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ZERO-MIXING CONCEPT AND THE ANSI Z21.13/AHRI 1500-2015.

Taking Condensing Boiler Operating Performance Closer to Laboratory Steady State Efficiency [SSET] Conditions.

Despite ASHRAE's continuous effort to prototype and experiment with new resource, integrating science and technology into HVAC buildings, field design fundamentals still being challenged by the gap between intended design and actual building energy performance. Today, there is a continuous struggle in the engineering field to develop the ultimate HVAC system that can effectively integrate energy production with system distribution. This is the case for modern condensing boilers, with lab-reported high efficiency ratings, that once integrated into the system are forced by hydronics to take a life of their own with unexpected consequence on overall system performance.

Before sold in the North American market, highly efficient condensing boilers are tested and certified under ANSI Z21.13/AHRI Standard 1500-2015. ANSI Steady State Efficiency Test [SSET] simulates artificial conditions by regulating parameters such as fuel, air-intake temperature/volume, air/gas mixture, water/brine temperatures, boiler entering flow, etc., all fixed during boiler firing to ensure that boiler efficiency performance is rated at steady state regime [Figure 1].

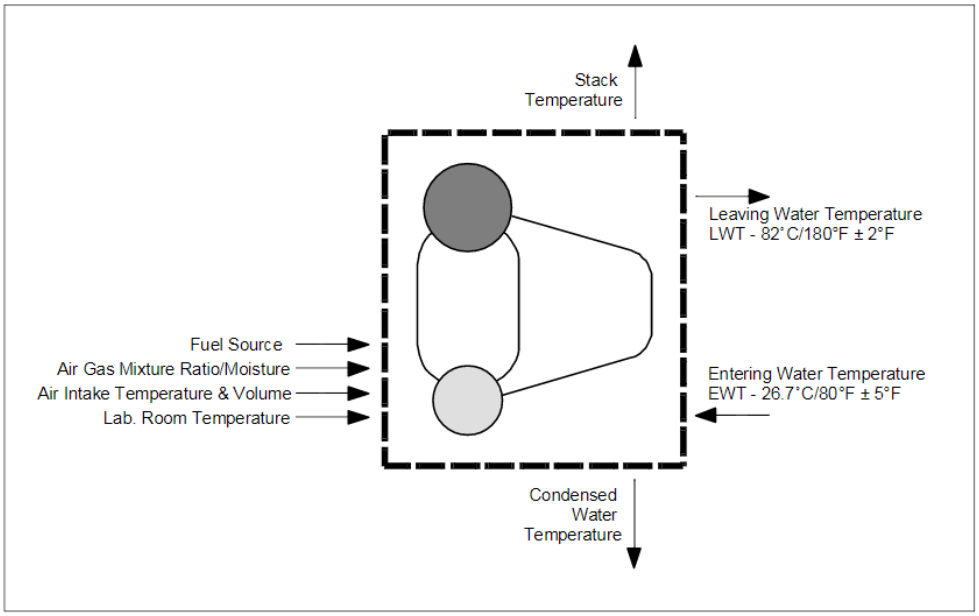

Figure-1. Boiler Steady State Test Controlled Parameters

SSET certified efficiencies become the bases for market technical information and set the standards for product competitiveness. This is done even though lab conditions are rarely achievable and do not properly relate to actual operating conditions. Currently there is no standardized methodology for accurately measuring boiler plant thermal efficiency under actual operating conditions. SSET-test most important take away for design purposes is that in order to achieve maximum thermal efficiencies condensing-boilers must operate with Entering Water Temperature (EWT) < 57°C/135°F.

Figure-2. below, show some typica boiler efficiency curves for condensing and non-condensing boilers. Condensing boilers achieve high efficiency by condensing water vapours in the exhaust gases and thus recovering its vaporisation latent heat, which would otherwise have been wasted. They can provide significant energy savings due to operating efficiencies as high as 98%, as compared to a peak efficiency of 80%, for conventional boilers. Condensing boilers required low Entering Water Temperatures (EWT) to realize the advertised efficiency and AFUE performance. ANSI specifies condensing-boiler performance testing with 27˚C/80˚F EWT and a ΔT≈55˚C/100˚F [temperature rise]; again, a condition not generally achieved with current design practices.

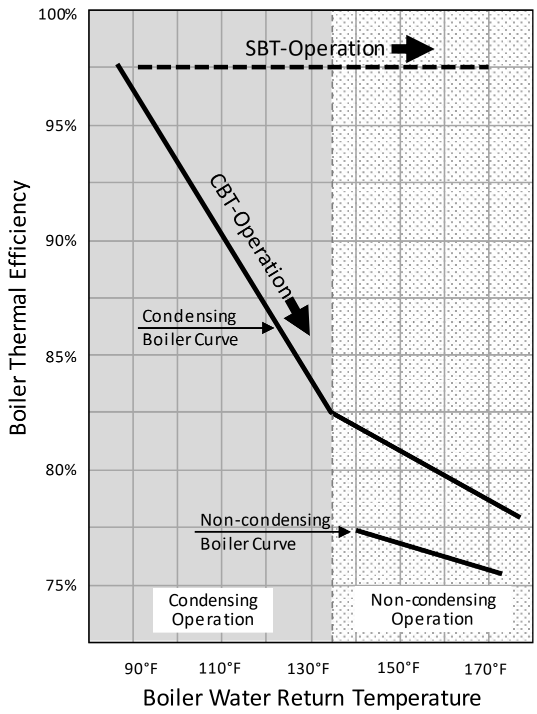

Figure-2. Boiler Thermal Efficiency -Vs- Water Return Temperature

Contrary to engineering fundamentals and manufacturers arguments specifying a condensing boiler does not guarantee achieving the expected savings since condensing boilers only operates in the condensing range from time-to-time. Despite the host of information available on the web from boiler factory reps, HVAC engineers, and commissioning agents, recommending design guidelines and discussing design issues, currently there is no consensus on proper design practices.

The new “ZERO-MIXING” concept application into HVAC hydronics set a different path forward on building retrofits and the design of new facilities. With the use of a Split Buffer Tank [SBT], as coupling/decoupling point for hot-water boiler-supply and colder-water building-return, the concept layouts a hydronic solution to the interconnectivity problem among loops flow causing the gap between lab results and actual performance. Along the way, SBT add the so necessary system thermal mass and a different temperature censoring configuration for boiler soft/short cycling elimination. System mixing elimination promotes year-round boiler-SSET/system operating conditions, maximizing overall system thermal performance, independent of outdoor fluctuating weather conditions, domestic hot water, snow melting system, or any other building heat demand.

System water mixing resulting from hydronics evils, the lack of system thermal mass, and censoring mix-signaling are the worst enemy of HVAC system performance. Water mixing problems may account for a 10% drop on system thermal efficiency while boiler soft/short cycling may impact system performance by up to 40%. Mixing is also present in other HVAC applications, such as: thermal solar, geothermal, CHP, chilled water, and light-industrial HVACs.

Zero-Mixing/SBT retrofits not only resolve the energy-efficiency/economical problem but also the environmental problem associated with the unnecessary burning of non-renewables and the increasing production of buildings GHG emissions. Beside energy saving, SBT economic retrofits promote cash flow business opportunities from GHG emissions reduction in the form of Carbon Credits.