

Ozone Disinfection and Sterilisation

A chemical-free technology

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By:

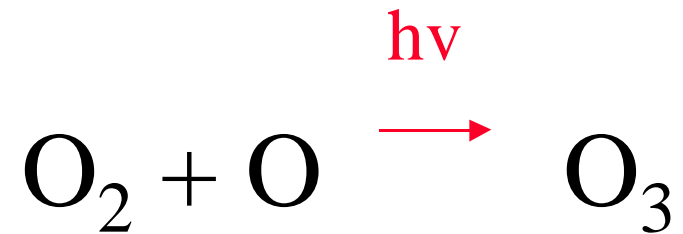
Marianne Salama, B.Eng

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Ozone

- Gas



- Half-life = 30 min.
- 1886: First use for disinfection
- 1907: Nice, Municipal Water Treatment

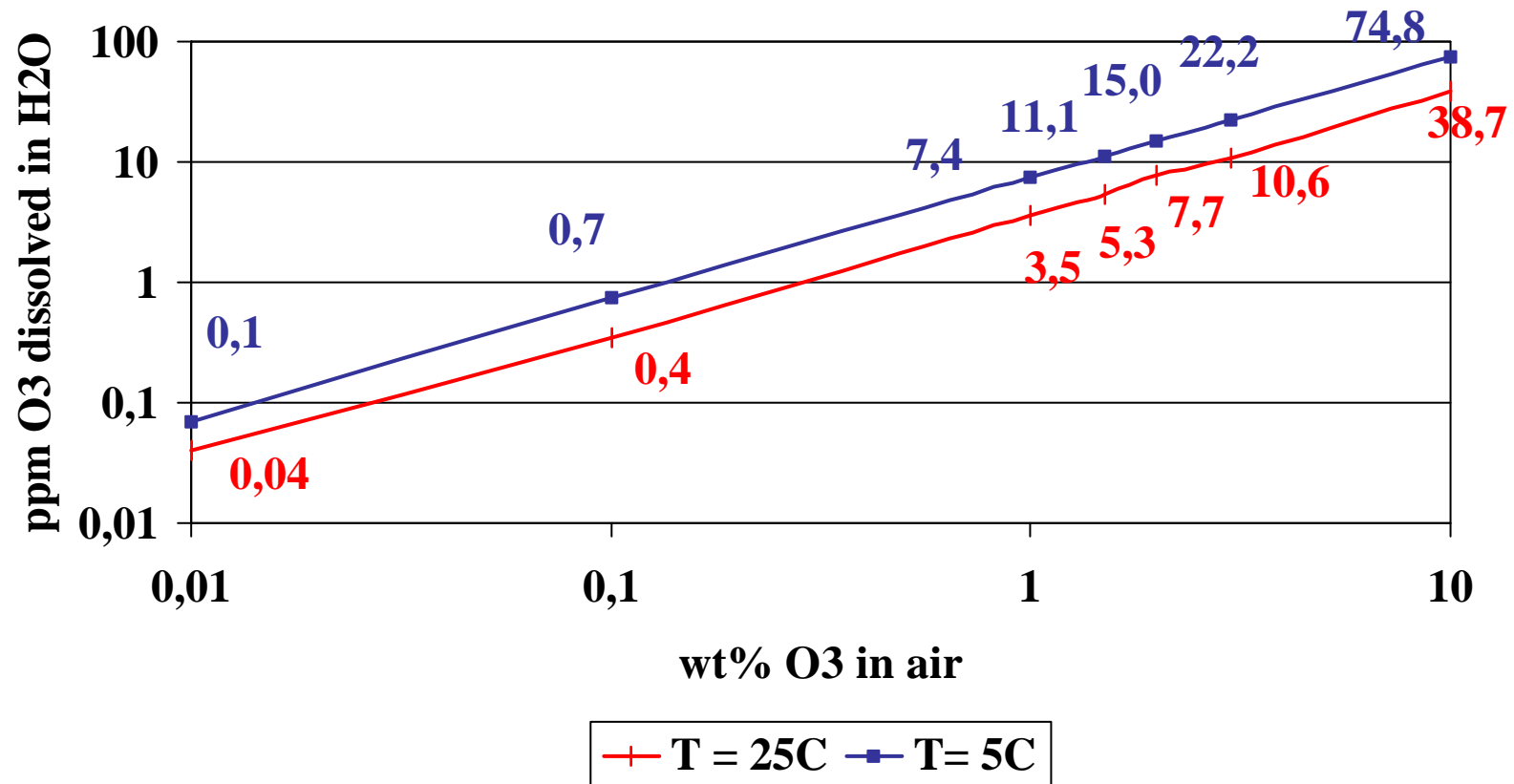
Reactivity

Oxidant	Redox (V)
OH^-	2.80
O	2.42
O_3	2.07
HOCl	1.49
Cl_2	1.36
H_2O_2	0.87
O_2	0.40

