

Standard Operating Procedure

Task: Working with Carbon Monoxide (CO) Gas

Date: 5/13/2014

Revision Date: 04/29/2016

Revision Date: 7/13/2018

Background

- CO is an odorless, colorless, tasteless, poisonous gas. The permissible exposure limit (PEL) for CO set forth by OSHA is 50 ppm for eight hours. The immediately dangerous to life or health (IDLH) value set forth by the US National Institute for Occupational Safety and Health (NIOSH) is 1200 ppm. *However, if any amount of CO is detected in the laboratory, steps must be taken to stop the leakage and potential exposure to CO.* Detectors must be worn to avoid possible intoxication due to leaks. CO detectors vary in their limits of detection, but 0-500 or 0-1000 ppm are typical ranges. These detectors will have different alarm thresholds for different amounts. Values of 35 ppm will trigger a warning and typically values >50 ppm will trigger a danger alarm.

Training Requirements:

- Lab safety training
- Working with CO training
- Changing gas cylinder training

Potential Hazards:

- Inhalation of a toxic gas
- Injuries from failure of pressurized gas cylinder
- Backfilling glassware cooled in liquid nitrogen will condense >50 atm CO. Injuries may result from a possible explosion upon expansion of the gas.

Special PPE Requirements:

- CO detector

Materials Needed:

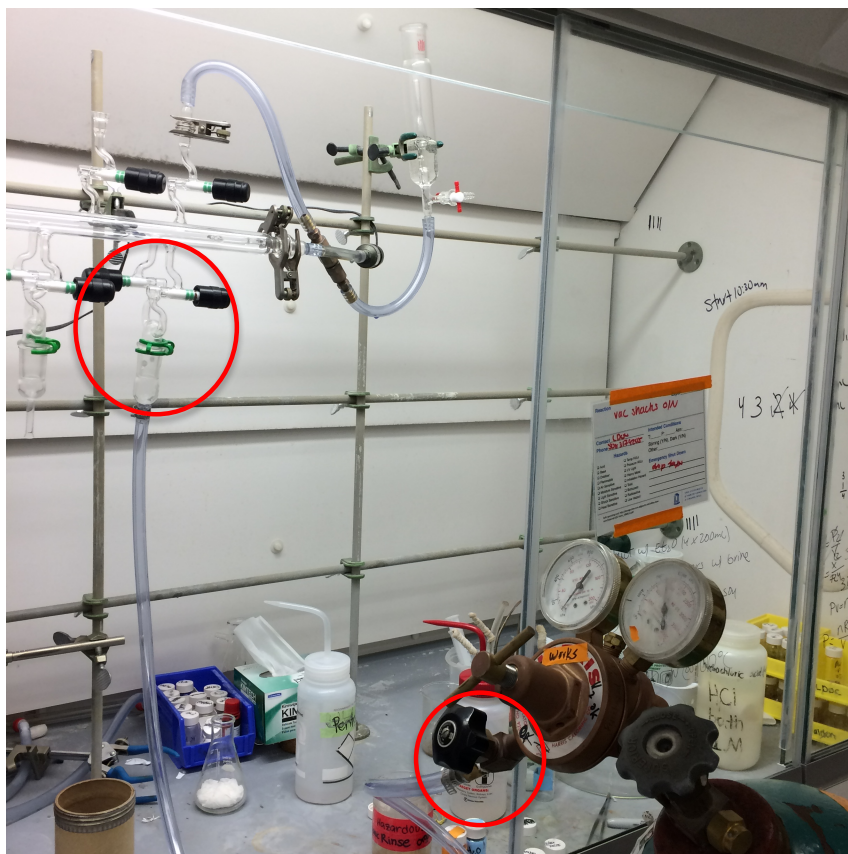
- CO gas cylinder
- Cylinder regulator CGA 350 (CGA 180 for lecture bottles: see SOP for lecture bottles)
- CO detector
- Schlenk line with a cross-over port connecting the gas and vacuum manifolds
- Crescent wrench
- Gas cylinder cart

Procedure:

1. Set up vacuum manifold and traps and pump down the vacuum line
2. Turn on the CO detector and wear on lab jacket



3. Properly secure the CO gas cylinder with a chain on the gas cylinder cart and place it next to the hood with the port facing towards the hood and the Schlenk line
4. Connect the CGA 350 cylinder regulator to the CO tank (see changing cylinders SOP). The regulator should be connected to tubing, which is to be connected *directly* to the gas manifold.
5. Connect the regulator *directly* to the gas manifold through a piece of tubing and an appropriate adaptor. Keep the front port (vacuum) shut at all times and only use the back port that corresponds to the back manifold (gas line). If using a lecture bottle, remove the end cap to the gas manifold and clamp the connection.

