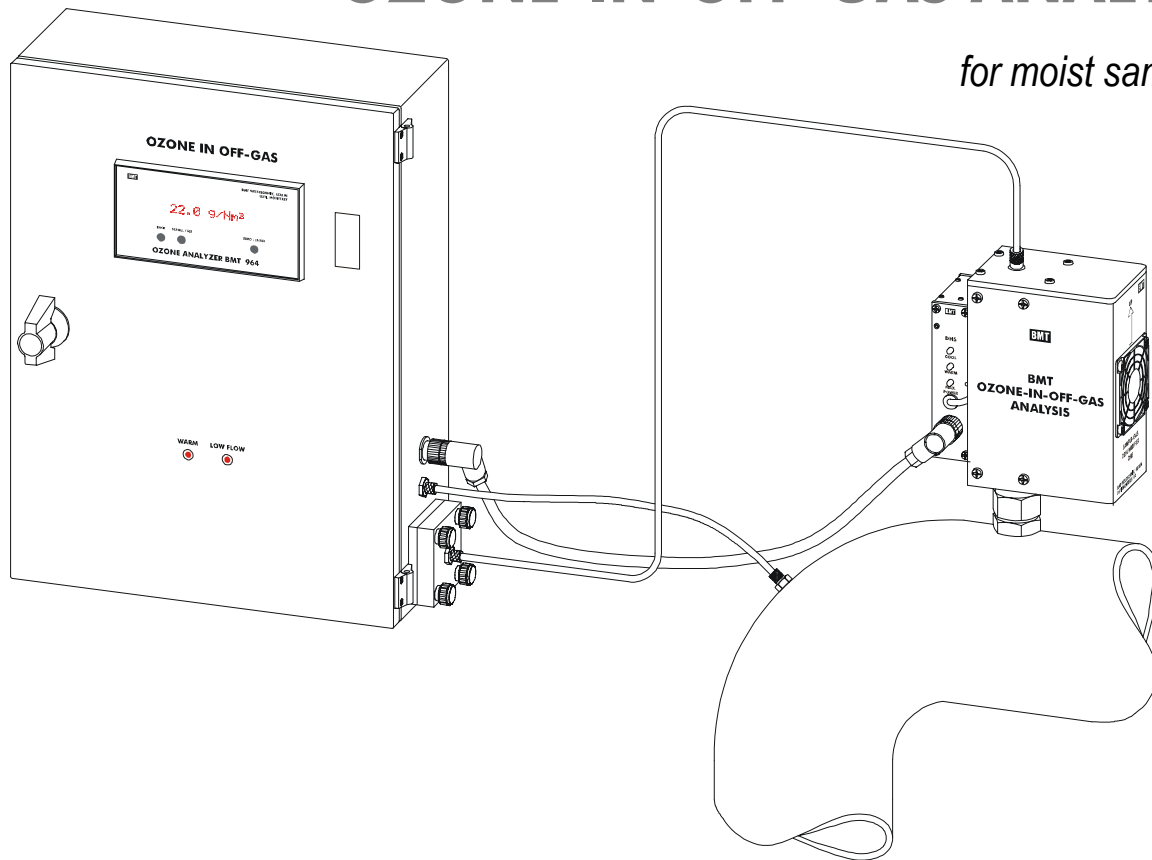


# OZONE-IN-OFF-GAS ANALYZER

*for moist sample gas*



## FEATURES

- Off-gas drying just at the sample point
- Prevents condensation in the sample line
- Peltier-electric cooling
- Condensate is removed automatically
- Sample gas pump, ozone resistant
- Low flow warning
- Ozone catalyst can be avoided
- Measurement ranges down to 5 g/Nm<sup>3</sup>
- Long-life mercury lamp
- Warranty 3 years, 5 years on the UV lamp
- High accuracy, error less than 0.5%
- Pressure and temperature compensated
- Built-in sample gas filter
- Built-in purge unit for automatic zeroing
- Display in g/Nm<sup>3</sup>, %wt/wt, or ppm<sub>v</sub>
- Timing sequence for automatic zeroing
- 4-20 mA and 0-10 V isolated outputs

## APPLICATIONS

- Ozone measurement in moist sample gas
- Municipal off-gas measurement
- Ozone measurement at atmospheric or sub-atmospheric sample pressure

The OZONE-IN-OFF-GAS ANALYZER is an ozone analysing system for moist ozone off-gas, typically consisting of the three major components:

