HOW IT WORKS

# OC Innovations OC1 & OC2 units – The Science behind the technology

## Technical briefing: Reactions of Ozone

Ozone was proposed as a distinct chemical compound by Christian Friedrich Schönbein in 1840, who named it after the Greek verb ozein ("to smell"), from the peculiar odor in lightning storms. The formula for ozone, O3, was not determined until 1865 by Jacques- Louis Soret and confirmed by Schönbein in 1867.

### Physical properties

Ozone is a pale blue gas, slightly soluble in water and much more soluble in inert non-polar Solvents such as carbon tetrachloride or fluorocarbons, where it forms a blue solution. Most people can detect about 0.01 ppm of ozone in air where it has a very specific sharp odour somewhat resembling chlorine bleach.
Structure
According to experimental evidence from microwave spectroscopy, ozone is a bent molecule, with symmetry similar to the water molecule.

### OC1 & OC2 units

The OC Innovations OC1 and OC2 untis designed to inject ozone into ductwork at a concentration of 1ppm. This is consumed during the process and we routinely measure 0.06ppm at the egress point. This is further reduced as it enters the atmosphere through a process of degradation to molecular oxygen and dispersion in the air.

### The degradation mechanism is:

$2O_3 \rightarrow 3O_2$
As such we find that the ozone levels are not measurable beyond 2 meters from the egress point. In sensitive areas we recommend installing a 0.1s dwell time copper oxide impregnated activated carbon which catalyses the destruction of ozone.

This is suitable for the low levels of ozone (0.06ppm which are typically found).


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## Reactions

Ozone is a powerful oxidizing agent, far stronger than $O_2$. It is also unstable at high concentrations, decaying to ordinary diatomic oxygen (in about half an hour in atmospheric conditions): $2\ O_3 \rightarrow 3\ O_2$

This reaction proceeds more rapidly with increasing temperature and increased pressure.

## With nitrogen and carbon compounds

Ozone oxidizes nitric oxide to nitrogen dioxide: $NO + O_3 \rightarrow NO_2 + O_2$ This reaction is accompanied by chemiluminescence. The $NO_2$ can be further oxidized: $NO_2 + O_3 \rightarrow N_2O_3 + O_2$

The $N_2O_3$ formed can react with $NO_2$ to form $N_2O_5$: Solid nitryl perchlorate can be made from $NO_2$, $ClO_2$, and $O_3$ gases: $2\ NO_2 + 2\ ClO_2 + 2\ O_3 \rightarrow 2\ NO_2ClO_4 + O_2$
Ozone does not react with ammonium salts but it oxidizes with ammonia to ammonium nitrate: $2\ NH_3 + 4\ O_3 \rightarrow NH_4NO_3 + 4\ O_2 + H_2O$ Ozone reacts with carbon to form carbon dioxide, even at room temperature:
$C + 2\ O_3 \rightarrow CO_2 + 2\ O_2$

## With sulfur compounds

Ozone oxidizes sulfides to sulfates. For example, lead(II) sulfide is oxidised to lead(II) sulfate: $PbS + 4\ O_3 \rightarrow PbSO_4 + 4\ O_2$ Sulfuric acid can be produced from ozone and either elemental sulfur or sulfur dioxide: $S + H_2O + O_3 \rightarrow H_2SO_4$
$3\ SO_2 + 3\ H_2O + O_3 \rightarrow 3\ H_2SO_4$ In the gas phase, ozone reacts with hydrogen sulfide to form sulfur dioxide: $H_2S + O_3 \rightarrow SO_2 + H_2O$ In an aqueous solution, however, two competing simultaneous reactions occur, one to produce elemental sulfur, and one to produce sulfuric acid: $H_2S + O_3 \rightarrow S + O_2 + H_2O$ $3\ H_2S + 4\ O_3 \rightarrow 3\ H_2SO_4$


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## Other substrates

All three atoms of ozone may also react, as in the reaction of tin(II) chloride with hydrochloric acid and ozone: 3 $SnCl_2$ + 6 HCl + $O_3$ -> 3

$SnCl_4$ + 3 $H_2O$ Iodine perchlorate can be made by treating iodine dissolved in cold anhydrous perchloric acid with ozone:
$I_2$ + 6 $HClO_4$ + $O_3$ -> 2 $I(ClO_4)_3$ + 3 $H_2O$

## Combustion

Ozone can be used for combustion reactions and combusting gases; ozone provides higher temperatures than combusting in dioxygen ($O_2$). The following is a reaction for the combustion of carbon subnitride which can also cause lower temperatures: 3 $C_4N_2$ + 4 $O_3$ -> 12 CO + 3 $N_2$ Ozone can react at cryogenic temperatures. At 77 K (−196 °C), atomic hydrogen reacts with liquid ozone to form a hydrogen superoxide radical, which dimerizes:[11] H + $O_3$  $HO_2$ + O 2 $HO_2$ -> $H_2O_4$

## Reduction to ozonides

Reduction of ozone gives the ozonide anion, $O_3^-$ . Derivatives of this anion are explosive and must be stored at cryogenic temperatures. Ozonides for all the alkali metals are known. $KO_3$, $RbO_3$, and $CsO_3$ can be prepared from their respective superoxides: $KO_2$ + $O_3$  $KO_3$ + $O_2$ Although $KO_3$ can be formed as above, it can also be formed from potassium hydroxide and ozone:[12] 2 KOH + 5 $O_3$ -> 2 $KO_3$ + 5 $O_2$ + $H_2O$ $NaO_3$ and $LiO_3$ must be prepared by action of $CsO_3$ in liquid $NH_3$ on an ion exchange resin containing $Na^+$ or $Li^+$ ions:[13] $CsO_3$ + $Na^+$ -> $Cs^+$ + $NaO_3$ A solution of calcium in ammonia reacts with ozone to give to ammonium ozonide and notcalcium ozonide:[11] 3 Ca + 10 $NH_3$ + 6 $O_3$ -> Ca·6$NH_3$ + $Ca(OH)_2$ + $Ca(NO_3)_2$ + 2 $NH_4O_3$ + 2 $O_2$ + $H_2$



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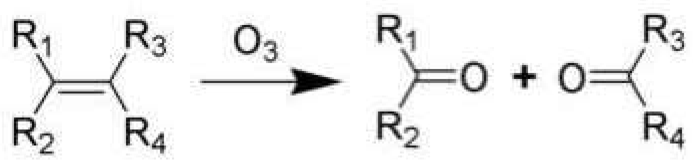
### Applications

Ozone can be used to remove manganese from water, forming a precipitate which can be filtered: 2 Mn2+ + 2 O3 + 4 H2O -> 2 MnO(OH)2 (s) + 2 O2 + 4 H+ Ozone will also detoxify cyanides by converting it to cyanate, which is a thousand times less toxic.v
CN- + O3 -> CNO− + O2 Ozone will also completely decompose urea:[14] (NH2)2CO + O3 -> N2 + CO2 + 2 H2O Ozone will cleave alkenes to form carbonyl compounds in the ozonolysis process.

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