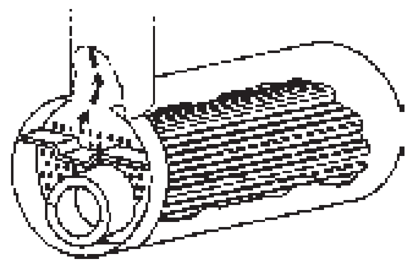
Water Efficiency

Water Management Options

Boilers



Boiler Water Impurities

All boiler make-up water contains impurities. As clean steam is released from the boiler, impurities build up. The increasing concentration of these impurities, such as dissolved solids, can lead to carryover into the steam, causing damage to piping, steam traps and even process equipment. The increasing concentration of suspended solids impurities in the boiler can form sludge, which impairs boiler efficiency and heat transfer capability.

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Blowdown

To maintain solids at an acceptable level, water is removed from the boiler system. This water bleed-off, termed "blowdown," from industrial boilers is an important part of boiler operations. Achieving the right amount of blowdown is critical. As with cooling towers, insufficient blowdown can lead to excessive buildup of impurities. Too much blowdown can lead to wasted water, treatment chemicals and energy.

Blowdown is released from beneath the water surface in the boiler's steam drum, mud drum, bottom header or from the bottom of the boiler. Surface water blowdown is often done continuously to reduce the level of dissolved solids, and bottom blowdown is performed periodically to remove sludge from the bottom of the boiler. Additionally, the blowdown heat can be used to increase the overall efficiency of the system.

The optimum amount of blowdown required is a function of boiler type, steam pressure, chemical treatment program and feedwater quality. Because supply water quality varies from place to place, no hard and fast rules exist as to the exact volume of blowdown required. Blowdown rates can very from one percent (of feedwater flow) to as much as 20 percent, with the typical range of four to eight percent.

Blowdown amount is typically calculated and controlled by measuring the conductivity of the boiler feed and blowdown water. Conductivity is a viable indicator of the overall total dissolved solid concentration. Blowdown for boilers is usually expressed in percentage:

$$\text{Percent Blowdown} = \frac{\text{Quality of Makeup Water}}{\text{Quality of Blowdown}}$$

$$= \frac{\text{TDS or } (\mu\text{mhos}) \text{ of Makeup}}{\text{TDS or } (\mu\text{mhos}) \text{ of Blowdown}}$$

Boiler water quality also is commonly expressed as cycles of concentration, which is simply the inverse of percent blowdown.

Optimizing Blowdown

Facility managers should know the optimum operating parameters for their boiler water quality. While optimizing boiler water treatment and control procedures can conserve water, more importantly, they will maintain proper boiler performance, extend life and save energy. The American Boiler Manufacturers Association and American Society of Mechanical Engineers have developed guidelines for water purity controls in boilers. These can be used as a starting point for determin-

Maximum Recommended Concentration Limits

Boiler Operating Pressure (psig)	Total Dissolved Solids (ppm)	Total Alkalinity (ppm)	Total Suspended Solids (ppm)
0 - 50	2,500	500	--
50 - 300	3,500	700	15
300 - 450	3,000	600	10

ing boiler blowdown needs. The maximum recommended concentration limits according to the ABMA is listed in the table below. Operating the boiler below these levels requires more blowdown, wasting water and energy, thus increasing the cost of operation. The total dissolved solids are the sum of all naturally occurring minerals dissolved in supply water and any treatment chemicals added to the system.

Recommended boiler blowdown practices also are described in Sections VI and VII of the ASME *Boiler and Pressure Vessel Code*. Facility managers can identify water- and energy-saving opportunities by comparing the blowdown and makeup water treatment practices with the ASME practices. The ASME *Boiler and Pressure Vessel Code* can be ordered through the ASME Web site at http://www.asme.org/bpvc/.

Action Plan for Optimizing Boiler Blowdown

- Monitor blowdown rates, feedwater quality and blowdown water quality.
- Work with experienced vendors and boiler service providers to determine best water treatment program to complement water efficiency goals.
- Establish maximum boiler water contaminant levels.
- Estimate cost and operation savings in water use, heat loss and chemical loss that can be accomplished by modifying concentration ratios.
- Evaluate implementing systems to continuously monitor and blowdown boiler water.

Automatic Blowdown Controls

There are two types of boiler blowdown: manual and automatic. Plants using manual blowdown must check samples many times a day or according to a set schedule, and adjust blowdown accordingly. With manual boiler blowdown control, operators are delayed in knowing when to conduct blowdown or for how long. They cannot immediately respond to the changes in feedwater conditions or variations in steam demand.

