Ozone

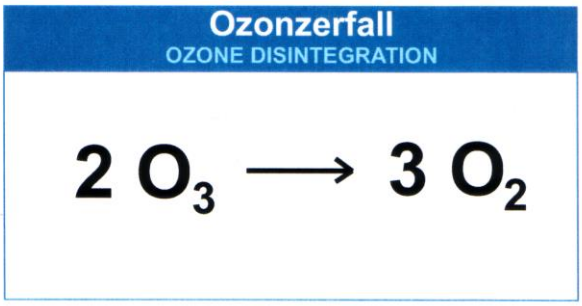
General information about ozone and how to manage it

When using short-wave ultra-violet radiation (UV), atmospheric oxygen is transformed and ozone is produced. The following information will give the user some general basic background and help for the handling of ozone.

Basics

Ozone (O_3) is a molecule consisting of three oxygen atoms as opposed to atmospheric oxygen (O_2) which has two oxygen atoms. Similarly, atmospheric ozone is invisible but has a slightly higher molecular weight. Ozone is a toxic gas. Ozone's odour (the name arises from the Hellenic word, ozein = to smell) is described differently depending on its concentration. Some say its smell is similar to cloves, chlorine or oxides of nitrogen.

UV radiation below 240 nm produces ozone (the maximum is around 187 nm). The ozone is produced for example during the operation of uv lamps or electrostatic discharge.



$$3\,O_2 \underset{}{\overset{h \cdot \nu}{\rightleftharpoons}} 2\,O_3$$

In everyday surroundings, ozone can be found in strong sun light, using a sun-bed, during lightning strikes, electric arc welding, household appliances and laser printers. The formation of ground level ozone during sunny days is increased by nitrogen oxides (exhaust gas). Ozone absorbs uv and this is the reason why we need it below the stratosphere where it absorbs uv and protects us against damage from the short-wave uv energy of the sun.

Very small quantities of ozone can be detected by the human nose. The threshold of nasal detection is about 0,01 ppm (ppm = parts per million), depending on the person. In closed rooms it is detected faster. The average ozone concentration in closed rooms is about 0.0015 ppm.

There are no internationally standardised limited values for ozone concentrations in the workplace. Some countries specify maximum values, others indicate that appropriate measures must be implemented at the workplace as part of an individual assessment.

Ozone concentrations higher than 0.1 ppm can deteriorate lung function; this means that the gas exchange in the lungs of carbon dioxide with the di-oxygen is disrupted. Concentrations above 0.2 ppm will cause a lack of concentration, chest pains and headache or dizziness. This phenomenon will disappear with the absence of ozone. Consequential damages are currently not known. Some sensitive people may have been subjected to this phenomenon at lower ozone concentrations but often other contaminants or additional contaminants are present, for example nitrogen oxides from exhaust gases. In our experience, this subject should be taken seriously.

Ozone degenerates itself. It dissociates itself spontaneously ($O_3 \rightarrow O_2 + 1/2\ O_2$, $\Delta H = +286$ kJ) with a half-life of three days at 20°C. At higher temperatures the dissociation will be much quicker. The half-life strongly depends from the ambient conditions in the room and the amount of dust particles in the air. In some cases the uv-system is cooled only by water around the uv lamp. This produces very high air temperatures around the lamp which leads to a quick degeneration of ozone.