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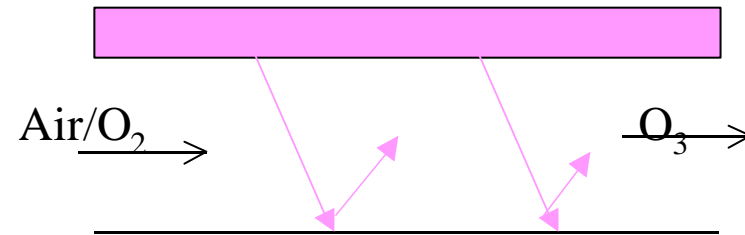
Mass Transfer

Water Technology, April 1998



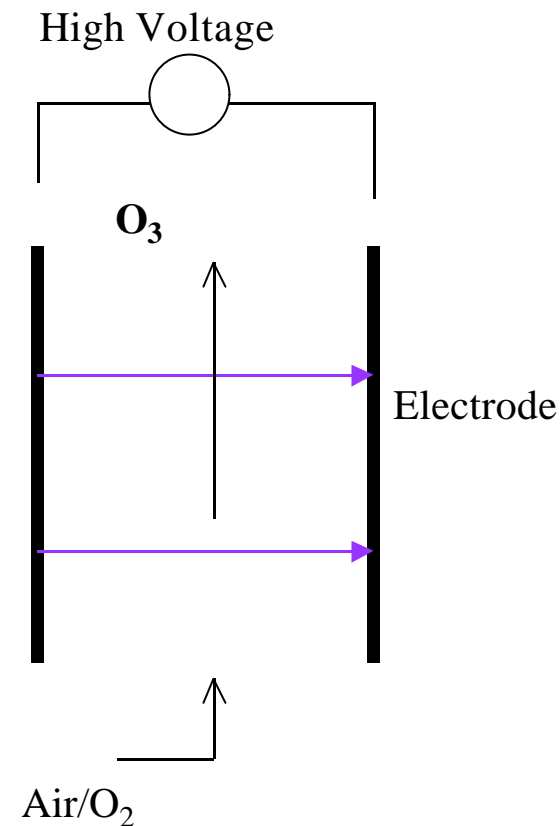
Ozone Production

- UV Lamp
 - Ave. ozone production/
UV lamp
 - 0.1 wt%



Ozone Production

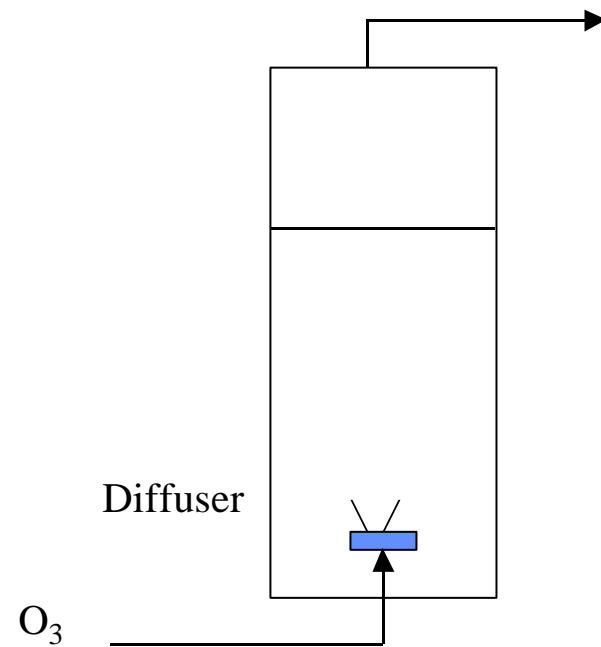
- Corona Discharge
 - Ave. Ozone production
 - 0 - 10 wt%
 - Energy Consumption
 - 20 kWh/kg O₃ with air (LF)
 - 10 kWh/kg O₃ with O₂ (LF)
 - 10 kWh/kg O₃ with air (HF)
 - 5 kWh/kg O₃ with O₂ (HF)



