Point-of-Use DHR Is Very Important in High Rise Buildings

Water heating system efficiency could vary from 58% to a "dismal" 12% in high rise buildings, according to the study discussed below from www.homeenergy.org/archive/hem.dis.anl.gov/eehem/97/970703.html. Fuel savings from a GFX installed at the ***point-of-use****, like those in the Troutdale Terrace Apartments and the Hilton Garden Inn, are therefore multiplied because the heat it recycles escapes distribution, stack, and standby losses. A system efficiency range of* ***12% to 58% means each Btu of waste heat recycled by GFX saves fuel-energy of 8.33 to 1.72 Btu****, respectively; with a large reduction in boiler loading and stack emissions.*

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TRENDS

Multifamily Research Gets in Hot Water

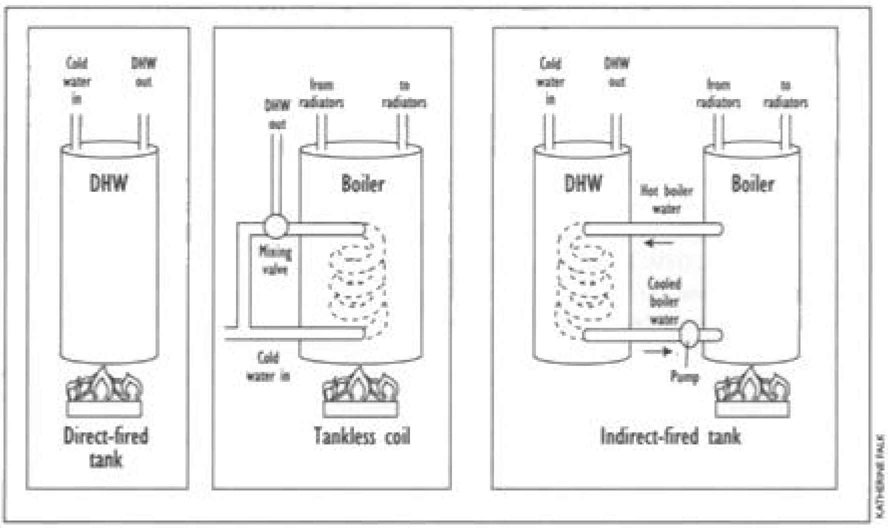

Figure 1. Three common multifamily water heating configurations are represented here. For the indirect-fired tank, the heat exchanger may be located in the tank as shown, or in the boiler. One other indirect-fired configuration involves the use of a dedicated boiler where the boiler water and the DHW are one and the same.

Many plumbing and heating designers have considered the tankless coil heating system to be the least efficient method of heating domestic hot water (DHW) in a multifamily building. These systems have been scorned largely because they require building boilers to be fired during summer months for the sole purpose of producing hot water. Nevertheless, the tankless coil has been one of the more popular systems used in New York City buildings, reflecting its low first cost and high reliability.

A recent study by the New York State Energy Research and Development Authority (NYSERDA) has demonstrated that the tankless coil is, in fact, slightly less efficient than two other common heating systems (the research was conducted by the EME Group and cofunded by Con Edison). The other two systems examined in the study were the direct-fired storage tank and the indirect-fired storage tank.

The direct-fired storage tank is a larger version of the water heater common to most detached homes across the country (see Figure 1). Indirect-fired tanks, which have been aggressively promoted but have found little use in single-family homes, consist of a boiler and a heavily insulated, nonfired storage tank. Water in these units is heated via a heat exchanger that is in the tank itself or in the boiler. Because of its extra capacity--the tank serves as a buffer during peak loads--the indirect unit can generally use a smaller boiler than a tankless coil.

The tankless coil is essentially a bundle of copper tubes situated inside a boiler. When there is a demand for DHW, cold water enters the coil, is heated by the boiler water to about 140°F-180°F, and is then mixed with cold water via a thermostatic tempering valve, typically down to a tap temperature of about 120°F.

