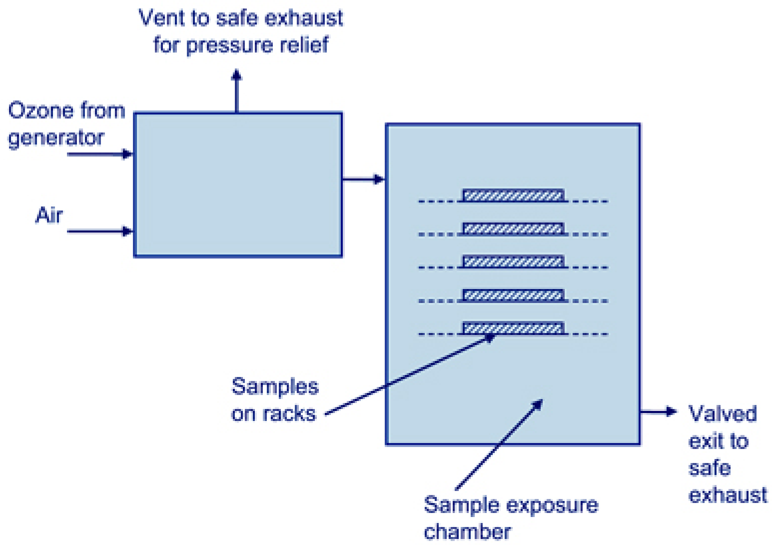
Ozone Exposure System Designed and Used to Test High-Altitude Airship Materials

High-altitude airships can receive high doses of ozone over short mission durations. For example, in 1 year at an altitude of 70,000 ft, the ozone fluence (number arriving per unit area) can be as high as 1.2×10^{24} molecules/cm^2. Ozone exposure at these levels can embrittle materials or change the performance of solar cells. It is important to expose components and materials to the expected ozone dosage to determine if the ozone exposure could cause any mission-critical failures.

A system was designed and used at the NASA Glenn Research Center to expose small materials and components to the desired dosage of ozone. Commercial ozone generators typically produce higher concentrations of ozone than are needed to simulate the Earth's upper atmosphere, so the output of a commercial generator was diluted in a mixing chamber with air. The output from the mixing chamber was then allowed to flow into an exposure chamber where the ozone concentration was monitored. The concentration needed to simulate the upper atmosphere was higher than the range of the ozone detector, however. To determine the concentration of ozone in the chamber, we conducted several tests--stopping the ozone flow altogether and watching the concentration of ozone in the exposure chamber as a function of time for different airflow rates. Initially, the detector was pegged off scale, but then it dropped to levels that the detector could read, and we generated a family of curves at different airflow rates by plotting the ozone concentration as a function of the time that the ozone was turned off. The data fit followed a simple exponential decay model, so this could then be used to determine the airflow rate that was needed to produce the desired concentration of ozone for the exposure duration needed. The flux (number per unit area per time) of ozone arriving at a surface in the Earth's upper atmosphere for test concentration and duration determination can be estimated by using standard gas laws giving the flux:

$$\text{flux} = 1/4 \times \text{density of ozone} \times \text{average velocity of ozone molecule}$$

By using this technique, we could achieve full mission fluences in a few hours of exposure in the laboratory. The data generated by testing exposed materials and components can give great insight into mission performance and can alert designers to potential critical failures.



Ozone-exposure system.

Find out more about this research at: http://www.grc.nasa.gov/WWW/epbranch/

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Programs/Projects: Exposure of components and materials for durability testing for high-altitude airship applications