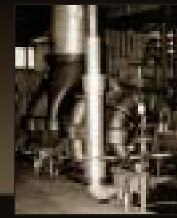
Steam

Motors



Compressed Air

## 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 a condensate return system is absent, estimate the cost of a condensate return and treatment system (as necessary) 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.

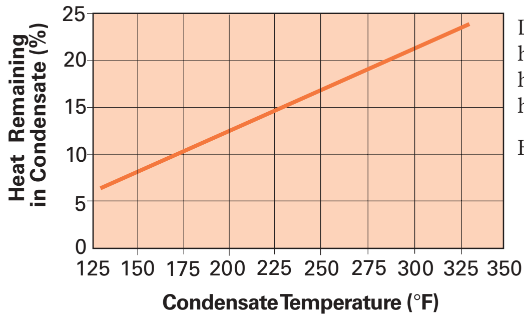
*Steam Tip Sheet information adapted from material provided by the Industrial Energy Extension Service of Georgia Tech and reviewed by the DOE BestPractices Steam Technical Subcommittee. For additional information on steam system efficiency measures, contact the OIT Clearinghouse at (800) 862-2086.*

# 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 power plant'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 make-up water is required, saving fuel, make-up 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 make-up 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 make-up water at 55°F.




Let:

$h_c$ = enthalpy of condensate at 180°F = 148 Btu/lb

$h_m$ = enthalpy of make-up 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 8,000 hours annually with an average boiler efficiency of 82%, and make-up 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 (MMBtu). 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)

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

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

**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

$$= \frac{(1 - 0.12) \times 10{,}000 \times 8{,}000 \times (180 - 55) \times \$3.00}{0.82 \times 10^6} = \$32{,}195$$

**Total Annual Savings Due to Return of an Additional 10,000 lbs/hr of Condensate**

= $33,760 + $32,195 = **$65,955**

## About DOE's Office of Industrial Technologies

The Office of Industrial Technologies (OIT), through partnerships with industry, government, and non-governmental organizations, develops and delivers advanced energy efficiency, renewable energy, and pollution prevention technologies for industrial applications. OIT is part of the U.S. Department of Energy's Office of Energy Efficiency and Renewable Energy.

OIT encourages industry-wide efforts to boost resource productivity through a strategy called Industries of the Future (IOF). IOF focuses on the following nine energy- and resource-intensive industries:

- Agriculture
- Aluminum
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- Glass
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- Mining
- Petroleum
- Steel

OIT and its BestPractices program offer a wide variety of resources to industrial partners that cover motor, steam, compressed air, and process heating systems. For example, BestPractices software can help you decide whether to replace or rewind motors (MotorMaster+), assess the efficiency of pumping systems (PSAT), or determine optimal insulation thickness for pipes and pressure vessels (3E Plus). Training is available to help you or your staff learn how to use these software programs and learn more about industrial systems. Workshops are held around the country on topics such as "Capturing the Value of Steam Efficiency," "Fundamentals and Advanced Management of Compressed Air Systems," and "Motor System Management." Available technical publications range from case studies and tip sheets to sourcebooks and market assessments. The *Energy Matters* newsletter, for example, provides timely articles and information on comprehensive energy systems for industry. You can access these resources and more by visiting the BestPractices Web site at **www.oit.doe.gov/bestpractices** or by contacting the OIT Clearinghouse at **800-862-2086** or via email at **clearinghouse@ee.doe.gov.**

BestPractices is part of the Office of Industrial Technologies' (OIT's) Industries of the Future strategy, which helps the country's most energy-intensive industries improve their competitiveness. BestPractices brings together the best-available and emerging technologies and practices to help companies begin improving energy efficiency, environmental performance, and productivity right now.

BestPractices focuses on plant systems, where significant efficiency improvements and savings can be achieved. Industry gains easy access to near-term and long-term solutions for improving the performance of motor, steam, compressed air, and process heating systems. In addition, the Industrial Assessment Centers provide comprehensive industrial energy evaluations to small and medium-size manufacturers.

**FOR ADDITIONAL INFORMATION, PLEASE CONTACT:**

Peter Salmon-Cox
Office of Industrial Technologies
Phone: (202) 586-2380
Fax: (202) 586-6507
Peter.Salmon-Cox@hq.doe.gov
www.oit.doe.gov/bestpractices

OIT Clearinghouse
Phone: (800) 862-2086
Fax: (360) 586-8303
clearinghouse@ee.doe.gov

Please send any comments, questions, or suggestions to
webmaster.oit@ee.doe.gov

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Office of Industrial Technologies
Energy Efficiency
and Renewable Energy
U.S. Department of Energy
Washington, DC 20585-0121

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