Monthly Flip Flops

For the purpose of its evaluation, EME installed four DHW systems in two side-by-side buildings. Each building had a direct-fired tank. One building also had a tankless coil in the boiler, and the other had indirect-fired tanks fed by the boiler. The systems were alternated monthly--a flip-flop test-- over the course of a year. All systems were heavily instrumented and monitored at 15-minute intervals.

The data showed small differences in efficiency among the three systems. The system with the tankless coil was the least efficient of the three, with overall efficiency at 34% (meaning that 2 out of every 3 Btu that went into heating the water were wasted). In comparison, direct- and indirect-fired tanks were slightly more efficient, with overall efficiencies of 35% and 37%, respectively. When the added first cost of these other two systems was factored in, the simple payback from choosing either one over the tankless coil was approximately 25 years! (The difference in first cost between the tankless coil and other systems in this project ranged between $3,000 and $4,000.)

The small difference in efficiency is not surprising. Modern, well-insulated, low water-volume boilers, especially those large enough to serve multifamily buildings, have relatively low jacket and off-cycle losses. Equipped with a tankless coil, they can compete effectively against the other two systems.

Losses to Circulation

The low efficiencies reflect the significant impact of DHW recirculation. New York City code requires a recirculation line in any building where the DHW must travel more than 50 feet from the boiler, which effectively means any building that is four units or larger. NYSERDA's study showed that the energy of recirculation accounted for up to 20% of all DHW energy, reflecting the fact that most recirculation pipes in older buildings are buried behind walls and are uninsulated.

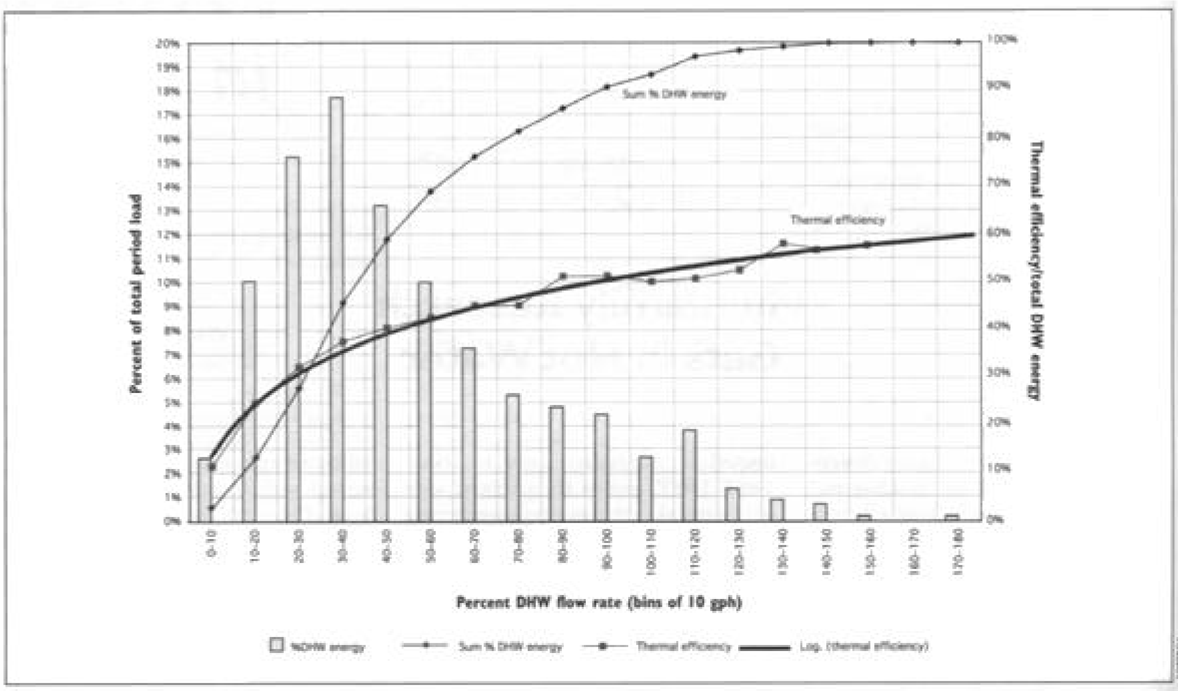

Figure 2. Distribution of DHW load with respect to flow rates. As shown in this graph, the direct-fired system was most efficient at high loads. At low-to-medium loads, the most frequent load type, efficiency was dismal.

