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BAS Control for Variable Flow Hydronic Systems in Laboratory Facilities

Introduction

This article covers the foundational aspects of Building Automation System (BAS) control for variable flow hydronic systems serving preheat, reheat, and cooling water for HVAC in laboratory buildings, including process cooling water systems serving chilled beams and MRI equipment.

Pump Redundancy and Staging

Hydronic system distribution pumps are required to be redundant (N+1) in NIH laboratory facilities. This means a minimum of two pumps are required; however, NIH preference is to have at least two primary pumps and one standby pump per system. Pump sequencing shall provide for automatic start of the backup pump upon primary pump failure, stopping the backup pump when it is no longer needed, rotation of the lead device, and maintenance lock out.

Flow and Capacity Control

Where a variable frequency drive (VFD) modulates pump capacity, the BAS controls the drive to maintain the differential pressure (dP) at the set point based on differential pressure sensors located in supply and return lines at selected locations. Pump speed modulation shall be based on a low signal selection of multiple differential pressure sensors. The dP set point may be reset based on terminal requirements when practical. Programming should be in place to avoid one terminal device driving the entire system unless it is critical. The BAS shall monitor flow on most systems; however, exceptions may be granted where there is no value to diagnostic monitoring or measurement and verification.

Bypass Valve Operation

The variable flow system must always have a means to operate under low-flow conditions (i.e., when the load is low enough for a single pump to be operating). The minimum continuous stable pump flow will be provided by the pump manufacturer and should be clearly indicated on equipment submittals and coordinated with controls sequences. The minimum flow bypass should be equipped with a 2-way control valve and a nearby dP sensor. If the pump speed begins to drop below the pump minimum flow, the 2-way control valve modulates open to maintain flow and the dP setpoint. The valve begins to modulate closed once the load on the system increases and the flow demand rises above its minimum setpoint for a specified duration. The BAS should be capable of monitoring control valve position and dP setpoint.

Temperature Control

The temperature control for hydronic loops depends on the application. For tertiary pumps supplying chilled water to air handlers and supplemental cooling units, the discharge temperature is controlled by modulating the 2-way control valve in the secondary water return in sequence based on reset schedule and bridge bypass flow. In summer, discharge temperature is the same as the incoming campus supply temperature. In the case of preheat and reheat systems with steam to water converters, the 1/3rd and 2/3rd steam control valves will be modulated in sequence to maintain leaving water temperature for each converter. In the case of process cooling water systems, the chilled water control valve for each heat exchanger shall be modulated to maintain leaving water temperature for each heat exchanger. The temperature set point may be reset. The supply and return temperatures on all systems shall be monitored by the BAS.

Pump Status

Status shall be monitored via current switch and the BAS shall prove pump status matches the command. Status must be valid whether the drive is normal or in bypass. The BAS shall enunciate a “pump failure” alarm whenever the pump is commanded to run and status is not proved within an adjustable debounce time. The BAS shall enunciate a “hand operation” alarm when the pump is commanded off and on status is indicated. In no case shall a loss of status coincident with a loss in power be alarmed as a failure. Drives shall have an automatic restart programmed. A Hand-Off-Auto (HOA) switch should be provided with the pump VFD or starter.

Fill Pressure Control

Fill pressure control on hydronic systems can be accomplished by a system connection to a makeup water source equipped with an automatic makeup control valve set to maintain a specified fill pressure. If it is a glycol system, a glycol pump and its associated pressure control sensor should be used to maintain the fill pressure from a water/glycol mixture source such as a tank or reservoir. In both water and glycol systems, the operation should be automatic, and the BAS should be capable of monitoring the fill pressure and flow.

High or Low Limit Control

Where a convertor (heat exchanger) is used in the system, there should be a high or low limit temperature switch located in the discharge piping of each convertor which shall close its respective control valve when leaving water/glycol temperature rises above or falls below a certain temperature. High limit switches are needed on steam to water/glycol converters serving preheat, reheat, or heat recovery systems as a system safety. A low limit switch may be needed on process cooling or chilled beam converters that may not be able to handle colder chilled water temperatures.

Conclusion

Reliable BAS monitoring and instrumentation is key to an effectively managed hydronic system for a safe and efficient operation strategy. Equipment staging, monitoring, and control instrument calibration should be routinely analyzed to ensure the system is operating as intended and at its most efficient ranges.

References

1. NIH *DRM*, Chapters 6 and 7