *Inset C*, refer to steps 1 through 6 in "Heat pipe" on page 4–27

Figure 4–4:

- for *Inset A*, refer to steps 1 through 6 in "Sensible wheel" on page 4–34
- for *Inset B*, refer to steps 1 through 6 in "Total-energy (enthalpy) wheel" on page 4–15

Application considerations

- Coil-loop energy recovery increases the static pressure on both sides of the air-distribution system—supply and exhaust. Contact the manufacturers of the heat-exchange devices for estimated pressure drops.
- Unlike other types of exhaust-air energy recovery, a coil-loop recovery system does *not* require close proximity of the exhaust, supply, or makeup air streams. It can recover heat from diverse exhaust locations scattered throughout the building.

Related reading

- "Air-to-Air Energy Recovery," *Engineers Newsletter* (volume 29, number 5)
- *Air-to-Air Energy Recovery in HVAC Systems* Applications Engineering Manual (Trane literature number SYS-APM003-EN)

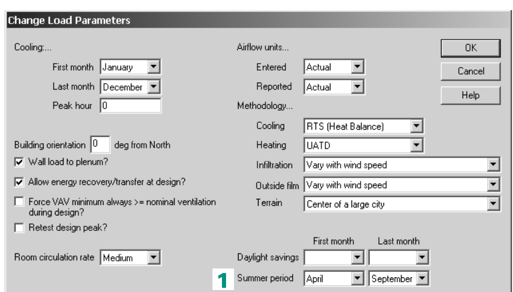
Sample scenario

To input the type of heat recovery in Figure 4–4, Inset C, we will model an office building with a dedicated ventilation unit (makeup-air unit) that dehumidifies the outdoor air, and then reheats the air to a room *neutral* dry-bulb temperature before the air is delivered directly to the space. Water-source heat-pump (WSHP) units are installed in the ceiling plenum above each room and handle the cooling and heating needs for the rooms. To reduce the amount of reheat energy needed, and to increase the dehumidification capacity of the cooling coil in the dedicated ventilation unit, a coil loop is used to precool the outdoor air stream *before* it enters the optional ventilation-unit cooling coil, and then reheat the dehumidified outdoor air *after* it leaves the optional ventilation-unit cooling coil.

Note: For details on modeling the WSHP portion of the system, refer to "Water-source heat-pump system" on page 3–68. For details on modeling the Dedicated Ventilation Unit portion of the system, refer to "Dedicated outdoor-air systems" on page 4–45.

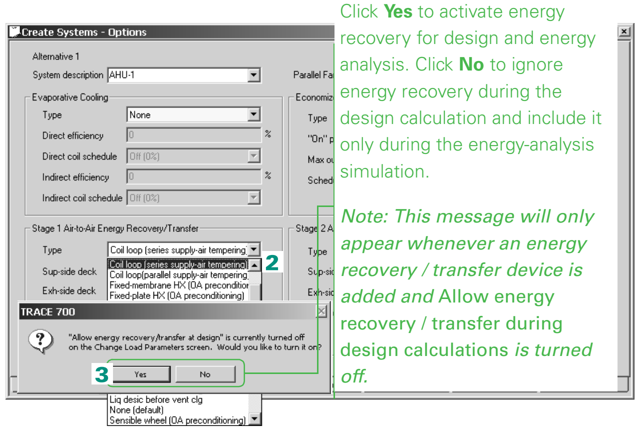
To model the coil-loop scenario:

1 On the **Actions** list, select **Change Load Parameters** and define the **first month** and **last month** of the summer (cooling) season. These entries help determine when the energy recovery / transfer device provides cooling rather than heating.



2 After defining the system, click the **Options** tab and select the desired air-to-air energy recovery / transfer type, which determines the type of energy recovery / transfer and the basic configuration. In this case, **Coil loop (series supply-air tempering)**.

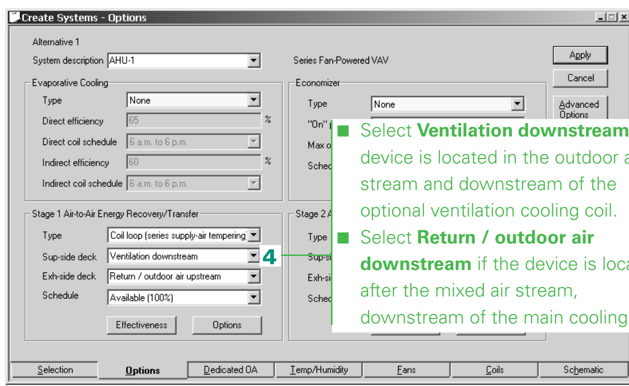
3 A message will appear that asks whether the user wants to account for energy recovery / transfer during the design and energy analysis simulations or only during the energy analysis simulation. Select **Yes** for this example.



Click **Yes** to activate energy recovery for design and energy analysis. Click **No** to ignore energy recovery during the design calculation and include it only during the energy-analysis simulation.