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Injection Methods

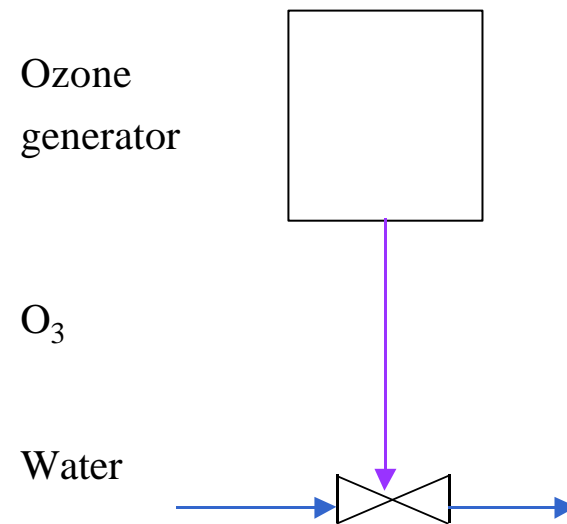
- Contact Column
 - Efficiency
 - 70% ozone dissolution



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Injection Methods

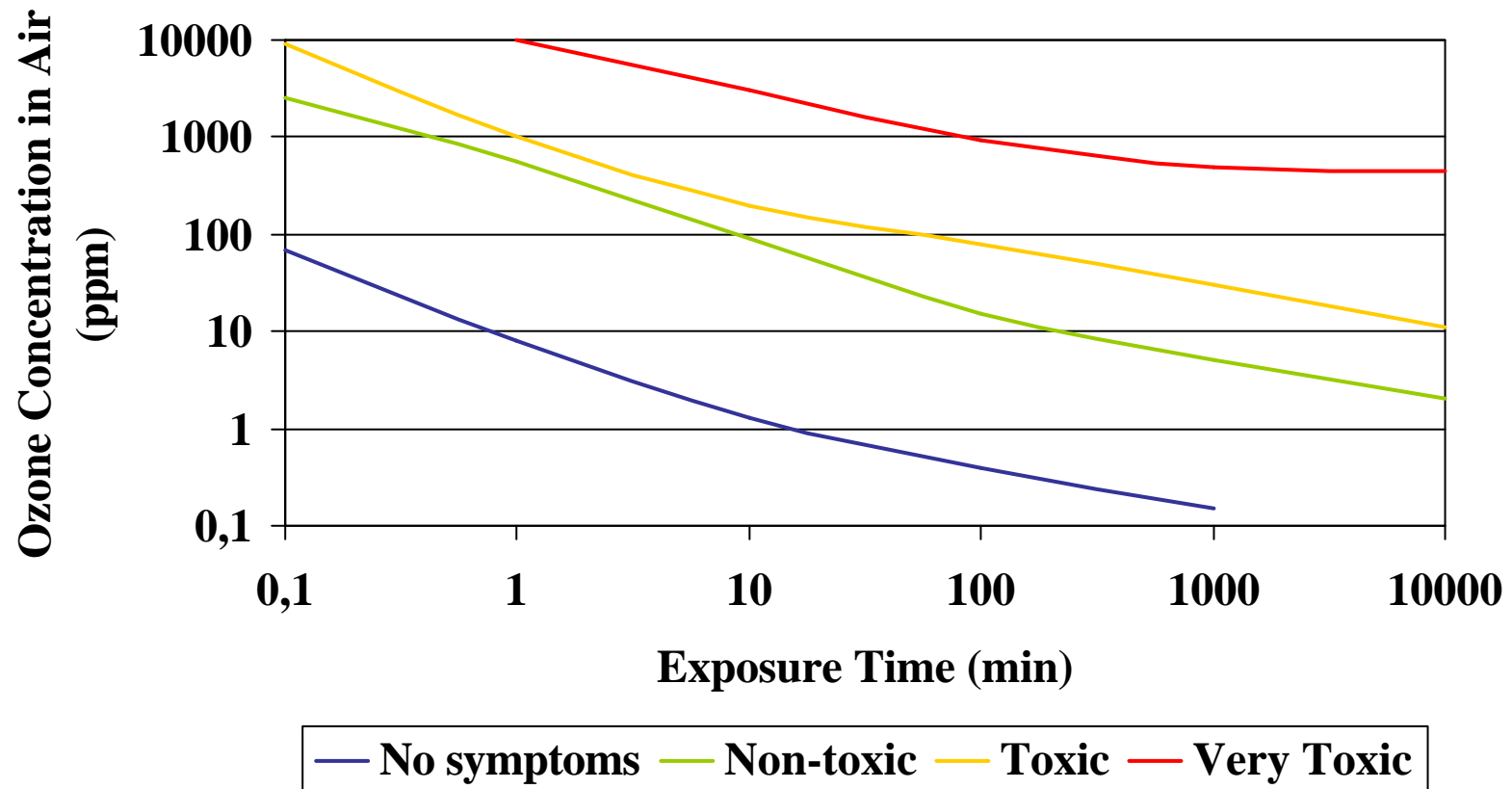
- Venturi
 - Efficiency
 - 90% ozone dissolution



