

TechNote TN-6

Zeroing an Ozone Analyzer

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Photometric ozone analysers are analog instruments. They need zero adjustment (zeroing) from time to time. But usually they do not need span adjustment (calibration). The reason is that the photometric measurement principle is ratiometric. Sensitivity of the photometer practically is defined only by the cuvette length - which is very stable. Every instability of the photo detectors, or of the radiation source, or of the transparency of the cuvette windows, will be compensated by zeroing, refer to our TechNote TN-1:

www.bmt-berlin.de/ozone_handbook.pdf

Transparency of the cuvette windows is influenced by dirt - whatever this is - deposited on the windows. We say: "The only real enemy of an ozone analyser is DIRT".

Zero stability of the UV-photometric OZONE ANALYZER BMT 964 is high, as long as the cuvette windows remain clean. The offset drift after one month typically is less than one percent of range, usually it is much less.

Actual zero "drift" of an ozone analyser mainly is due to dirt on the cuvette windows, dirt which has entered the analyser together with the ozone sample gas. This is the reason why it really pays off to do everything possible to protecting the ozone analyser from any kind of dirt contained in the ozone sample gas.

The zeroing function of an ozone analyser may be initiated only when the cuvette is absolutely free of ozone! In other words: The ozone analyser must not be zeroed unless

the cuvette had been sufficiently purged with an ozone-free purge gas, usually oxygen or clean air.

The ambient air around an ozone analyser possibly could contain a bit of ozone. If the common TLV (Threshold Limit Value) of 0.1 ppmv is not exceeded the ambient air is good enough as a zero ozone reference. The ozone content of 0.1 ppmv equals 0.000214 g/Nm³. When used as the zero reference for an ozone analyser with the measurement range of e.g. 200 g/Nm³ the ozone content of the ambient could result in a zero error of maximally 0.000107 % of range.

The procedure of zeroing a photometric ozone analyser has two steps:

1. pneumatic: purging the cuvette with an ozone-free gas
2. electric: zeroing the photometer circuit

Step 2. (zeroing) can be made by push button action from the front panel, or remotely by different electric signals, or automatically by the internal zero timer.

Step 1. (purging) can be made arbitrarily by the user (10 seconds at about 1 l/min), or by what we call a "purge unit". A purge unit is the combination of a 3-way electric solenoid valve and a small air pump driven by an electric motor. The standard OZONE ANALYZER BMT 964 and the portable version BMT 964 BT do not have a purge unit, but a built-in purge unit is available as an option. All other BMT ozone gas analysers are equipped with a purge unit.

The purge gas (usually pumped by a small electric air pump) has to overcome the pressure head at the outlet of the ozone analyser. In the VENT mode the outlet of the analyser is at atmospheric pressure, or a few millibars above. But if the pressure head is higher the pump has to be capable of driving enough purge air through the analyser, even against this higher pressure head. In the BMT Off-Gas System e.g. the purge pump can purge the instrument even against a pressure head of 1 bar.

The OZONE ANALYZER BMT 964 has an electric relay contact (28 V, 0.5 A max.) for switching an external purge unit provided by the user. After initiation of the Auto Zero function the purge unit is activated, and 10 seconds later the photometer is set to zero (see the BMT 964 manual, chapter "7 Zeroing the BMT 964", copy attached).

It is important to not mix up the names, and the meanings, of the two steps necessary for zeroing an ozone analyser. We call the simple photometer zero setting "Zeroing" (step 2.). The complete procedure, including purging (step 1.) with ozone-free gas, we call "Automatic Zeroing". This wording is arbitrary, of course. But it remains inevitable that the user of an ozone analyser really knows about the importance of zeroing his instrument.

How often should the ozone analyser be zeroed? This is a question we cannot answer. The reason is simple: We do not know how much dirt gets into a certain analyser. In case no dirt is contained in the sample gas (e.g. in the ultra clean semiconductor industry) we recommend to automatically zero the instrument every 24 hours, or - if manually - at least once a week, depending on the accuracy demanded.

When the OZONE ANALYZER BMT 964 is zeroed it gives you an information about the degree of dirtytness. This information is stored

in the Event Log of the BMT 964, which holds 48 time-stamped entries. The Event Log can be retrieved with the Windows software "BMT 964 Link" coming with the instrument. This information on the increase of cuvette dirtytness over time provides a valuable aid for determining the zero interval.