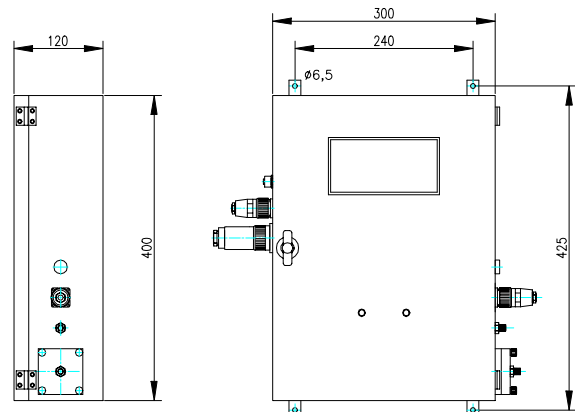
- UV-photometric ozone analyser
- Peltier-electric sample gas dryer
- ozone resistant sample gas pump

Measuring the ozone content in an ozone process off-gas is not a simple task. Not one process actually equals the other. Usually the ozone off-gas comes from a reactor vessel at about atmospheric pressure, and has a high dew point temperature equal to, or even exceeding, the ambient temperature. An ozone resistant sample gas pump is needed to bring the sample gas to the ozone analyser. To prevent condensation in the sample tube, water vapor has to be removed from the sample to reduce dew point temperature below the deepest ambient temperature which could occur.

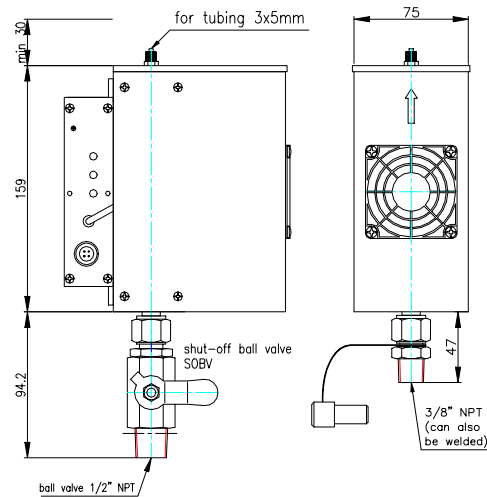
Using a sample gas pump has an important advantage: The ozone sample gas can be directed back to the reactor after it has passed the ozone analyser. No ozone destruct is necessary.

## SPECIFICATIONS

|                                 |   |
|---------------------------------|---|
| measurement principle           | dual-beam UV photometer (254 nm), no moving parts   |
| MTBF                            | instrument incl. UV lamp 65,000 h, excl. UV lamp 120,000 h  |
| UV lamp                         | low pressure mercury lamp, long life design, burnt-in for 300 h   |
| display                         | 16 character alphanumeric backlit LCD   |
| concentration ranges            | 50, 100 g/Nm <sup>3</sup> , selectable units g/Nm <sup>3</sup> , %wt/wt and ppm <sub>v</sub>  |
| optional ranges                 | 5, 10, 20 g/Nm <sup>3</sup> , selectable units g/Nm <sup>3</sup> , %wt/wt and ppm <sub>v</sub>  |
| accuracy                        | after zeroing the max. error is the sum: 0.4% of measurement + 0.1% of scale  |
| repeatability error             | 0.2 % of measurement  |
| zero drift                      | typ. 0.2% of range per day, after warm-up, non-cumulative   |
| max. inlet pressure             | 1 bar above pressure range  |
| ambient temperature             | ozone analyser: 0 - 50°C (non-condensing), dryer: contact factory!  |
| materials in contact with ozone | quartz (cuvette windows), Al <sub>2</sub> O <sub>3</sub> (cuvette), FPM (window seals), PTFE (tubing), stainless steel (fittings, cuvette spacer)   |
| inlet gas port                  | for 3x5 mm (1/8" x 3/16") tubing, opt. 4x6 mm, or 1/8" or 1/4" or 6mm Swagelok<br>Built-in sample gas filter is standard  |
| outlet gas port                 | for 4x6 mm tubing   |
| flow rate                       | 0.5 l/min typical   |
| temperature compensation        | is standard   |
| pressure compensation           | with built-in cuvette pressure transducer, for ozone measurement at an arbitrary systemic pressure, abs. pressure range 1.15 bara (optional 1.5 or 2.0 bara, see text, please specify range)<br>units selectable: bar, psi, Torr, MPa |
| signal outputs                  | concentration 4 - 20 mA (isolated, active)<br>concentration 0 - 10 V (isolated)   |
| concentration alarms            | High Alarm, Low Alarm, latching, not latching   |
| control input                   | set to zero (24 V, 18 mA, isolated)   |
| control outputs                 | relay contacts, 28 V, 0.5 A, isolated:<br>Lamp Low, Cuvette Dirty, High Alarm, Low Alarm  |
| error handling                  | Error Relay: 30 V, 1 A, summarizing instrument failures<br>Warnings and errors: Lamp Low Warning, Lamp Low Error, Lamp Off Error, Cuvette Dirty Warning, Cuvette Dirty Error, Overrange, Overpressure                                 |
| serial interface                | RS-232, bidirectional, 2400 - 38400 Baud  |
| automatic zeroing               | with internal purge pump and solenoid valve   |
| software                        | BMT 964 Link, instrument configuration and readout of Event and Error Logs on a Windows PC  |
| power                           | wide range input: 100 - 240 VAC, 200 VA   |
| dimensions (W x H x D)          | 400 x 300 x 120 mm (W x H x D)  |
| weight                          | approx. 6.5 kg  |
| compliance                      | CE-marked (EMC & safety), cTUVus NRTL-listed  |



