APPLICATION NOTE

Sample Cooler

A sample cooler, as the name implies, is used to cool a sample from a process stream.

A sample cooler is a small shell and coil heat exchanger. The sample to be cooled flows through the tube side of the cooler. The cooling fluid, usually water, flows through the shell side of the cooler. The typical range of flow rates are:

- Sample: 50 – 3300 cc/min
- Cooling Water: 3 – 12 gpm

The cooled sample is then taken to a laboratory for analysis or, in some cases, piped to in-line process instrumentation for continuous monitoring of certain properties such as conductivity, pH or chemical constituents.

Representative Samples

To get a truly representative sample, adequate sample flow must be obtained. Electric Power Research Institute (EPRI) recommends a flow rate of 6 ft/sec (1.8 m/sec) on water samples. When ¼" OD x .049" AW sample tube is used, a flow rate of 1200 cc/min gives the desired 6 ft/sec (1.8 m/sec). Generally speaking, a 2.4 square foot (0.22 square meter) cooler is adequate for 1200 cc/min water samples, whereas a 3.5 square foot (0.33 square meter) or larger cooler should be used for 3300 cc/min water samples.

For steam samples, flow rates are generally lower due to the high velocity of the steam as it flows to the sample panel. Generally, flow rates of between 500 – 1000 cc/min are found to be adequate. The cooler size is determined by the required flow rate and the steam inlet pressure. As the source pressure decreases, the cooler performance decreases and a larger cooler is required. This is due to the relative densities of different steam pressures. Pressure drop is also a major consideration when sizing a cooler for a steam application.

Two-Stage Cooling

If the sample is to be fed to an in-line analyzer, rough cooling may not be sufficient. Some analyzers, particularly conductivity and pH, are very sensitive to temperature. Temperature compensation can be built into the instrument, but this can be inaccurate since the required compensation will vary with the different ions that could be present in the sample. As a result, when high accuracy is desired, the sample must be cooled to 77°F (25°C).

To achieve this, two-stage cooling of the sample is often used. In the first stage, the hot sample is rough cooled using plant cooling water. In the second stage, mechanical refrigeration is used to obtain the required temperature control. Since the first stage cooling is much less expensive than the second stage, Sentry close approach coolers offer a great advantage over less efficient coolers. The more heat removed in the first (or primary) stage, the less heat remains to be removed in the second stage by the expensive refrigeration system. For example, if a sample line flow is 1200 cc/min, a reduction of 20° F (11° C) in the sample temperature to the second stage results in a load reduction on the chiller of about 3200 BTU per hour (.9 kilowatt-hour). In a sample panel with ten such lines, the load reduction would equal three tons of refrigeration.

For the second stage coolers (often called secondary or finishing coolers), Sentry close approach coolers are again recommended. To achieve precise temperature control of samples, the most effective system employs a Temperature Control Unit (TCU) in conjunction with close approach sample coolers. (For detailed discussion on precise temperature control, see Application Note APP 5.8.2). With the TCU approach, the chilled water to the coolers is maintained at 76° F (24° C) ± .5° F. By using sample coolers that can hold an approach temperature of less than 1° F (-17° C), all samples can then be cooled to 77° F (25° C), ± 1° F.

Installation

Sample coolers can be mounted either vertically or horizontally, preferably vertical on high temperature lines. The sample tube connections may be made using weld or compression fittings. Cooling water connections are female pipe thread. Sizes are indicated on product bulletins.

Coolers are typically installed with isolation valves in the cooling water piping to facilitate service. A ball valve or quick disconnect coupling (QDC) should be used on the inlet and a globe valve on the outlet so that throttling occurs downstream of the cooler. This ensures full cooling water pressure in the cooler, limiting boiling of the cooling water. A relief valve or three-way valve is recommended in the cooling water piping to prevent over pressurizing the shell side in case the cooling water valves are closed while the sample is flowing, or in the event of a sample tube rupture.

Service

The only service that coolers normally require is occasional descaling of the shell side. This can be done chemically or mechanically after removing the shell. The frequency of this cleaning depends on the hardness level and the outlet temperature of the cooling water. When a significant increase in the approach temperature occurs, it is time to descale the cooler. If the cooler is used in continuous steam service, inhibited demineralized cooling water may be required to avoid frequent descaling.

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