

# IMPORTANCE OF HIGH OZONE CONCENTRATION AND HIGH GAS PRESSURE

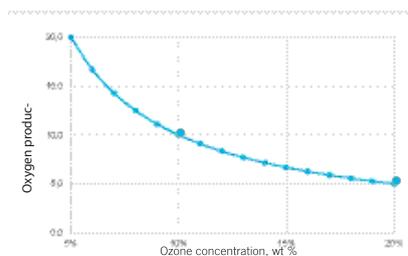
High ozone concentration is redefining the way ozone installations are designed as it enables key improvement to performance at several different points in the system.

An ozone installation for water treatment is more than an ozone generator. The efficiency of the total installation is very important for treatment performance. Using Primozone ozone technology together with a correctly designed ozone solution will mean both lower investment costs and reduced running costs.

## OZONE CONCENTRATION

During the production of ozone (see fact box to the right) two possible reactions can occur. Depending on the ozone generator construction the probability of the preferred reaction i.e. creating ozone can be increased. Oxygen will always be present and therefore the outgoing gas will always be a mixture. The ratio between the outgoing ozone and the oxygen is what constitutes the ozone concentration. Ozone concentration is usually expressed using wt % or g/Nm<sup>3</sup>.

1. wt % - typically around 10 wt % meaning that the ozone gas is 10 percent of the total weight of the gas mixture
2. g/Nm<sup>3</sup> - meaning the weight of ozone in comparison to the remaining volume of the gas, at a given temperature and pressure.



THE GRAPH ABOVE SHOWS SAVINGS IN OXYGEN AT HIGH OZONE CONCENTRATIONS. FROM 10 TO 20 WT% THE OXYGEN

The ozone amount, measured in g/h is the total amount of ozone produced every hour. Depending on the concentration of the gas mixture, the total amount of oxygen needed to produce ozone will vary. For example, if the ozone concentration is doubled, the amount of oxygen feed to the system is reduced to half, see graph above.

## Ozone dissolution

The process of dissolving ozone in water is optimized by maximizing the surface area between the gas and the water. This can be done by using for example bubble diffusers, venturi injectors or static mixers.

Given a certain gas volume, very small gas bubbles have a bigger surface than one big bubble. This means that small gas bubbles are dissolved better.

## BASICS - OZONE PRODUCTION

Industrial ozone generators are feed with 95% (min) oxygen from for e.g. PSA or LOX. The ozone generator then adds energy to the diatomic oxygen molecules via electrical discharges, hence breaking up the covalent bond between the oxygen atoms that form the molecule. This results in  $O_2 = 2 \times O_1$ .

The  $O_1$  (usually referred to as oxygen radicals) tries to find a lower energy state and depending on the availability of other molecules, they form 1 of 2 possible reactions with other oxygen atoms/molecules, ie ozone ( $O_1 + O_2 = O_3$ ) or oxygen ( $O_1 + O_1 = O_2$ )

Both these reactions will occur inside of an ozone generator, making the outgoing gas from an ozone generator into a gas mixture between oxygen and ozone.

Once the ozone is produced it has to be dissolved into the water that needs to be treated.

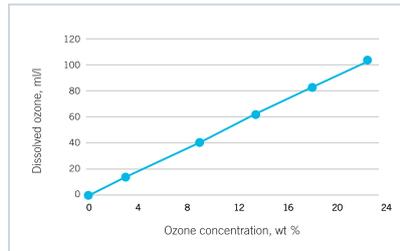
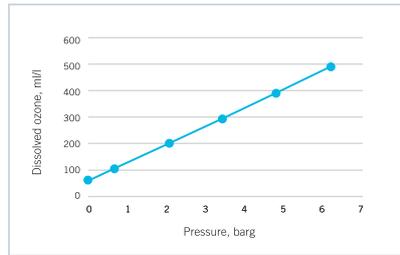
When the ozone is successfully dissolved it will find pollutants to react with. The ozone reaction or ozone oxidation occurs when the ozone is broken down into oxygen ( $O_2$ ) and oxygen radical ( $O_1$ ). The radical reacts with the pollutant in the water.

Once the oxygen radical has reacted with the pollutant all that remain is oxygen ( $O_2$ ).

Maximizing the surface will only dissolve ozone until the saturation limit is reached. To dissolve more ozone the saturation limit can be pushed further up by increasing the pressure. When dissolving ozone in water the biggest challenge is to dissolve enough ozone to reach the PPM demand of the customer.

Methods of increasing ozone dissolution in water. Physically one can do two things, reduced the amount of oxygen that needs to be dissolved (e.g. having higher ozone concentration) or increasing the pressure of the dissolution system. It all comes down to the physical law formulated by William Henry in 1803, also known as Henry's law;

“At a constant temperature, the amount of a given gas that dissolves in a given type and volume of liquid is directly proportional to the partial pressure of that gas in equilibrium with that liquid.”



AMOUNT OF DISSOLVED OZONE IS DIRECTLY PROPORTIONAL TO THE GAS PRESSURE AT ANY GIVEN TEMPERATURE HERE 10C

### PRIMOZONE OZONE TECHNOLOGY

The dissolution system must have a lower pressure than the ozone generators to enable a gas flow from the generators to the dissolution system. But the saturation limit for the water is based on the actual pressure at the dissolution; hence the discharge pressure of the ozone generator is crucial.

### PRIMOZONE OZONE TECHNOLOGY

The high pressure (up to 4 bar/58 psi) and high ozone concentration (up to 20 wt%) enabled by the Primozone ozone technology will increase the performance of the complete ozone installation by;

- reducing the amount of oxygen needed with 50%
- enabling up to 95% more dissolved ozone in the water
- creating 50% less off-gas

In the end this means

- lower investment costs and
- reduced running costs