From the BMT 964 Manual:

7 Zeroing the BMT 964

The zero reading of the instrument (the value displayed without any ozone in the cuvette) may undergo slight changes, which among others can be induced by

- namely: soiling of the cuvette
- aging of the UV-lamp
- influence of temperature

In order to compensate these effects BMT MESSTECHNIK recommends zeroing the BMT 964 every 24 hours. Depending on the demands on accuracy and individual stability of an instrument the time interval between two zeroing actions can be much longer.

It is very important to really make sure that no ozone is present in the cuvette during zeroing! Before zeroing the BMT 964 has to be purged with oxygen or filtered air.

Zeroing can be initiated in the following ways:

- pressing the ZERO button with succeeding confirmation
- driving the Zero-input (Pin 11) with 24 VDC
- via the serial interface in User-Mode by sending the character 'A'
- automatically, time controlled by the BMT 964 internal timer (see manual, page 20)
- via the serial interface in Link-Mode by sending the command *83#3.14159
- from a Windows PC by using the program BMT 964 Link

The display will show information about zeroing. In each zero cycle the dirtytness of the cuvette is determined. This value is displayed on the front panel and sent via the serial interface. Increased

dirtytness will lead to a Dirty Warning or a Dirty Error respectively (see page 23 of the manual).

During the whole zeroing action the last measured concentration result is used to set the analog outputs to a constant value. The serial interface in User-Mode sends out the last measured concentration and, instead of dirtytness, the string 'AAAA'.

Automatic Zeroing with Control of Purge Gas

Purge gas control can be taken over by the BMT 964. The relay contact Purge (Pin 2) is used for this purpose. This contact (max. 28V, 0.5A) can switch e.g. a BMT Purge Unit PUDC2, which consists of a solenoid valve and a small air pump with dust filter. An external 24 VDC power supply is necessary to power the PUDC2. Alternatively, the instrument can be ordered with a built-in Internal Purge Unit. In both cases the parameter **Autozero Interval** has to be set to a time interval between 1 hour and 99 hours (either by use of the front panel menu, the program BMT 964 Link or the Link-Mode command *45#). Automatic zeroing will be activated after this time interval. Additional automatic zero cycles can be initiated within this interval, which reset the built in Zero-Timer.

In case **Autozero Interval** is set higher than zero (1 to 99h), there will be an additional automatic zero cycle approx. 15 minutes after each power up. Also, the purge contact is activated on each zeroing cycle (only if Autozero Interval > 0h).

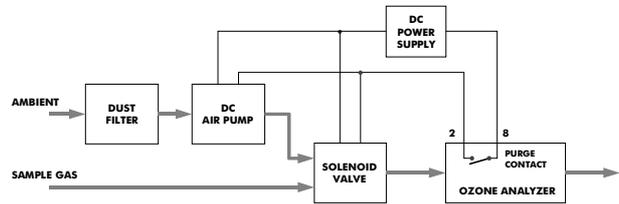
Attention: Activation of the Automatic Zeroing with Control of Purge Gas is meaningful only if the relay contact Purge (pin 2) is used to somehow activate purging of the cuvette in order to remove any ozone.

One complete automatic zero cycle needs 20 seconds. It consists of three phases:

1. purge period, 10 seconds (the instrument displays *Purging...*)
2. zero calculation, 2 seconds (it displays *Zeroing...* and the calculated cuvette dirtytness)
3. waiting period, 8 seconds (it displays *Sampling...*), during which the cuvette is refilled with ozone.

During the complete zeroing period of 20 seconds the analog outputs are set to the stored

concentration value measured immediately before the start of the zeroing cycle. In the User Mode the RS-232 transmits the same concentration, and 'AAAA' instead of the cuvette's dirtytness.



The above setup shows the components needed for automatic zeroing. It is very important to provide automatic switching of purge gas, before the Autozero Interval is set to other values than zero hours! Otherwise, the instrument could possibly calculate the zero value with ozone in the cuvette. The Autozero Interval is described on page 17 of the manual.

It should be pointed out, that setting the Autozero Interval to zero hours actually means, that the analyzer does **not** go through the purge cycle described above and does **not** activate the Purge Control contact! In this case, the user shall never initiate zeroing with ozone in the cuvette. With the option Internal Purge Unit, or in the cabinet version, the analyzer takes care about switching to zero gas, itself.

In case the OZONE ANALYZER BMT 964 is equipped with an Internal Purge Unit (solenoid valve and air pump with particle filter) as an option, e.g. in the model BMT 964 BT the terminal 2 may not be connected externally because it is already connected to the internal 5 VDC power supply!