SIZING THE CONDENSATE RECEIVER & PUMP FOR A STEAM BOILER

By Henry Manczyk, CPE, CEM
Manczyk Energy Consulting

When steam is generated and transported throughout the heating system, it condenses in the heat exchange process and flows to a holding vessel, which is commonly referred to us as a condensate receiver, from which it returns to the boiler.

One of the most effective ways to increase overall heating system efficiency is to return condensate back to the boiler. It makes sense for several reasons, the more condensate that is returned back to the boiler results in less make-up water that is required. Returning condensate back to the boiler has a significant impact on system costs: it saves fuel, make-up water, and chemicals and treatment expenses.

Fuel savings are realized because a majority of the returned condensate is in the range of 130° and 200°F, thus reducing the amount of fresh make-up water at an average of 50°F that must otherwise be heated to a point where the evaporation process begins. In various situations, the thermal energy in the condensate can be 10% to 15% of the total steam energy content of a specific system.

A condensate receiver that is too big primarily costs the owner too much in the original equipment investment. If it is sized too small, however, the condensate will overflow and fresh make-up water will be demanded, requiring unnecessary heating, chemicals, and water. Here is how to select a properly sized condensate receiver and condensate pump.

Condensate Receiver and Pump Selection:

For common installation it has been customary to pick a condensate receiver of adequate size to hold a volume equivalent to the condensate evaporated by the boiler in a 1/4 to 1/3 hour period at the normal firing rate of the boiler.

Example:

Condensate Receiver Capacity Selection:

A boiler has 22.4 boiler horsepower evaporating 772.8 lbs. of steam per hour.

$$\text{Receiver capacity} = \frac{(HP)\ (34.5)}{(8.33)\ (3)}$$

$$\text{Capacity} = \frac{(22.4)\ (34.5)}{(8.33)\ (3)} = 30.92 \text{ Gallons}$$

Or (0.069) (HP) (minutes) = Gallons

(0.069) (22.4) (20) = 30.92 Gallons

Selected 30 Gallon receiver

Condensate Pump GPM Selection:

1 Boiler HP = 33,475 BTU per hour

(22.4 HP) (33,475) = 750,000 BTUs

1 EDR = 240 BTUs

$$\text{EDR} = \frac{750{,}000}{240} = 3{,}125$$

1,000 sq. ft. EDR yields ½ GPM condensate

Therefore:

$$\text{GPM} = \frac{(3{,}125)\ (0.5)}{1{,}000} = 1.56 \text{ GPM}$$

Sizing Factor for 1/3 hour = 3

(1.56) (3) = 4.68 GPM

Selected pump is 6 GPM

Typical duplex condensate return pump unit

Definitions & Conversions:

- 1 Boiler HP = 34.5 lbs. of steam per hour at 212 degrees F.
- 1 Gallon = 8.33 lbs.
- GPM = Gallons per minute
- One-third of 1 hour = 20 minutes
- Sizing Factor = 1/(fraction of an hour)
- HP = Horsepower
- EDR = Equivalent Direct Radiation = 240 BTUs (steam)
- 1 Boiler HP = Evaporation of 0.069 GPM

Conclusion:

The selection of a condensate receiver and pump should be given careful consideration so the steam system is properly balanced and operates at its optimum efficiency.

References

Energy Tips, June 2001, Tip Sheet #8, Return Condensate to the Boiler, Office of Industrial Technologies, US. DOE.

Tech Talk, May 2002, Volume 17, Issue 1, Selecting Condensate Transfer and Boiler Feed Equipment, by Bell & Gossett Company.

Sizing For Condensate Receivers (spect), by The Peerless Heater Company