

DOD - Defined Ozone Dosage

A method to prepare ozonated water with a defined ozone concentration



FEATURES

- Concentrated, freshly prepared ozone solution in ultra-pure water
- Precise measurement of dissolved ozone
- Ozone content up to 30 mg/l (30 ppmw)
- Stable ozone concentration

APPLICATIONS

- Preparation of defined ozone stock solutions
- Experimental ozone-in-water processes

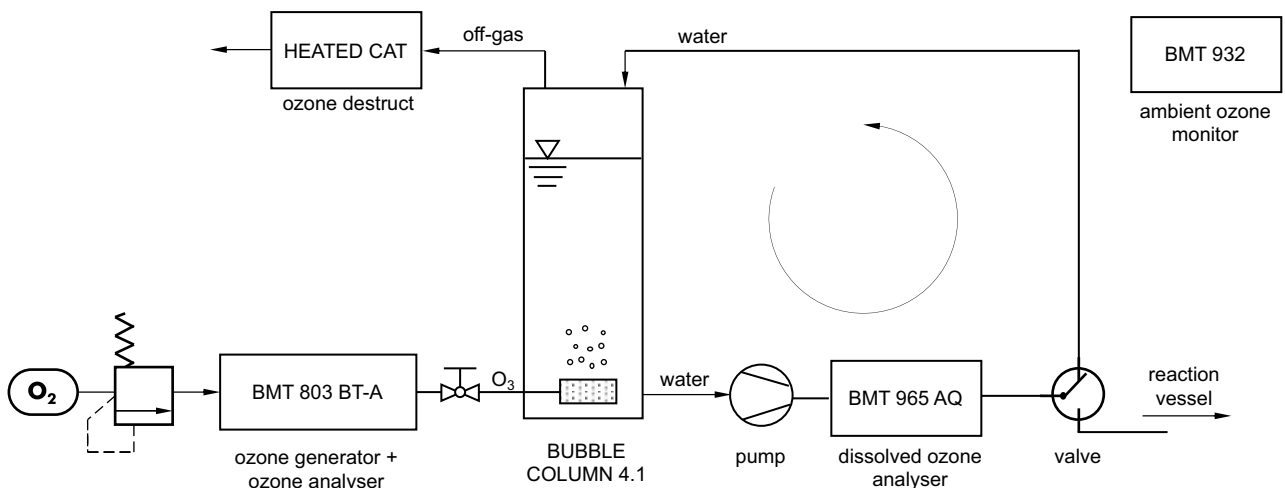
Principle of Defined Ozone Dosage (DOD)

The Defined Ozone Dosage (DOD) method is an excellent procedure for experimental ozone-based processes in water treatment applications to investigate the complex kinetics of ozone-related reactions and the effectiveness and application of dissolved ozone through laboratory experiments under controlled conditions. It precisely determines the amount of ozone that is brought into the process. The DOD setup is based on a recirculating system that produces an ozonated stock solution in ultra-pure water with a constant and uniform ozone concentration. Once a stable stock solution has been prepared, a defined volume of the ozonated solution - with a well-known amount of ozone - is released into a reactor and mixed with a defined volume of the sample water to be treated. Effective stirring is recommended to achieve a uniform concentration in the reaction vessel.

Equipment and Materials

The OZONE GENERATOR BMT 803 BT-A is a small, air cooled ozone source and provides all necessary controls and displays for operating the ozone generator, including the OZONE ANALYZER BMT 965 ST to measure and control the gas phase ozone concentration. Operation is from oxygen. The BUBBLE COLUMN BBC 4.1 is used to dissolve ozone in water. It consists of a glass cylinder with a volume of 1.4 litres, a diffuser made of porous glass to produce fine gas bubbles and a special head for easy tubing feed-through. The counter-current gas-liquid flow offers an enhanced mass transfer efficiency.

The OZONE-IN-WATER SENSOR BMT 965 AQ is a UV photometer for direct and real-time measurement of ozone dissolved in pure water. The HEATED CAT is a catalytic ozone destruct designed to destroy the ozone in the off-gas. Heating is always necessary when the stock solution temperature exceeds the ambient temperature, as this prevents condensation. The OZONE MONITOR BMT 932 is recommended for ambient ozone measurement and TLV monitoring.



