## Condensate Recovery Produces Savings

A large specialty paper plant reduced its boiler makeup water rate from about 35% of steam production to between 14% and 20% by returning additional condensate. Annual savings added up to more than $300,000.

## Suggested Actions

Reduce operating costs through maximizing the return of hot condensate to the boiler. Consider the following actions:

- If the condensate return system is absent, estimate the cost of a condensate return system and install one if economically justified.
- Repair steam distribution and condensate return system leaks.
- Insulate condensate return system piping to conserve heat and protect personnel against burns.

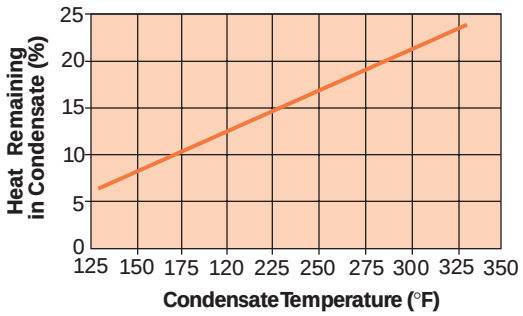
*Adapted from an Energy TIPS fact sheet that was originally published by the Industrial Energy Extension Service of Georgia Tech. For additional information on industrial energy efficiency measures, contact the OIT Clearinghouse at (800) 862-2086.*

# Return Condensate to the Boiler

When steam transfers its heat in a manufacturing process, heat exchanger, or heating coil, it reverts to a liquid phase called condensate. An attractive method of improving your powerplant's energy efficiency is to increase the condensate return to the boiler.

Returning hot condensate to the boiler makes sense for several reasons. As more condensate is returned, less makeup water is required, saving fuel, makeup water, and chemicals and treatment costs. Less condensate discharged into a sewer system reduces disposal costs. Return of high purity condensate also reduces energy losses due to boiler blowdown. Significant fuel savings occur as most returned condensate is relatively hot (130°F to 225°F), reducing the amount of cold makeup water (50°F to 60°F) that must be heated.

A simple calculation indicates that energy in the condensate can be more than 10% of the total steam energy content of a typical system. The graph shows the heat remaining in the condensate at various condensate temperatures, for a steam system operating at 100 psig, with makeup water at 55°F.




Let:
$h_c$ = enthalpy of condensate at 180°F = 148 Btu / lb
$h_m$ = enthalpy of makeup water at 55°F = 23 Btu / lb
$h_s$ = enthalpy of steam at 100 psig = 1189 Btu / lb

Heat remaining in condensate (%):

$= (h_c - h_m) / (h_s - h_m) \times 100$

$= (148 - 23) / (1189 - 23) \times 100 = 10.7\%$

## Example

Consider a steam system that returns an additional 10,000 lbs / hr of condensate at 180°F due to distribution modifications. Assume this system operates 8000 hours annually with an average boiler efficiency of 82%, and makeup water temperature of 55°F. The water and sewage costs for the plant are $0.002 / gal and the water treatment cost is $0.002 / gal. The fuel cost is $3.00 per Million Btu (MBtu). Assuming a 12% flash steam loss*, calculate the overall annual savings.

**Annual Water, Sewage, and Chemicals Savings** = (1 – Flash Steam Fraction) x (Condensate Load in lbs / hr) x Annual Operating Hours x (Total Water Costs in $ / gal) ÷ (Water Density in lbs / gal)

$$= \frac{(1 - 0.12) \times 10{,}000 \times 8{,}000 \times \$0.004}{8.34} = \$33{,}760$$

**Annual Fuel Savings** = (1 – Flash Steam Fraction) x (Condensate Load in lbs / hr) x Annual Operating Hours x (Makeup Water Temperature rise in °F) x (Fuel Cost in $ / Btu) ) ÷ Boiler Efficiency

$$= \frac{(1 - 0.12) \times 10{,}000 \times 8{,}000 \times (180 - 55) \times \$3.0}{0.82 \times 10^6} = \$33{,}760$$

**Total Annual Savings Due to Return of an Additional 10,000 lbs/hr of Condensate = $33,760 + $32,195 = $65,955**

* When saturated condensate is reduced to some lower pressure, some condensate flashes off to steam again. This amount is the flash steam loss.

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