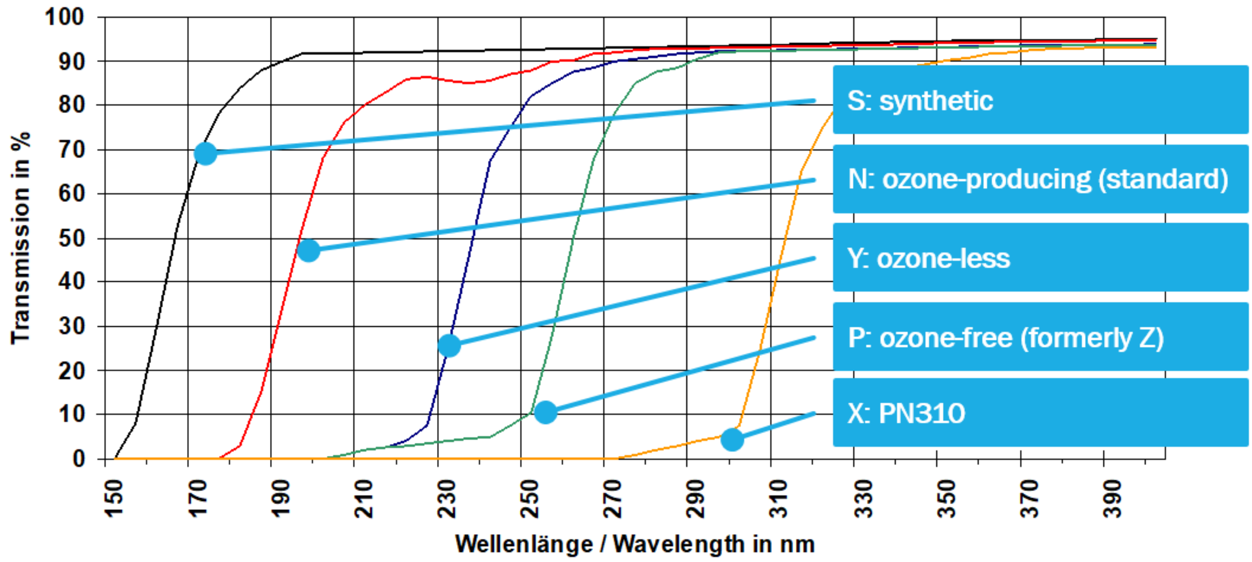
How to handle ozone – practical advice

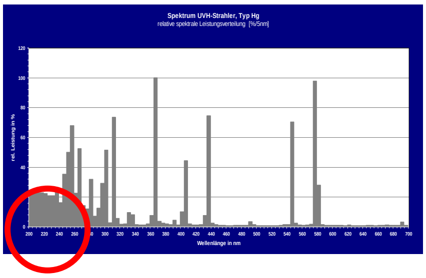
Because of the different types of uv curing stations / uv dryers and the fact that each system uses different exhaust air volumes, **no general statement can be made regarding the quantity of ozone produced**. The ozone levels should be measured at each work station or exhaust duct. The most typical method is to use a ozone measuring tube (e.g. test tube for measuring range 0,05...0,7 ppm). A defined amount of air is pumped through the test equipment. The colour change in the test tube gives the ozone concentration.

Our **ozone-free lamps** (Glass type P) have a built-in filter which filters out wavelengths below 235 nm (at room temperature) which results in no production of ozone. Because there is a part of the UVC wavelength missing this could result in insufficient curing. But this will depend on the chemistry of the substrate.

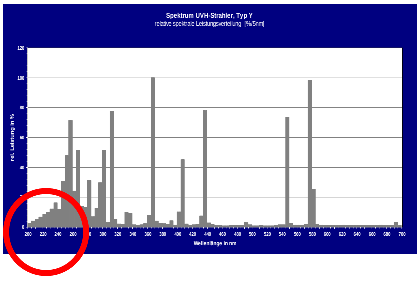
As an alternative, **ozone-less** lamps (Glass type Y) can be used, which filter out radiation below 215nm. This produces ozone only if the temperature is low and during the initial start up. The curing results must be checked carefully as they depend on the chemistry of the substrate.

Transmission curves of different quartz glass types:

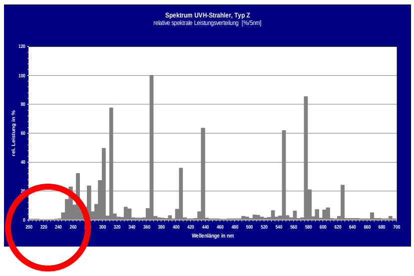




Standard quartz glass



ozone-less quartz glass (Y)



ozone-free quartz glass (Z)

Conversion of different ozone units

By calculation with the molar mass the ozone concentration can be converted from ppm to mg/m³ and vice versa (valid at p=1013 hPa and 20°C acc. to DIN 1319):

c_{mg} = Molar Mass Ozon / Molvol. Ozon x c_{ppm}

Calculation: c_{mg} = 48g/mol / 24,1 L/mol x c_{ppm}

Note for converting the units:

1 mg/L = 1000 mg/m^3
1 ppm = 1000 ppb = 2 mg/Nm^3