Exhaust air heat recovery systems have been used extensively for many years to reduce energy costs in commercial facilities. This Technology Update describes the available systems, discusses their advantages and disadvantages, explains when such systems are economically viable, and lists potential applications.

System Types

There are various types of exhaust air heat recovery (EAHR) systems: run-around closed loop, heat wheel, passive refrigerant, air-to-air, and exhaust recirculation. Each has its advantages and disadvantages. All of the systems described here (except exhaust recirculation) are based on the principle that heat naturally flows from warm matter to cool matter. The systems described below can both preheat ventilation air in the winter and precool ventilation air in the summer. Each of the systems will add to the static pressure loss of air distribution systems and may require larger exhaust and ventilation fans.

Run-Around Closed Loop

This system consists of a recovery coil in the exhaust air stream connected to a preheat coil in the outside (ventilation) air stream (Figure 1). A pump circulates a water/glycol solution between the two coils. Warm return air passes over the recovery coil, the glycol solution picks up the heat, the solution is pumped to the preheat coil, and the heat is

![Figure 1. Run-around heat recovery system with glycol loop](image-url)
transferred to the cool ventilation air stream. Then the pump circulates the cool solution back to the exhaust side to repeat the cycle.

Advantages:
- Can recover heat from a remote exhaust location.
- Exhaust and ventilation air streams are isolated (i.e., no chance of cross contamination).

Disadvantages:
- Installation of piping between remotely located coils is costly.
- Greater separation between exhaust and ventilation decreases efficiency of heat recovery.

**Heat Wheel**

A heat wheel is mounted with half of the wheel in the exhaust duct and half in the supply air duct (Figure 2). The wheel’s axle splits the two ducts. The wheel can be 1 to 10 feet in diameter and 6 to 30 inches thick.

The material that makes up the wheel is the heat exchange surface. The wheel can be filled with shredded metal (like a pot scrubber), shredded plastic, or corrugated paper fiber (like cardboard). Many modern wheels have a corrugated plastic sheet wrapped around the axle to form passages through the depth of the wheel.

The wheel rotates slowly through the two air streams. As warm exhaust air passes through the wheel’s material, heat is transferred from the air to the material. As the wheel rotates around to the ventilation side, this heat is transferred from the material to the cool ventilation air.

Some heat wheels contain a desiccant material that transfers moisture between the air streams as well as heat. In areas with warm, humid summers, this can reduce the latent load on air conditioning systems. In areas with cold, dry winters, this effectively increases the humidity inside the building without expending additional energy.

Advantages:
- Cost is reasonably low.
- New exchanger cores are relatively easy to clean.
- Recovers heat efficiently.

Disadvantages:
- Exhaust and ventilation ducts must be physically adjacent.
- Some cross contamination does occur, which may limit applications in hospitals, health care facilities, bathrooms, and research facilities.
- The wheel is somewhat more susceptible to clogging than that in the run-around system. Although modern core materials are fairly durable and much easier to clean than their older counterparts, they can be maintenance intensive or require additional filtering. Therefore, this system should not be used for kitchen range hood exhaust.
- More space height may be required for installation than for other EAHR system types.

**Passive Refrigerant**

This system consists of two attached chambers, one located in the exhaust air duct and one in the ventilation air duct. One of the chambers contains a liquid refrigerant that passively transfers heat (energy) from exhaust air to ventilation air. The process starts as exhaust air passes over the chamber containing the liquid refrigerant. The refrigerant absorbs heat and vaporizes, rising into the chamber in the ventila-
tion air stream. The cooler ventilation air removes the heat from the refrigerant. Then the refrigerant condenses and returns to the exhaust air chamber to repeat the cycle.

**Advantages:**
- Requires no pumps, motors, or compressors.
- Easy to maintain and keep clean.

**Disadvantages:**
- Exhaust and ventilation ducts must be physically adjacent.
- Cost is somewhat higher than other EAHR system types.
- Will not work at low differential temperatures.

**Air-to-Air**

This system transfers energy through a crossover grid or through plate heat exchangers made of metal or plastic (Figure 3). Warm air passing between the plates transfers its energy by conduction through the material to another grid or plate where the air is warmed. The plates form alternating exhaust and ventilation air pathways.

**Advantages:**
- Cross contamination between ducts is minimal (if any).
- Requires no liquid or pumps.
- Most systems are relatively easy to clean and maintain.

**Disadvantages:**
- Exhaust and ventilation ducts must be physically adjacent.

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**Exhaust Recirculation**

This system recirculates most of the exhausted air back into the space after filtering it, eliminating the need to exhaust air. Although it does not eliminate minimum ventilation air requirements, it may reduce them. This system is best used in areas where large amounts of particulates must be removed from the exhaust air stream, such as wood or metal shops, high smoking areas, and welding shops. These areas would otherwise require substantial rates of exhaust and ventilation air.

**Advantages:**
- Eliminates energy waste by recirculating rather than exhausting warm air.
- Provides higher efficiency than exhaust systems.

**Disadvantages:**
- May not be able to remove gaseous contaminants from the air stream.
- Requires regular maintenance.

**Efficiency**

Efficiencies (also referred to as effectiveness) of these systems vary from around 50 to 75 percent and sometimes higher. That is, they recover about 50 to 70 percent of
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the energy that would otherwise be wasted. The efficiency of each system varies widely, depending on size, duct work layout, equipment type, and inside and outside air temperatures.

Economics

The conditions generally necessary for an EAHR system to be economically viable are the following:

High Volume. To make EAHR pay off you need to operate a volume of about 3,000 CFM of exhaust air (at one point) for 8 hours per day or more.

Cold Climate. Given the same operating conditions; EAHR will save more money in colder climates than in milder climates. Without EAHR, more fuel is used in colder climates than in milder climates, because the ventilation air must be heated. Since EAHR decreases the need for this energy, you will see a greater difference in your heating bills when the weather is cold.

Expensive Heating Fuel. EAHR is most economical when it displaces the need for expensive heating fuels, such as fuel oil and electricity, rather than less expensive fuels, such as natural gas.

Applications

Common applications for EAHR include the following:

- Facilities that require 100 percent outside ventilation, such as hospitals, health care facilities, and research facilities

- Facilities that require large exhaust air volume flow rates, such as light industrial facilities, kitchens, and natatoriums (swimming pools)

- Facilities in which large amounts of airborne particulates are produced that would otherwise require substantial rates of exhaust and ventilation air, such as wood or metal shops, high smoking areas, and welding shops