Another interesting finding was the distribution of DHW flow. DHW systems are difficult to design and size, because of the wide range of flow from zero to peak demand. The DHW demand in the buildings ranged from 0 to 180 gallons per hour (gph). Of the total DHW flow, 70% was at 60 gph or less, 90% was at 100 gph or less, and the range of 120 to 180 gph represented a mere 2% of the total (see Figure 2).

Implications for Future System Design

As shown by the upper line on Figure 1, the direct-fired system, like the other systems, has higher thermal efficiency at higher loads--almost double the average. Unfortunately, this high efficiency is almost useless because it occurs during very brief periods. For example, at 140-150 gph, efficiency is about 58%; however, this load occurs less than 1% of the total period load. At low loads, such as 0-10 gph, efficiency is dismal (about 12%).

When developing new systems, designers should strive for higher efficiency at low loads. One approach would be to downsize the main boiler significantly, and install a small booster boiler that would come on only during peak DHW demand. Overall first cost would be similar, but the system would operate closer to the full capacity of the downsized boiler, and thus more efficiently. Several manufacturers currently market water heating systems that are energy efficient at low and high loads.

Recirculation line losses must also be addressed--even if the energy codes do not address them. Recirculation flow can be optimized and the temperature reduced during periods of low draw using demand-sensitive, temperature-reducing controls (see "Controlling Recirculation Loop Heat Losses," HE Jan/Feb '93, p. 9).

Piping losses can be reduced if lines are insulated. If piping is scheduled for replacement, or if it is accessible, installing insulation could reduce losses considerably--the N.Y. State Energy Code recommends a minimum of R-4 insulation for pipes less than 3/4 inch in diameter. NYSERDA is currently evaluating recirculation control strategies to identify and demonstrate the lowest-cost strategies for minimizing line losses.

--Tom Sahagian and Norine Karins

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ADTEC STAR SAVER POWER FEEDBACK WATER HEATER

A Star

SPECIFICATIONS

Maximum Dimensions	60" high (replaces 60" of drain pipe) 6" wide 9.5" deep
Net Weight	60 pounds with GFX Model G3-60
A-Star 22kW	
Power Requirements	
Voltage	240 Volts AC (Two 50A circuits required)
Maximum Current	46 Amperes per circuit 92 Amperes total
Maximum Power	11 Kilowatts per circuit 22 Kilowatts total
Flow Rates to obtain 120°F	
Cold Water Inlet Temperatures	
40°F	2.9 gpm
50°F	3.2 gpm
60°F	3.8 gpm
A-Star 11kW	
Power Requirements	
Voltage	240 Volts AC
Maximum Current	46 Amperes
Maximum Power	11 Kilowatts
Flow Rates to obtain 120°F	
Cold Water Inlet Temperatures	
40°F	1.8 gpm
50°F	2.3 gpm
60°F	2.6 gpm

Introducing the Adtec Star Saver, the world's first power feedback water heater; one that integrates the Adtec Tankless Water Heater with the GFX drainwater heat recovery system. The "A-Star" incorporates a feedback loop utilizing heat that normally goes down residential and commercial drains, to boost performance and lower the amount of electricity used. According to evaluations funded by the U.S. Department of Energy, compared to bulky and wasteful tank-type water heaters, A-Star can lower electrical usage for residential hot water users by 50 - 65%. This level of efficiency combined with space saving, water saving, easy installation, affordability, and reliability is unrivaled in today's water heating market.

The A-Star 22kW model will deliver a great deal of hot water at great savings. The A-Star 11kW model will deliver plenty of hot water when there is less power available.

(A-STAR-TS-02-2002)

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