An automatic blowdown control constantly monitors boiler water conductivity and adjusts the blowdown rate accordingly to maintain the desired water chemistry. A probe measures the conductivity and provides feedback to the controller driving a modulating blowdown valve. An automatic blowdown control can keep the blowdown rate uniformly close to the maximum allowable dissolved solids level, while minimizing blowdown and reducing energy losses.

Purchasing and installing an automatic blowdown control system can cost from $2,500 to $6,000 with generally a one- to three-year payback period on the investment. A complete system should consist of a low- or high-pressure conductivity probe, temperature compensation and signal condition equipment, and a blowdown-modulating valve.

Changing from manual blowdown control to automatic control can reduce a boiler's energy use by two to five percent and reduce blowdown water losses by up to 20 percent.

Maximizing Condensate Return

Improving condensate return is another way to minimize blowdown water and maximize cycles of concentration at which a boiler operates. By increasing condensate return, operators will increase the concentration cycles, decrease chemical usage, decrease blowdown and conserve the heat value of the high-temperature condensate. A well-functioning steam trap inspection program is essential to maximizing condensate return. When steam traps exceed condensate temperature, the trap is leaking steam. Use infrared temperature gun/device to check this. Steam lines and traps should be checked for leaks periodically and repairs should be scheduled. Such repairs are typically very cost effective because of the potential for energy savings. Condensate return systems and automatic shut-off controls should be considered for boiler systems not utilizing them. Consultation can be conducted with boiler vendors, service providers and other technical assistance providers.

Improving External and Internal Water Treatment

External or feedwater pre-treatment systems remove impurities form the boiler feedwater. Treatment systems address three areas:

1. Removal of suspended solids
2. Removal of hardness and other soluble impurities
3. Oxygen removal

There are several technologies available to pretreat boiler feed water. These include softeners, reverse osmosis and demineralization. Increasing feedwater quality will increase the cycles of concentration at which a boiler can operate.

Internal water treatment regimes for boilers seek to manage corrosion and deposits. Choices for internal and external water treatment approaches are interdependent. While seeking to optimize boiler water systems, the importance of using knowledgeable people to ensure proper evaluation of water treatment needs cannot be overemphasized. It is best to utilize someone familiar with boiler system operation as well.

Blowdown Heat Recovery Units

The evaluation of reclaiming heat from blowdown is a wise consideration. Systems with continuous blowdown rates exceeding five percent of the steam generation rate are often good candidates for a blowdown waste heat recovery system. The blowdown water has the same temperature and pressure as the boiler water. Before this high-energy waste is discharged, the residual heat in blowdown can be recovered with a flash tank, a heat exchanger or the combination of the two. A boiler blowdown heat recovery project at Augusta Newsprint Mill in Georgia saved the company $31,000 in fuel costs and 14,000 MMBtu in energy annually.

CASE STUDY

Clean Cooling Water Reuse

Safelite Glass Company in Enfield, N.C., utilizes water from air compressors and hydraulic fluid cooling water for boiler makeup. Clean once-through cooling water is a good candidate for boiler water make up. The reuse practice saved 8.5 million gallons of city water per year and was implemented for $3,000. Simple payback was two months.

CASE STUDY

Chemical Free Boiler Water Treatment

Vanir Solar Construction in Fletcher operates a 150-hp boiler around the clock during the heating season. The boiler has a high condensate return and very high-quality make-up water. The water treatment system for the boiler utilized a conventional approach of chemical treatment using phosphate, hydroxide alkalinity (caustic) and sulfite. Beginning in the 2007-08 heating season, a non-chemical treatment water system was installed by Fluidyne International. The new treatment system reduced boiler corrosion and deposits while significantly reducing boiler blowdown water. With visual inspection, rusty deposits in the boiler and condensate return lines were disappearing from the walls of the wetted areas. The annual (heating season) savings related just to blowdown, including water, sewer and energy costs, was $4,070. The new system is saving 189,000 gallons of water annually. Significant additional savings were achieved in eliminated chemical costs and chemical servicing.

N.C. Division of Pollution Prevention and Environmental Assistance
Pollution Prevention Pays

The North Carolina Division of Pollution Prevention and Environmental Assistance provides free, non-regulatory technical assistance and education on methods to eliminate, reduce, or recycle wastes before they become pollutants or require disposal. Telephone DPPEA at (919) 715-6500 or (800) 763-0136 for assistance with issues in this fact sheet or any of your waste reduction concerns.

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