TechNote TN-3

Off-Gas Ozone Measurement: Drying

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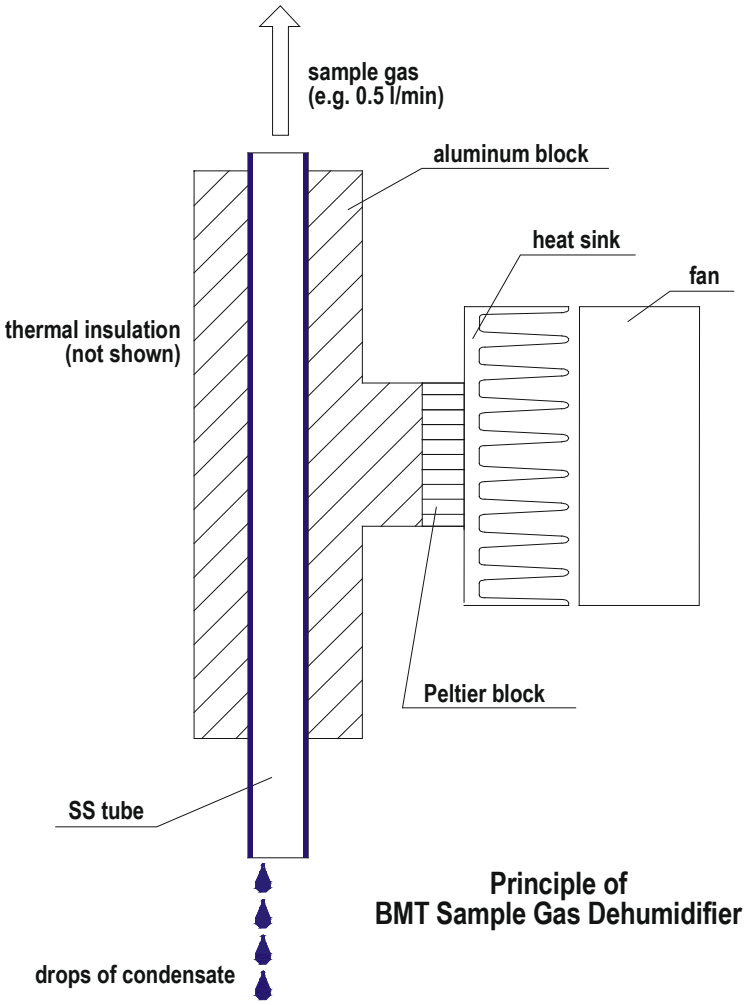
Off-gas from a wet ozone process is saturated with water vapor at the temperature in the reactor vessel. Sometimes this temperature is higher than the ambient temperature around the reactor. When the ozone content of this off-gas has to be measured, some of the water has to be removed from the sample gas.

Water vapor in an ozone sample gas does not interfere with the photometric measurement of the ozone contained in the sample gas. This is true for the relatively high ozone concentration in an off-gas (usually several g/m³). It is even true for the measurement of ambient ozone concentration (only a fraction of one ppm).

This is the reason why it is not necessary to reduce the water content of the sample gas to a dew point temperature less than the ambient temperature. Water removal is necessary only to prevent condensation of the water vapor inside the ozone sample system (tubing, photometer, etc.).

But reduction of the water vapor dew point obviously has to be performed at the point of withdrawal of the sample (e.g. on top of the reaction vessel, or on a large diameter off-gas tube) to avoid condensate build-up in the sample tubing leading from the sample point to the photometric ozone analyser. If any dryer is located only just before the photometer, condensation of the water vapor takes place in the sample tubing.

Drying of a sample gas to a dew point temperature lower than the ambient temperature can simply be achieved by cooling down the sample gas to a temperature lower than the ambient. During cooling part of the water vapor will condensate, and now has to be removed. The BMT Sample Gas Dehumifiers are cooled by a solid state electric Peltier cooler. They represent the most efficient way of removing the condensate directly from the cooler, and at the same time continuously leading it back into the reaction vessel.



Principle of BMT Sample Gas Dehumidifier

But the BMT Sample Gas Dehumidifier could do more than only remove water vapor. Every other vapor contained in the sample gas will be reduced by cooling when its dew point is

higher than the internal temperature of the cooler. In the BMT Sample Gas Dehumidifier the internal temperature is only about +1°C. This low temperature is not necessary to sufficiently reduce the dew point temperature of the water vapor. But it helps to partly remove other kinds of vapor, e.g. from hydrocarbons, which could interfere with the photometric ozone measurement at 254 nm UV, and which namely could soil the cuvette windows of the photometer.

But it is not alway necessary to cool down the sample gas to such a low temperature as it is possible with the Peltier cooler.

When the dew point temperature T_D of the ozone sample gas is near the ambient temperature T_A it may be sufficient to use only tap water as the coolant. Usually tap water is cooler than the ambient room temperature. When the temperature difference is sufficiently high (approx. 10 K or more) our Simple Sample Cooler SSC 1 can be installed which has to be fed with a low flow of cool tap water (0.5 l/min or less). No electric power supply is needed, and no electronics are involved.

When the dew point temperature T_D is between the ambient temperature T_A and about T_A+10K it could be sufficient to only keep the ozone sample gas at its elevated temperature until the sample gas will enter the ozone analyser. Inside an OZONE ANALYZER BMT 964 the temperature is about 10K higher than the ambient temperature. The reason is the electric power inevitably dissipated in the analyser. No water will condensate on the way of the ozone sample gas from the sample point to the ozone analyser when the sample gas tubing would be included in a thermally isolating cover, and a low power heat source be included which produces only enough heat to keep the temperature of the sample gas constant.

But for the reasons mentioned above cooling the sample gas down to +1°C still is the recommended method for drying ozone sample gas.

In any off-gas ozone monitoring system it is important to start the sample gas flow through the ozone analyser not before the ozone analyser has warmed up, and not before any sample gas processing system is in its steady state, e.g. the sample gas cooler has become cold.