Case Study: BASF SE and Bayer AG utilise the DOD method to analyse the impact of potential by-products of active substances in ozone water treatment

Problem

Manufacturers of plant protection products and biocidal products are obliged to identify and assess the risk of these substances to prevent any harmful effects on human health, either directly or indirectly through substances that may be formed during water treatment. A recently published guidance [1] provides a framework for applicants and authorities to provide objective evidence by compiling and submitting comprehensive test data. An experimental procedure is proposed to identify potential by-products resulting from ozone treatment processes. Following the guidance, a significant amount of testing is now required and consequently, it is of highest importance to establish a test setup that is capable of providing reliable and reproducible results.

Solution

Researchers from BASF SE and Bayer AG decided to establish laboratory ozonation test facilities to analyse the impact of potential by-products of active substances in water treatment. In these projects BMT Messtechnik GmbH has been involved in planning and prototyping the Defined Ozone Dosage (DOD) test setups based on the sketch on page 1.

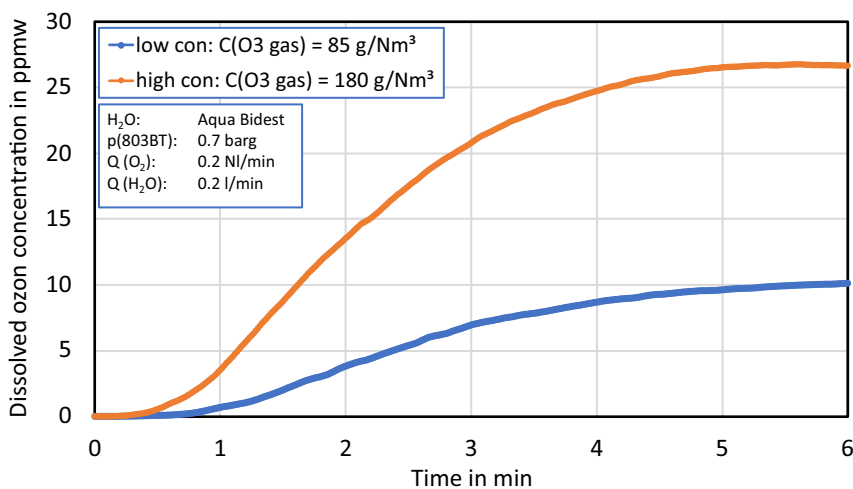
Ozone is produced by the OZONE GENERATOR BMT 803 BT-A, which operates on the corona discharge principle. Pure oxygen is used as feed gas. Oxygen mass flow rate, gaseous ozone concentration and pressure are regulated on the ozone generator. The dissolution of ozone involves mass transfer from the gas phase to the liquid phase. This is achieved by injecting gaseous ozone into the ultra-pure water loop through the BUBBLE COLUMN BBC 4.1. The fine bubbles, and also the counter-current gas-liquid flow contribute an enhanced mass transfer efficiency. The ozonated water is circulated for a few minutes by an ozone-resistant pump, while the OZONE-IN-WATER-SENSOR BMT 965 AQ measures the dissolved ozone concentration in real-time. Once a stable and uniform ozone stock solution has been prepared, a defined volume - with a well-known amount of ozone - is dosed into a reactor and mixed with a defined volume of the solution to be treated. The reaction takes place with uniform concentration distribution by effective stirring of the sample.

The ozone in off-gas is destroyed by the ozone destruct unit HEATED CAT. A multi-channel ambient OZONE MONITOR BMT 932 is used to measure and monitor the ozone content of the ambient air for TLV monitoring.

Results

The robust and reliable laboratory test setup provides precise and reliable measurements with superior stability in pure water applications. A saturated stock solution is formed within a few minutes and is then available for use in batch reactors.

Common dissolved ozone concentration can reach about 30 mg/l (30 ppmw) in ultra-pure water at 20 °C water temperature, depending on the oxygen flow rate, the water flow rate and the ozone in gas concentration. The figure below shows the results for two setpoints with different ozone in gas (on-gas) concentrations.



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[1]: Guidance document on the impact of water treatment processes on residues of active substances or their metabolites in water abstracted for the production of drinking water, doi: 10.2903/j.efsa.2023.8194