main cabinet BMT 964 OG



Peltier-electric dryer DH5

The ozone analyser is the OZONE ANALYZER BMT 964 which has proved its reliability in thousands of installations.

Our ozone resistant Sample Gas Pump SGP-5 has proved its longevity over many years. The unsurpassed simplicity of our Peltier-electric Sample Gas Dehumidifier DH5 makes it ideal for processing moist ozone off-gas prior to ozone measurement (refer to the appendix "Sample Gas Drying")

We recommend to feed the sample gas back to the reactor vessel after ozone measurement (see sketch above). Feeding back the sample avoids problems with a catalytic ozone

destruct which could be deteriorated or destroyed by substances contained in the off-gas. Feedback configuration is restricted to applications with low sample gas pressure (about -0.1 to 1.0 barg).

The long service life of the sample gas pump SGP-5 is due to their minute stroke of only  $\pm 0.7$  mm, and their rugged brushless DC motor. With zero pressure head the pump moves 0.5 l/min of sample gas. Against a pressure head of 100 mbar it still can pump 0.35 l/min. In the recommended feedback configuration, the actual pressure head is only a few millibars. The only important restriction for the pump is its sensitivity to the pressure difference between the inner (systemic) and the outer (atmospheric) pressure. The systemic pressure may not be lower than 100 mbar below atmospheric. But it may be up to 1 bar higher than atmospheric.

Sample gas flow rate is measured by an ozone resistant thermal mass flow meter. A LOW FLOW warning is given when the flow rate drops below about 0.3 l/min, e.g. when the sample gas pump would fail.

The OZONE-IN-OFF-GAS ANALYZER is contained in a wall mount aluminum cabinet 40 x 30 x 12 cm (H x W x D) with yellow powder coating. The Sample Gas Dehumidifier DH5 is held by an SS fitting, with or without a shut-off ball valve (SOBV). The fitting sizes are 3/8" NPT (fitting without SOBV) or 1/2" NPT (fitting with SOBV).

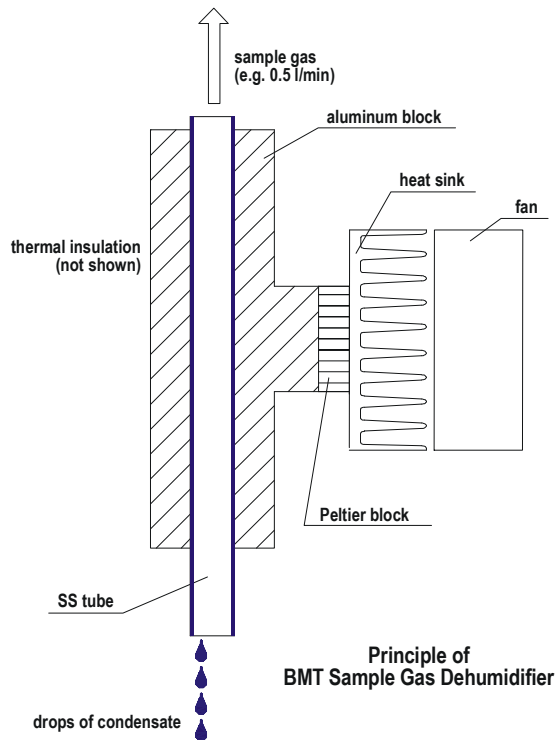
Ozone off-gas leaving an ozone process is not always at atmospheric pressure. Sometimes it is at an elevated pressure, and transport of the sample gas to the ozone analyser does not need a pump. Sometimes the off-gas is not moist, and does not need drying. The OZONE-IN-OFF-GAS ANALYZER can be adapted to every one of these different conditions.

If your ozone-in-off-gas measurement problem is different, and if it needs discussion, please do not hesitate to contact us!

**APPENDIX**      TechNote TN-3  
**Sample Gas Drying**

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/m<sup>3</sup>).

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 lowest 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 Dehumidifiers 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.

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.

When the dew point temperature  $T_D$  is between the ambient temperature  $T_A$  and about  $T_A + 10\text{ K}$  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 10 K 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.

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