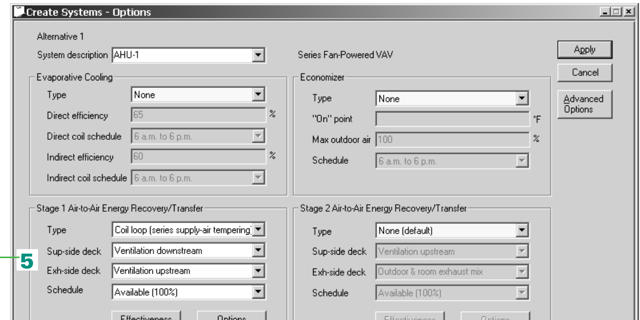
Note: This message will only appear whenever an energy recovery / transfer device is added and Allow energy recovery / transfer during design calculations *is turned off.*

4 Select the appropriate supply-side deck for the device. For this example, **Ventilation downstream** will be selected as the supply-side deck. The coil loop will be used to reheat the ventilation air downstream of the optional ventilation cooling coil.



- Select **Ventilation downstream** if the device is located in the outdoor air stream and downstream of the optional ventilation cooling coil.
- Select **Return / outdoor air downstream** if the device is located after the mixed air stream, downstream of the main cooling coil.

5 Select the exhaust-side deck for the device. In this case, **Ventilation upstream** will be selected as the exhaust-side deck. The coil loop will be used to precool the ventilation air upstream of the optional ventilation cooling coil.

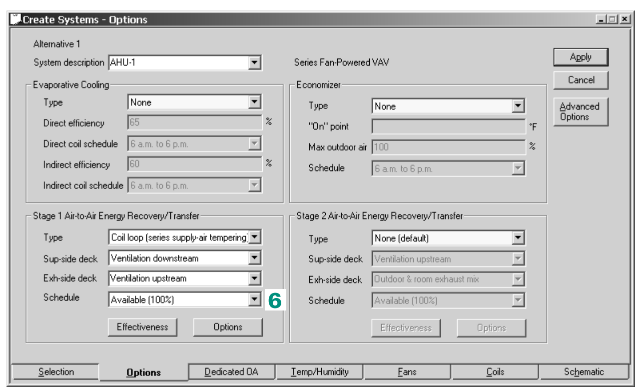


- Select **Return / outdoor air upstream** if the mixed air stream (recirculated return air—after room exhaust and system exhaust—plus the ventilation) is used as the exhaust side.
- Select **Ventilation upstream** if the outdoor air, before it enters the make-up air (dedicated ventilation) unit, is going to be used as the exhaust side. This selection should only be used in combination with a make-up air unit. In this case, **Ventilation upstream** will be selected as the exhaust-side deck. The coil loop will be used to precool the ventilation air upstream of the optional ventilation cooling coil.

Note: If the proper airstreams are not selected for supply-side and exhaust-side decks of the energy recovery/transfer device, then the unit will not function correctly or may not function at all.

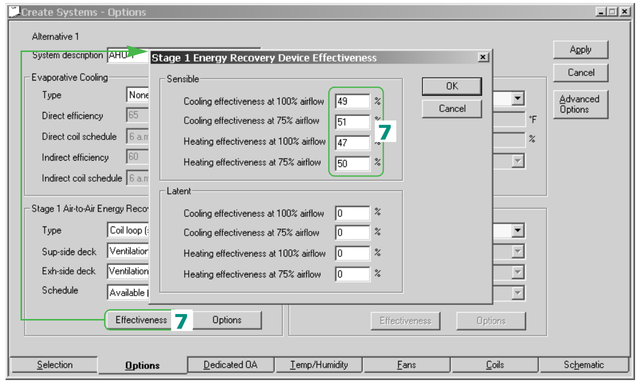
Note: If both stage 1 and stage 2 energy recovery/transfer devices are given the same exhaust-side deck, then stage 1 will be upstream of stage 2.

6 Choose the schedule that describes when the coil loop is permitted to operate. The schedule **Available 100%** will allow the device to operate year-round.



7 Input the coil-loop effectiveness (essentially how efficiently the coil loop recovers energy) by clicking **Effectiveness** and entering the sensible effectiveness percentages at different airflows. Click **OK** and then click **Apply** when finished.

Note: To further refine the model of the energy-recovery device, the **Options** *button on the* **Options** *tab can be used to define such items as parasitic energy consumers (such as the pump in this example), static pressure drop, bypass dampers, part load controls, economizer lockout, and frost prevention.*



Note: Cooling Effectiveness *refers to supply-side ARI entering conditions at 95°F dry bulb / 78°F wet bulb and exhaust-side air entering at 75°F dry bulb / 63°F wet bulb.* Heating Effectiveness *refers to supply-side ARI entering conditions at 35°F dry bulb / 33°F wet bulb and exhaust-side air entering at 70°F dry bulb / 58°F wet bulb.*

Additional Item

1 When adding a coil loop to an airside system, it is recommended that the minimum and maximum cooling supply-air dry bulbs be set equal to each other to fix the value for the cooling supply-air dry bulb. This is suggested because TRACE 700 cannot psychrometrically solve for the cooling supply-air dry bulb when an energy recovery / transfer device is attached to the Return/ Outdoor deck. Please read the **FAQ** and **Oversizing and Undersizing** sections of the manual for the ramifications of fixing a cooling supply-air dry bulb.