Fulton Heating Solutions, Inc.

Engineering Guide

Condensing Hydronic Boilers

Minimum System Flow

MINIMUM SYSTEM LOAD CONDITIONS

To determine the complete flow potential range, building load should be calculated at both the design day condition, and at the minimum load condition. Consider the building heat loss cases at varying outdoor temperatures, zone demands, occupancies, and other factors when performing this analysis. In an ideal heating plant condition, the turndown of the load can be matched by the turndown of the pumps, and the turndown of the boiler plant output. This situation will allow the BTUs being generated by the boilers to be consumed by the building at the same rate, while maintaining the intended delta-T.

For hydronic heating systems utilizing high-mass high-volume firetube condensing boilers, the boilers are generally not the limiting factor when determining minimum system flow. Instead, this is typically dictated by desired system (circuit) response time, or more commonly the minimum flow limit of the pumps for both thermal protection and hydraulic stability.

For example, a pump selected with a 40% minimum flow has an effective turndown ratio of 2.5:1, while a modular boiler plant with three conventional 5:1 turndown burners will have a total plant turndown of 15:1. The boilers will have six times greater turndown capability than the pump, therefore the limiting factor for minimum flow will be the pump. The boiler delta-T will decrease in the condition where the burners modulate to a point where they have greater turndown than the pumps.

MINIMUM FLOW TO PREVENT NUISANCE MANUAL RESET HIGH LIMIT TRIPS

Regardless of the manufacturer, all boilers with CSD-1 controls must include both an operating high temperature limit and a manual reset high temperature limit (MRHL). A typical condensing boiler MRHL device will safely shutdown and lockout boiler around 200°F to 210°F, therefore it typically recommended to operate below a maximum setpoint of 185 or 190°F. The flow rate required to prevent nuisance lockouts will vary based on the glycol percentage, boiler firing rate and return water temperature.

For example, consider a boiler operating with an output of 1,000,000 BTU/hr in a water (no glycol) system. At a return water temperature of 170°F, a flow rate of at least 133 GPM will be required to prevent the outlet temperature from exceeding 185°F. While in a condition where the return water temperature is a much lower 120°F, only 30 GPM will be required. It is important that the heat generated by the boiler is consumed by the users. If the water is only re-circulating through the boiler, with no heat rejection, increasing the flow rate will not dissipate heat or prevent a nuisance lockout.

The minimum flow required to prevent nuisance lockouts will often exceed the published minimum flow rating to protect the heat exchanger. Some boilers, including several from Fulton's product lines, do not have minimum flow limits but will still of course need proper flow to both heat the building and prevent nuisance lockouts. Reference the "Calculating Flow Rate" Engineering Guide for instructions on how to calculate flow rates.

AVOID NEAR BOILER THREE-WAY VALVES AND BYPASS LOOPS

Three-way and bypass valves used to maintain minimum flow during low-demand conditions should be installed at the furthest location from the boilers. The bypass valve is controlled by the Building Automation System (BAS).

When a bypass is installed near the boilers, the reaction time of the hydronic circuit decreases substantially when the valve opens, potentially causing a normally tuned PID to overshoot and risk high temperature lockouts.

Note: Not all components are shown on the P&ID for simplification purposes.