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| **Brueckner Lab-Specific Standard Operating Procedure (LSOP):**  **Ozone (O3) (in a stream of oxygen, O2)** | | | | | | |
| **Principal Investigator(PI):** Christian Brueckner | | | | | | |
| **Building:** Chemistry | | | | | | **Lab(s) Covered by LSOP:** R413/R415 |
| **Department:** Chemistry | | | | | | **Lab Phone Number(s):** 6-6596/6-6598 |
| **Chemical** | | **GHS Pictograms** | | **Definitions** | | |
| **Ozone** | |  | | **Severe Toxicity.** May cause severe injury or death upon inhalation/exposure.  **Oxidizing Agent.** Oxidizing gases, liquids, or solids.  ***Corrosive.*** Skin corrosion/burns. May cause ocular damage. | | |
| **SECTION 1 – CHEMICAL(S) and HAZARDS** | | | | | | |
| Ozone (Triatomic oxygen) a colorless gas with a strong, acrid smell, can be fatal if inhaled or absorbed through skin. It can cause damage to the gastrointestinal tract, respiratory tract, skin, and eyes. Symptoms of exposure include headache, coughing, dry throat, shortness of breath, chest tightness, vomiting, pulmonary edema, asthma, and lung damage. It is highly unstable and highly reactive. Target Organ: Lungs  Ozone is generally being generated with the help of an ozone generator that uses pure compressed O2 (refer to the Compressed Gases LSOP) as starting material; the gas stream delivered contains oxygen with the (low) ozone concentrations as per specification of the ozone generator. | | | | | | |
| **SECTION 2 – ADMINISTRATIVE CONTROLS** | | | | | | |
| * Anyone using the chemicals and procedures described herein needs to have undergone the annual EH&S Chemical Hygiene Training: <http://www.ehs.uconn.edu/Chemical/?p=training>. * Lab-specific safety training must be provided by the principal investigator (PI) or other qualified personnel to all researchers working with ozone. Documentation of training is required. * Read the safety data sheet (SDS) for ozone prior to use: <http://www.msds.com> (search for ozone in oxygen). * Researchers must not work alone with ozone. * Experiments should be performed during normal business hours (i.e., 8:00 am-5:00 pm Mon-Fri), if possible. | | | | | | |
| **SECTION 3 – ENGINEERING CONTROLS** | | | | | | |
| * All research with ozone must be conducted in a chemical fume hood with the sash at the lowest working height and with sliding sash panels (if applicable) aligned to form a barrier between the researcher and the experiment. * Chemical fume hoods must have been tested by EHS within the last year. If the hood is not working properly, contact Facilities (860-486-3113) to repair the hood or EHS to retest (860-486-3613). * The generation of ozone outside of a chemical fume hoods is not an option! | | | | | | |
| **SECTION 4 – WORK PRACTICES** | | | | | | |
| Ozone cannot be stored for any extended period of time and must be generated with the help of an ozone generator each time it is needed. Keep away from all readily oxidizable materials. Keep cool and protect from sunlight. | | | | | | |
| **SECTION 5 – PERSONAL PROTECTIVE EQUIPMENT** | | | | | | |
| At a minimum, a closed-up lab coat, closed-toed footwear and chemical safety glasses that meet ANSI standard Z-87.1 must be worn. Nitrile gloves must be worn. | | | | | | |
| **SECTION 6 – STORAGE** | | | | | | |
| Ozone cannot be stored. Solutions with some ozone dissolved can be stored over very short periods of time; keep cool. Ozone may be absorbed onto silica gel and then possesses a slightly extended shelf live (E. Proksch, A. de Meijere, *Angew. Chem. Int. Ed. Engl.* **1976**, *15*, 761–762.). | | | | | | |
| **SECTION 7 – SPILLS AND ACCIDENTS PROCEDURES** | | | | | | |
| * Evacuate the laboratory immediately. * Close door(s) to lab and post a “**NO ENTRY**” sign(s) or other warning information on the door specifically warning of an ozone leak. * Activate the fire alarm and call **911.** * Do not re-enter area until instructed to do so by UCFD or other emergency personnel.   **Report any incident to the PI and fill out the** [**accident form**](https://www.google.com/url?sa=t&rct=j&q=&esrc=s&source=web&cd=1&ved=0ahUKEwiF3bPe1dPXAhVRRN8KHX4wDf4QFggmMAA&url=https%3A%2F%2Fchemistry.uconn.edu%2Fwp-content%2Fuploads%2Fsites%2F1259%2F2015%2F09%2FIncident-Report-Form.doc&usg=AOvVaw3Uov8IQ2Z-Kan) | | | | | | |
| |  | | --- | | **SECTION 8 – FIRST AID PROCEDURES** | | | | | | | |
| First Aid- Eyes | | | 1. Immediately move to the eyewash station, hold eyelids open and flush with water. Remove contact lenses while flushing (if applicable). 2. Have another person from the lab dial **911** and specifically mention ozone exposure. 3. Continue flushing the eyes until emergency personnel arrives. | | | |
| First Aid- Skin | | | 1. Immediately move to safety shower or other water source and begin rinsing affected area(s). Remove contaminated clothing (if applicable) while flushing. 2. Have another person from the lab dial **911** and specifically mention ozone exposure. 3. Flush affected area(s) under safety shower for 15 min and keep rinsing affected area(s) until emergency personnel arrives | | | |
| First Aid- Ingestion | | | 1. Immediately rinse the mouth with cold water. 2. Have another person from the lab dial **911** and specifically mention ozone exposure. | | | |