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Ozone Toxicity

Ref: Perry, Chemical Engineering, Mai 1993



Protection from Exposure

- **Adsorption** $2 \text{O}_3 + \text{C.A/Al} \rightarrow 3 \text{O}_2$
 - Activated Carbon
 - Activated Alumina
- **Destruction** $2 \text{O}_3 + \text{Energy} \rightarrow 3 \text{O}_2$
 - Thermal
 - UV (254 nm)

Biological Lethal Coefficients of Common Disinfectants

Ref: Hamil et Clawson, Water Technology, Avril 1997

Disinfectant	Entero-bacteria	Virus	Bacterial Spores	Amoebic Cysts
O_3	500	5	2	0.5
HOCl	20	1	0.05	0.05
OCl^-	0.2	<0.02	<0.0005	0.0005
NH_2Cl	0.1	0.0005	0.001	0.02

BLC : high value = high disinfection power

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CT for Common Disinfectants

(pH = 6 - 9)

Ref: Hamil et Clawson, Water Technology, Avril 1997

Micro-organisms	Free Chlorine Chloramine NH ₂ Cl	Chlorine Dioxide ClO ₂	Ozone O ₃
E.Coli	0.034 – 0.05	0.4-0.75	0.02
Rotavirus	0.01 – 0.05	0.2 – 2.1	0.006 – 0.06
G. lamblia cysts	47 – 150	—	0.5 – 0.6
G. muris cysts	30 – 630	7.2 – 18.5	1.8 – 2.0

* CT = Conc. O₃ (ppm) x Contact Time (min)

* Established by EPA, 99.9% neutralisation of micro-organisms

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Comparing Disinfectants

	Ozone	UV	Chlore
E. coli	Yes	Yes	Yes
Salmonella	Yes	Yes	Yes
Giardia	Yes	Yes	Yes
Legionnaire	Yes	No	No
Crypto-sporidium	Yes	No	No
Virus	Yes	No	No
Algues	Yes	Non	No
THM	No	No	Yes
Cancer	No	No	Yes

Ozone Applications (Water)

Rules of Thumb

Application	Conc. O₃ (ppm)	Contact Time (min)
Reverse Osmosis Water	0.3 – 0.5	4 – 5
Drinking Water	1.0 – 2.0	5 – 10
Pool	0.3 – 0.7	1
Seafood Wash	0.1 – 0.15	1-2
Fruit & vegetable wash	0.2 – 0.4	1-5
Hydroponic	0.1 – 0.2	2-5
Cooling Tower	0.2 – 0.5	2
Pre-surgical wash	3 – 5	3-5

Ozone Applications (Air)

Contaminant	Applications	Conc. O ₃
Bacteria - Rhizoctonia Solani - Phytophthora Solani	Meat	0.1 ppm
Ethene	Fruits	0.05 ppm
Spores	Cheese	0.02 ppm
Salmonella	Eggs	0.1 ppm
Mold	Starch, flour, straw, grains	0.05 ppm*
Fats & Grease	Cotton, wool	0.05 ppm**

* Secondary Effect: Bleaching

** Secondary Effect: Improved dye-ability

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Conclusion

- FDA, USDA & EPA approved
- Used since the beginning of the century
- Several applications
- Affordable technology

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Dissolution

Ref: Perry, Chemical Engineering, Mai 1993

