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Study of Reactions Between Ozone and VOCs Present in Work Atmospheres

The COVID-19 pandemic has led to the proliferation of air purifiers employing various methods to remove volatile organic compounds (VOCs). However, the French Research and Safety Institute for the Prevention of Occupational Accidents and Diseases (INRS) has observed that some purifiers emit high concentrations of ozone (O3), ranging from 100 to over 1,000 ppbv. O3 triggers the oxidation of VOCs rapidly forming of low-volatility, poly-oxygenated molecules which condense to become particle precursors [1-3]. These organic molecules and nano-sized particles in the air pose potential health risks. However, the chemical pathways leading from the first oxygenated intermediates to particle formation are still unknown: the challenge rests in identifying the structures of the maximum number of intermediates along the growth pathway, in order to understand the mechanisms involved.
This study aims to investigate the specific reactions of O3 with terpenes—VOCs representative of work environments—under ambient pressure and temperature conditions. Using gas flow tube reactors and analytical tools such mass spectrometry and gas chromatography, we identified and quantified gas-phase products. Based on literature and the characteristic aerosol appearance time from previous experiments, a quartz flow tube reactor was developed and dimensioned to achieve residence times of the order of one second.

Initial validation experiments focused on isoprene (C5H8), a fundamental building block of terpenes whose ozonolysis has been extensively studied, e.g. [4]. Key ozonolysis stable products—methyl vinyl ketone, methacrolein, and formaldehyde—were successfully identified, which provides confidence in the experimental method used. Additional products, including acetic acid, formic acid, oxygenated ring structures (e.g., furans), and various aldehydes (saturated, such as ethanal, and unsaturated, such as butenal and pentenal), were also detected.

Future studies will focus on aerosol quantification during isoprene ozonolysis and also on more complex terpenes, such as α-pinene and limonene, aiming to deepen the understanding of terpene ozonolysis mechanisms and inform health-related guidelines based on these findings.

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