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5.3.1 Heat-Recovery Water Heating

Heat recovery is the capture of energy contained in fluids or gases that would otherwise be lost from a facility. Heat sources may include heat pumps, chillers, steam condensate lines, hot air associated with kitchen and laundry facilities, power-generation equipment (such as microturbines or fuel cells), and wastewater drain lines.

Opportunities

There are two basic requirements for heat-recovery water heating: (1) hot water demand must be great enough to justify equipment and maintenance costs, and (2) the waste heat temperature must be high enough to serve as a useful heat source. Large facilities such as hospitals and military bases often have the perfect mix of waste heat and demand for hot water to effectively use waste-heat-recovery systems for water heating. Consider heat-recovery water heating whenever adding or replacing large heating or air-conditioning equipment. For example, double-bundle chillers can easily provide for the recovery of heat normally lost to a cooling tower. The simplest heat-recovery water preheaters can even work with small commercial kitchens and housing units.

Technical Information

How waste heat is captured and utilized depend upon the temperature of the waste heat source. Where water temperature of 140–180°F (60–82°C) is required, waste heat sources with higher temperatures should be used. Lower-temperature sources, such as hot kitchen air or drainline water, may require mechanical systems to concentrate the heat or supplemental heating using another fuel (i.e., the waste heat serving to *preheat* the water).

Hot gas heat exchangers. The refrigeration cycle of an air conditioner or heat pump provides an opportunity to recover heat for water heating. HVAC compressors concentrate heat by compressing a gaseous refrigerant. The resultant superheated gas is normally pumped to a condenser for heat rejection. However, a hot-gas-to-water heat exchanger may be placed into the refrigerant line between the compressor and condenser coils to capture a portion of the rejected heat. In this system, water is looped between the water storage tank and the heat exchanger when the HVAC system is on. Heat pumps operating in the heating mode do not have waste heat because the hot gas is used for space heating. However, the heat pump system can still heat water more efficiently than electric resistance heating.

Double-bundle condensers. Some chillers have condensers that make it possible to heat water with waste heat recovery. Double-bundle condensers contain two sets of water tubes bundled within the condenser shell. Heat is rejected from the system by releasing superheated gas into the shell and removing heat as the refrigerant condenses by one of two methods. During the heating season, water pumped through the "winter bundle" absorbs heat that can be used for water heating or heating the perimeter of the building. During the cooling season, water pumped through the "summer bundle" rejects heat to the cooling tower after hot water needs are met.

Heat from engines. Heat exchangers can be placed on exhausts of reciprocating engines and gas turbines to capture heat for water heating or steam generation. Water jackets may also be placed on engines in order to capture heat from the engine and exhaust in series. Some of this equipment also acts as a silencer to replace or supplement noise-reduction equipment needed to meet noise-control requirements. Systems for domestic heating are unpressurized, but temperatures above 210°F (99°C) are possible with pressurized systems. Designers must be careful that the pressure drop is less than the back pressure allowed by the engine manufacturer.

Waste heat from electrical power generation can also be used for water heating. With fuel cells and microturbines beginning to be used for distributed power generation in buildings, for example, there are opportunities to recover the waste heat. See *Section 5.8.8 – Combined Heat and Power*.

Heat from boiler flues. Hot flue gases from boilers can provide a source of waste heat for a variety of uses. The most common use is for preheating boiler feed water. Heat exchangers used in flues must be constructed to withstand the highly corrosive nature of cooled flue gases.

Source: WaterFilm Energy, Inc.

The gravity film exchange (GFX) drainline heat exchangers —technology developed under a DOE grant—make sense in facilities with significant water heating loads, such as kitchens, laundromats, prisons, and military barracks. The system shown above is being installed in a hotel.

Steam condensate heat exchangers. Buildings with steam systems for space heating or kitchen facilities may recover some of the heat contained in hot condensate. Condensate is continuously formed in steam systems when steam loses heat in the distribution lines or when it performs work. A condensate receiver reduces steam to atmospheric pressure to allow reintroduction into the boiler. Condensate heat for heating water can be captured by a heat exchanger located in the condensate return before the receiver.

Heat pump water heaters. Rooms containing laundries and food preparation facilities are often extremely hot and uncomfortable for staff. Heat from the air can be captured for heating water by using a dedicated heat pump that mechanically concentrates the diffuse heat contained in the air. These systems are discussed in *Section 5.3 – Water Heating.*

Refrigeration equipment. Commercial refrigerators and freezers may be installed with condensing units at one location. This will enhance the economic feasibility of capturing heat from hot refrigerant gases for water heating.

Drainline heat recovery. Energy required to heat domestic water may be reduced by preheating with waste heat from drainlines. Kitchens and laundries offer the greatest opportunities for this type of heat recovery since water temperatures are fairly high and schedules are predictable. Drainline-heat-recovery systems can also work in group shower facilities (dormitories, barracks, prisons, etc.) and in residential housing units. The simplest such system has a coil of copper pipe wrapped tightly around a section of copper drainline. Cold water flowing to the water heater flows through this coil and is preheated whenever hot water is going down the drain. More complex systems with heat exchangers within the drainline must be designed to filter out waste materials or provide back-flushing to remove sediment that could cause clogging. It is also necessary to ensure that potable water is not fouled by the wastewater.

References

"Heat Exchangers in Aggressive Environments," Center for the Analysis and Dissemination of Demonstrated Energy Technologies (CADDET), Analysis Series #16, 1995.

Vasile, C. F., "Residential Waste Water Heat Recovery System: GFX," Center for the Analysis and Dissemination of Demonstrated Energy Technologies (CADDET), No. 4, December 1997.