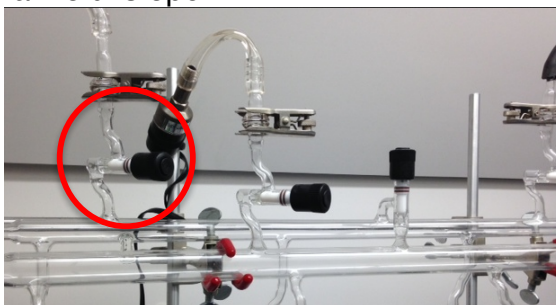


6. Check that the gas manifold is connected to a bubbler and will be venting towards the back of the hood. Check that the vacuum is venting into the hood.
7. Shut the needle valve on the regulator and rotate the regulator dial to the lowest setting (all the way counter-clockwise). Open the cylinder valve of the CO tank to pressurize

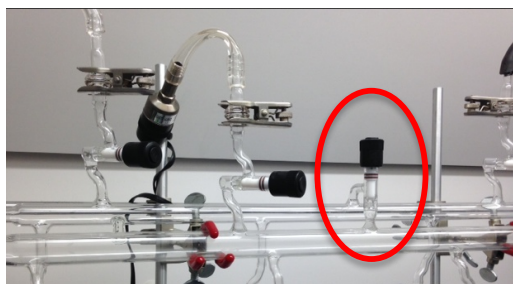
the regulator. Note the starting pressure on the regulator and close the cylinder valve. Wait 3 minutes and see if any pressure drop occurs. *If a pressure drop occurs open the gas port leading to the Schlenk line first, followed by the needle valve, to allow CO to vent out through the bubbler towards the back of the hood. Close the needle valve and troubleshoot the regulator connection.*



8. Once the regulator connection has been tested for leaks, close the special (usually inert gas) gas inlet valve and ensure the needle valve on the regulator is closed and the gas port leading to the gas manifold is open.



9. Open the crossover valve to pump down the back manifold up to the needle valve on the regulator. *Note: If a crossover valve is not available, place a cap on one of the ports of the Schlenk line and open both valves (gas and vacuum) to pump down the back manifold.*



10. Close the crossover valve. Open the cylinder valve and adjust the regulator to ~15-20 psi using the regulator dial. Close the cylinder valve. Open the needle valve to fill the back manifold with CO, then close the needle valve.

11. Open the crossover to pump down the manifold all the way to the needle valve once more. Open the cylinder valve to pressurize up to the needle valve and leave the cylinder valve open.
12. Once the system has been pumped down up to the needle valve, close the crossover and open the needle valve to fill the gas line with CO. Once the back manifold is filled and CO is flowing through the line and out through the bubbler use normal Schlenk techniques to perform your chemistry.
13. When finished, shut the cylinder valve and allow the pressure in the regulator to dissipate through the bubbler before shutting the needle valve.
14. Pump down the back manifold by opening the crossover valve to remove CO from the back manifold.
15. Shut the crossover, and then open up the special gas inlet to purge out the back manifold with an inert gas.
16. Allow the vacuum pump to run for at least 10 minutes before dropping traps as some CO might condense. Active vacuum should remove any condensed CO.
17. Shut off special gas (inert gas) flow and close the gas port connected to the regulator on the Schlenk line. Disconnect the tubing from the Schlenk line.
18. Remove the CO regulator from the gas cylinder and cap the gas cylinder. Once the cylinder is capped transport it back to its storage place and secure it with two straps against a wall.
19. Purge out the CO regulator by opening the needle valve and running nitrogen through the regulator for 30 seconds.
20. Shut off CO detectors.

References and Related SOPs:

- Changing gas cylinders SOP
- Grainger Carbon Monoxide Facts: <https://www.grainger.com/content/qt-236-carbon-monoxide-facts>
- OSHA Carbon Monoxide Fact Sheet: https://www.osha.gov/OshDoc/data_General_Facts/carbonmonoxide-factsheet.pdf
- Dräger Pac 5500 Single-Gas Detection Device: http://www.draeger.com/sites/assets/PublishingImages/Products/cin_pac_3500/US/pac-5500-pi-9094170-en-us.pdf
- Honeywell Analytics Single-Gas detectors: http://www.honeywellanalytics.com/~media/honeywell-analytics/products/toxipro/documents/english/ss01132c_toxipro_spec_sheet_flr_7-25-12.pdf?la=en

- Centers for Disease Control and Prevention, US National Institute for Occupational Safety and Health (NIOSH): Carbon monoxide:
<http://www.cdc.gov/niosh/idlh/630080.html>