# DETERMINATION OF OZONE HALF-LIFE WITHIN A CLOSED CYLINDER

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Currently work is being performed to better understand the effects of ozone on microorganisms. The goal of the project is to control microorganisms with ozone in a continuous-flow grain treatment system. It is necessary to gain a better understanding of ozone, particularly the ozone being produced at our facilities. Ozone is a high energy form of elemental oxygen that slowly decomposes to dioxygen accordingly: $O_3 \rightarrow 3/2\ O_2$, $\Delta H = -145$ kJ/mol [i]. It is known to be a strong oxidizing agent, reacting with almost every organic material. Experiments concerning half-life, calibration and the final control of microbes will all be performed with our lab ozone generator.

Determining the half life concentration of the ozone being generated in our lab will help us determine the stability of ozone in high airflow situations. All chemical elements experience a time when the initial concentration is reduced by half. This period is called half-life time, and is denoted most commonly by $t_{1/2}$. The half-life $t_{1/2}$ is defined as the reaction time after which half the initial amount of reactant has been consumed[i].

$$\text{Half-life} = \frac{0.69315}{\text{Decay constant}}$$ [ii]

Eqn 1. Calculation of half life of a gas, using the gases known decay constant.

Weilandics et al (1988)[iii] determined that the chemical decay constant of ozone (gas) was 3.1e-4 ($s^{-1}$). From Eqn. 1, this decay constant yields $t_{1/2}$ = 2235.97 sec = 37.26 min., for ozone this means that, at any concentration, after ~37 minutes the initial ozone concentration will be reduced by half.

The main objective of our half-life experiments was to determine the half-life of the ozone being generated by our laboratory and pilot-scale equipment. Results will be used to determine the decay constant for our ozone equipment and compare it to the value Weilandics et al (1988) calculated. The half-life time will be used in future ozone experiments and models. In this experiment ozone was produced in the lab through dielectric excitation of oxygen. This excitation transforms the oxygen ($O_2$) molecules found in air to ozone ($O_3$), the following shows the chemical formula for the change, $O_2 + O_2 \rightarrow O_3 + O$, the next reaction is $O + O_2 \rightarrow O_3$. Ozone was pumped into a chamber, until the chamber was completely filled with $O_3$, once this occurred the chamber was sealed and measurements of $O_3$ concentration were taken using gas detection tubes.

The results from the two experiments completed yielded half-life times significantly greater than the value calculated using the half-life equation and the standard decay

constant value of ozone. Both tests showed that the half-life of ozone was ~27 hours. In experiment 1 the initial ozone concentration was approx. 1700ppm, in the second experiment the initial ozone concentration was approx. 700ppm. A third replication is currently underway. In a second series of tests, a fan will be introduced into the cylinder in order to quantify the effect of air movement on the half-life time of ozone.

[i] Eagleson M. (1994) Concise Encyclopedia Chemistry. New York; Walter de Gruyter.
[ii] Wolberg J. (2006) Data Analysis Using the Method of Least Squares: Extracting the Most Information from Experiments. Springer.
[iii] Weilandics et al. (1988) Ozone Production Due to Synchrotron Radiation. *Nuclear Instruments and Methods in Physics Research*. Holland; 691-698.