The Value of Condensate

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Deaerated feedwater is pumped into a boiler, converted to steam, travels through the steam distribution system to do work, changes phase from gas to a liquid, and forms condensate. If the condensate-return system is not functioning or the condensate is contaminated, it may end up being dumped down the drain instead of being returned to the boiler system. Sending condensate down the drain is the equivalent to pouring money down the drain because condensate can be a source of high purity, high temperature makeup water for the boiler system. Being able to calculate the dollar value of condensate can help justify condensate recovery projects such as polishers, pump repairs, new piping, and upgrades.

Condensate Value

The value of condensate can be broken down into the following categories:

- Water cost
- Sewer cost
- Fuel cost
- Chemical cost
- Pretreatment costs
- Blowdown cost

Calculation

As a basis for both current and future condensate recovery projects and ideas, it is recommended to come up with a condensate value based upon 1,000 gallons (e.g., $16.81/1,000 gallons condensate). This serves two purposes:

Condensate recovery values can easily be calculated. For example, if a condensate receiver pump is broken and it is estimated that 1,000,000 gallons/year of condensate (or 1.9 gpm) is being dumped down the drain at a condensate value of $16.81/1,000 gallons, the value of this wasted condensate is 1,000,000 * $16.81/1,000 = $16,810/year. This could pay for the pump repair.

It puts the condensate value into conceptual terms. The answer will be in dollars and cents and applied to a volume that most people can easily visualize.

Water and Sewer Cost

Water and sewer costs are typically easy to come by in a facility. If well water is being used, take into account the pumping costs. Water and sewer costs are typically reported in 1,000 gallon increments. If not, convert the cost to dollars per 1,000 gallons. (Note: The density of water is 8.335 lb/gallon, and there are 7.481 gallons/cubic foot.) If condensate is being dumped down the drain, then sewer costs are certainly a part of the condensate value.

Fuel Cost

Condensate that is not returned to the boiler system must be replaced with makeup water. Fuel cost is based upon the amount of energy it takes to heat makeup water up to the temperature of the unrecovered condensate. It takes 1 BTU to raise 1 pound of water by 1° F. To determine how many BTU's are required to heat 1 pound of makeup water to the condensate temperature, simply subtract the makeup temperature from the condensate temperature. To base the value on 1,000 gallons of condensate as recommended previously, multiply the BTU/lb calculated by 8,335 pounds. (Note: 1,000 gallons of water weighs 8,335 pounds.) This is the theoretical amount of energy required to heat the makeup water.

Boiler efficiency must not be forgotten though. Not all the energy available in the fuel is transferred to the water to make steam. Some energy is lost out the exhaust stack with the combustion gases, some is lost as radiated heat, and some is lost with blowdown. If the boiler efficiency of converting the energy content of fuel into steam is not known, a conservative estimate of 80% (or 0.80) can be used. Divide the BTU/lb required that was just calculated by the boiler efficiency as a fraction. This is the actual amount of energy required to heat the makeup water.

To calculate the amount of fuel needed, divide the energy required by the fuel energy value. Then multiply the fuel required by the cost of the fuel. Table 1 lists the fuel energy content of common fuels.

Table 1: Fuel Energy Content

Natural Gas	1,000 BTU/cubic foot
Coal – Anthracite	13,900 BTU/lb
Coal – Bituminous	14,000 BTU/lb
Coal – Sub-bituminous	12,600 BTU/lb
Coal – Lignite	11,000 BTU/lb
No. 2 Burner Fuel Oil	140,000 BTU/gal
No. 4 Heavy Fuel Oil	144,000 BTU/gal
No. 5 Heavy Fuel Oil	150,000 BTU/gal
No. 6 Heavy Fuel Oil 2.7% Sulfur	152,000 BTU/gal
No. 6 Heavy Fuel Oil 0.3% Sulfur	143,800 BTU/gal

Chemical Cost

Condensate line treatments such as neutralizing amines are the primary chemicals found in condensate. Filming amines are also used, but since they are typically non-volatile chemicals, they are not recycled back into the steam lines when the condensate is recovered and essentially add zero value. With the concentration and unit price of the treatment chemical, the chemical cost can be calculated.