| First Aid- Inhalation | | | 1. Move to fresh air. 2. Dial **911.** 3. Inform emergency responders that the accident involved ozone. | | | |
| **Report any incident to the PI and fill out the** [**accident form**](https://www.google.com/url?sa=t&rct=j&q=&esrc=s&source=web&cd=1&ved=0ahUKEwiF3bPe1dPXAhVRRN8KHX4wDf4QFggmMAA&url=https%3A%2F%2Fchemistry.uconn.edu%2Fwp-content%2Fuploads%2Fsites%2F1259%2F2015%2F09%2FIncident-Report-Form.doc&usg=AOvVaw3Uov8IQ2Z-Kan) | | | | | | |
| **SECTION 9 – HAZARDOUS WASTE MANAGEMENT** | | | | | | |
| * All wastes that might contain ozone must be quenched using a reductant (glucose, 0.1-1 M aqueous sodium bisulfite, sodium thiosulfate, NaBH4) and must be labeled with “Hazardous Waste” stickers or tags, use full chemical names to describe the waste, be stored in sturdy, plastic containers with tight-fitting caps or lids, and be stored alone or with other compatible chemicals. * Hazardous wastes must be stored at a green “Satellite Accumulation Area” sign prior to disposal by EHS. * Once the containers are 80% filled, fill our EH&S [chemical waste pickup form.](http://ehs.uconn.edu/Regulated%20Waste%20Management/index.php) | | | | | | |
| **SECTION 10 – DECONTAMINATION PROCEDURES (*Attach or insert steps. Add more lines as necessary).*** | | | | | | |
| Work Area | Decontaminate equipment through a water rinse; use soap. | | | | | |
| Personal Hygiene | Use standard chemical hygiene practices regarding PPE.  Upon contamination, wash affected areas immediately. | | | | | |
| Disposal | Off-gassing of ozone from the set-up should only be taking place under the fume hood, with the set-up exhaust piped straight past the muffles for efficient exhaust. Alternatively, use a bubbler set-up filled with a 0.1-1 M aqueous sodium bisulfite or sodium thiosulfate solution that quenches the ozone. | | | | | |
| **SECTION 11 – SPECIFIC PROCEDURE** | | | | | | |
| A typical use of ozone in our laboratories is described in: Sharma, M.; Meehan, E.; Mercado, B. Q.; Brückner, C. ‘Oxazolochlorins 16. β‑Alkyloxazolochlorins: Revisiting the Ozonation of Octaalkylporphyrins, and Beyond’*, Chem.–Eur. J.* **2016**, *22*, 11706–11718.  CAUTION! Ozone is a highly toxic and strong oxidizing agent and forms potentially explosive ozonides. Handle with care, perform all experiments in a well-ventilated fume hood, and test all solutions for the presence of ozonides (KI-starch paper or dedicated ozonide test strips) before heating or evaporating them to dryness.  *3,7,8,12,13,17,18-Heptaethyl-3-hydroxy-2-oxachlorin (****6a****). General Procedure for the Ozonation of Octaalkylporphyrins*  Ozone (flow rate 300 µL O3/min in oxygen) was passed at ambient conditions over a solution of OEP (**5**, 200 mg, 380 × 10-6 mol) dissolved in CHCl3 (150 mL, EtOH-stabilized). Reaction progress was monitored by UV-visible spectroscopy: The appearance of a peak at ~645 nm indicates the formation of the product. The ozonation was continued until the UV-visible spectrum of the reaction mixture reflected a 2:1 ratio of the max intensities of the chlorin and porphyrin (~10 min). The ozonide in the crude reaction mixture was quenched by addition of a methanolic NaBH4 solution (75 mg NaBH4 in 1-2 mL MeOH) and the resulting mixture was stirred at ambient temperature for 2-3 h. The solvent was then evaporated by rotary evaporation and product **6a** was isolated by flash column chromatography (silica gel–CHCl3/hexanes 7:3). The main polar fraction was isolated and evaporated to obtain product **6a** in 37% yield (48 mg); 34% (67 mg) of the starting material **5** were recovered as the least polar fraction. | | | | | | |

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| **SECTION 12A. APPROVAL** | | | |
| I have reviewed, understand and agree to follow this lab-specific standard operating procedure (LSOP) for ozone*.* Failure to follow this LSOP or lab-specific training guidelines is a violation of the [*University Health & Safety Policy*](http://policy.uconn.edu/2011/05/19/health-and-safety-policy/) and [*University Code of Conduct*](http://policy.uconn.edu/2011/05/17/employee-code-of-conduct/).  Further approval and/or review of this LSOP by the PI/Supervisor is required if any of the following events occur:   * A significant change in amount (i.e., doubling of the scale of reaction) or substitution of the chemicals in the procedure is planned * A major change in the agreed-upon experimental set-up is planned (heating instead of room temp, etc.) * Any signs of a failure in safety design or equipment are observed * Any signs or symptoms of a chemical exposure to any personnel are observed * Unexpected and/or potentially dangerous experimental results occur (e.g., fire, uncontrolled buildup of heat and/or pressure, etc.) | | | |
| **Researcher Name/Signature** | **Trainer Name/Signature** | **Training Date** | |
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| **SECTION 12B. PRINCIPAL INVESTIGATOR CERTIFICATION** | | | |
| I approve the contents of the lab-specific standard operating procedure listed above. | | | |
| **PI Signature:** | | | **Date:** |
| **A HARD OR ELECTRONIC COPY (https://bruckner.research.uconn.edu/safety-resources/) OF EACH LAB-SPECIFIC STANDARD OPERATING PROCEDURE MUST BE READILY AVAILBALE IN THE LAB.** | | | |