"Close Temperature Control"

Previous newsletter articles have discussed why many sample conditioning systems are designed with close temperature control. The Electric Power Research Institute (EPRI) recommends 25Å0.5°C (77Å1°F) in order to eliminate the inaccuracy of temperature compensation. While temperature compensation equations have gotten more sophisticated for various boiler chemistry treatment options, the inaccuracy of both the temperature measurement and the solution compensation (which depends on the exact chemical composition of the water) can introduce errors. When monitoring high purity water, for example, the correction can be as great as 3% for every 1°F away from 77°F.

Close temperature control of samples in power plants is considered most serious in the following general applications:

1. Nuclear power plant secondary, turbine, and feedwater systems
2. Fossil plants with high boiler water purity, typically 1500 psig-2000 psig or higher
3. High cooling water temperature, such as 95°F or higher
4. Varying cooling water temperature over the daily cycle - such as when cooling tower water is used without temperature control.

The two most common methods used for close temperature control will be discussed here - multiple sample isothermal bath vs. high efficiency secondary coolers for each sample.

The major differences between a bath and individual secondary coolers are as follows:

1. A high performance cooler is piped for counterflow - allowing a temperature crossover. That means that the sample can be cooled below the temperature of the final cooling water. In a bath, the sample can only approach the water temperature, and some samples will have a closer approach than others.
2. The cooler is tightly baffled, creating high turbulence and very high rates of heat transfer. While some agitation is usually supplied with a bath, the heat transfer is still very low compared with a sample cooler.

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3. The cooling water inlet temperature is constant across a bank of coolers while in a bath the area near the inlet will be measurably colder than near the outlet.
4. The high efficiency of the sample cooler allows ALL samples to be cooled within 1°F of the cooling water inlet temperature despite variations in flow rate and incoming temperature of each line. Since the bath can only provide a moderate approach to the actual bath temperature, each line must be adjusted to get close to 77°F. Daily adjustments are sometimes required to keep the samples within 4 or 5°F of the desired temperature. To overcome this, a mixing valve is sometimes used to mix subcooled sample with hot sample to better control the final sample temperature.
5. Finally, the sample cooler can provide heating if needed whereas the bath can actually ice up in winter months.

For secondary cooling, a chiller with ultra precise temperature control (+/- 0.5°F) should be used. The system should include a hot gas bypass to allow control over the full load range. The chiller should also have the capacity to elevate sample temperatures if the primary coolers can overcool samples in winter months.

Several utility systems were surveyed to compare the performance of bath systems to ones with dedicated secondary coolers. Over 20 systems from plants which were 2-20 years old were surveyed with the following final temperature control results:

Dedicated high efficiency sample coolers 77 +/- 1.1°F
Isothermal bath systems 78 +/- 6.5°F

The conclusion is that to achieve 77 +/- 1°F final temperature with minimum maintenance, dedicated secondary coolers and a Temperature Control Unit with hot gas bypass should be used.

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