Pretreatment Cost

It takes pretreatment equipment to produce water of high enough quality to replace the condensate that is not being recovered. Boiler systems may have water softeners, dealkalizers, reverse osmosis, deionization, etc. Each of these treatment schemes has a cost associated with every gallon of water produced. This cost should be calculated so the value of recovered condensate can be determined.

Blowdown Cost

If all that is desired is the direct value of each gallon of condensate, this has now been achieved. This alone may be enough to justify the cost to recover the condensate (e.g., $14.06/1,000 gallons). However, returning more condensate back to the boiler system can have the additional benefit of improving feedwater quality, increasing the number of boiler cycles of concentration, and reducing the amount of blowdown. Blowdown savings are a real, quantifiable savings that can be factored into the overall condensate value as well. Costs included in the value of blowdown are water, sewer, fuel, chemicals, and pretreatment. These are very similar to the costs directly associated with the condensate. Blowdown savings require more complex calculations that require iterations that cannot be adequately detailed in this article. For example, a 100,000 lb/hr boiler running at 5% blowdown, 50% condensate return, and soft water makeup will realize 105 gallons or $2.75 of blowdown savings for every 1,000 gallons of condensate that are recovered.

Summary

As has been shown in this article, the value of condensate can be quite substantial when all the effects of unrecovered condensate are taken into consideration (e.g., $14.06 + $2.75 = $16.81 per 1,000 gallons of condensate recovered).

Figures 1 and 2 illustrate the impact each component of the total condensate value for a 100,000 lb/hr boiler running at 5% blowdown, 50% condensate return, and soft water makeup. From Figure 1, fuel is the largest contributor at 54%, followed by sewer at 18%, and then blowdown. Blowdown savings were 16% of the total condensate value further showing the impact that recovering condensate could have on the overall boiler system.

Figure 2 shows the breakdown of savings for the blowdown alone. As expected, fuel was the major contributor at 75%, followed by sewer at 12%.

Condensate is a very valuable resource that is designed to be recovered and used back in the boiler system. When pumps break, condensate lines leak, contamination occurs, or condensate-return systems break down, often times an easy solution is to dump the condensate to a drain. This is the equivalent to pouring money down the drain that may quickly justify the expense it takes to recover the condensate once again.

Figure 1: Total Condensate Value

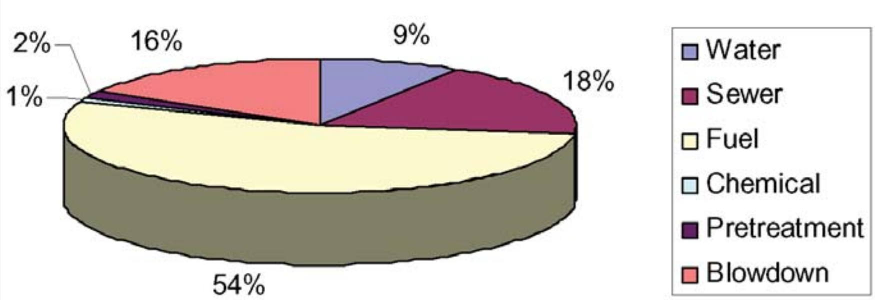
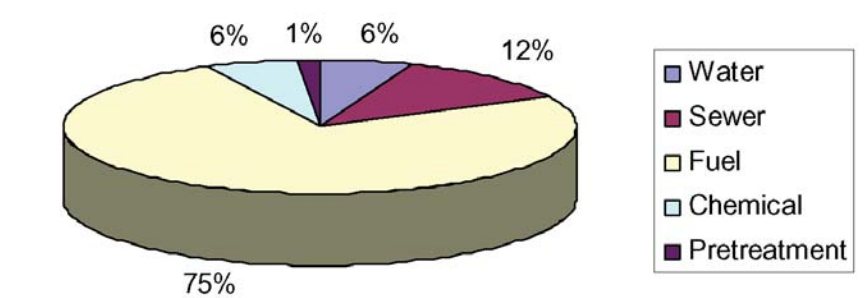


Figure 2: Blowdown Savings



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