Condensing & Non-Condensing Boilers / Water Heaters

Condensation

- Condensation occurs when the flue/exhaust gas cools to the point where it can no longer retain moisture. This moisture falls out of the gas and is the *condensation*
- Both "Non-Condensing" and "Condensing" CAN condense. Only "Condensing" boilers are designed to handle the condensation whereas condensation in a "Non-Condensing" unit will drastically reduce its lifespan
- Condensation typically has a pH level of 3.0-5.0 (acidic)
- Potential condensation volume is **1 Gallon per 100,000btu** input
    - i.e a 800,000btu Boiler could potentially have 8 gallons per hour of condensate
- Condensation is run to a trap and then either to a condensate neutralization kit or to the drain.
    - A *Condensate Neutralization Kit* is a big box of limestone that brings pH back closer to 6.0-7.2 before going to a drain

Temperatures

- Return Water Temperature dictates efficiency and condensation of the boiler
    - Return **<130°** will condense | Return **>130°** will not condense (Natural Gas)
    - Propane gas condenses at **122°**
- Consider outdoor air reset during boiler selection. A system may run at **180°** 2 months out of the year but reset back to **110°** or **130°** for the remainder of the year. In this situation a condensing boiler would still be recommended
- For a domestic water heating system, the cooler we can store the tank the more the heater will condense. Since we bring make-up water to the inlet of the heater, condensation will still occur to some extent even if tank is stored at 140°

Venting

- Typical **Non-Condensing** boilers use a Double Wall B-Vent (Category I)
    - Category I vent is negative pressure, is not air-tight, and is not corrosion resistant
        - Typically can only be run 35-50' and generally needs vertical termination
- Typical **Condensing** boilers use PVC/CPVC/Polypropylene/Stainless Steel (Category IV)
    - Category IV vent is positive pressure, is air tight, and is corrosion resistant
        - Typically can be run up to 100' with vertical or sidewall termination
- Category IV vent will have some condensation occurring in the vent stack as flue gasses cool off
    - For this reason, Category IV venting should pitch back towards the boiler for proper condensate disposal. There should be no low points or dips which could cause condensate to become trapped in the flue stack
- Category IV vent should **not** be common vented due to positive pressure in the stack. Outside venting experts would be needed to design a vent system should common venting be required
- Category I vent will always be larger than the same BTU input of Category IV vent
    - A non-condensing 1,435,000btu Lochinvar CopperFin 1 requires 12" Double Wall B-Vent
        - A condensing 1,500,000btu Lochinvar Armor X2 requires 6" Category IV Vent

Piping

Piping remains, for the most part, same in mechanical systems. A few differences:

- Many older boilers for hydronic systems are large mass with a lot of water volume in them. They are almost always piped in a *full-flow* arrangement with a single pump moving water through the system and the boiler
    - Many newer boilers, both condensing and non-condensing, are *low-mass* units with very little water content in them. For this reason, they would likely need to be piped *primary/secondary* where the system flow has its own pump and the boilers have their own pump
- It is highly recommended on all *non-condensing boilers* to have an automatic or thermostatic 3 way valve installed as a protection against condensation. These are relatively inexpensive and can increase the life of a boiler by years
- On *domestic hot water* applications, the primary change is that our make-up water would be piped on the *inlet* side of the water heater. In the past, we would pipe it on the *outlet* of the water heater so as not to condense

Materials

- General consensus is that **stainless steel** is the best choice for condensing boiler or water heaters heat exchangers. It features the highest corrosion resistant properties which translates to a wider allowable pH range
- Other heat exchangers are offered in aluminum and cast-iron but may have pH imitations, lower pressure ratings, or special chemical treatments required
- Pay attention to the **Igniter** on condensing units. The best choice is a **stainless steel spark ignition** due to its longevity and reliability
    - Some boilers still use older **Hot Surface Igniters** in their condensing product. HSI's are time proven for non-condensing units however they do not stand up well in a moist, condensing boiler atmosphere. These are made of silicon-carbine or silicon-nitride and will be ruined if even one drop of moisture/condensation hits it while it is hot

Summary

Non-Condensing (Generalizations)

- Lower up-front equipment cost, however costly venting can reduce the overall cost savings
- Efficiencies from 81% - 88%
- Firing or burners are usually either 100% on/ 100% off or are staged (eg a 2,000,000btu with 4 stages of firing). A select few units do have 5:1 modulation rather than staging.
- Usually has multiples of burners (Anywhere from 5 to 30 burners). Again, a few do have just one burner
- Larger footprint, possibly larger water volume for increased flow rates through boiler
- Require return water temp above 130° in order to have long-life

Condensing (Generalizations)

- Increased up-front equipment cost. Depending on application, fuel savings payback may be 12-36 months vs cost of non-condensing unit
- More flexible venting due to smaller diameter vent as well as increased allowable distances
- Majority of condensing units have only 1 or 2 burners
- Small footprint due to low water volume inside heat exchanger
- Can operate with any return water temperature. Efficiencies are realized once return water is below dewpoint around 130°
- Anywhere from 3:1 – 25:1 turndown, in 1% increments, for firing rate. Designed for exact load-matching
- Efficiencies up to 99% at low return water temperature and low firing rate