Lane Community College

Rev 2-2025 MP

Science Division

Safety / Work Instructions

Dry Ice Fog Visualization Test for Fume Hoods

Introduction / Purpose

Dry ice or frozen carbon dioxide (CO_2) sublimes to form gaseous CO_2. Visible water vapor is produced when dry ice sublimes in water. A method has been developed that uses this property of dry ice to visualize airflow in fume hoods. The method was developed as an alternative to the well-established American Society of Heating and Air-Conditioning Engineers (ASHRAE) 110-1995 tracer gas test method of measuring laboratory chemical hood performance which is expensive and less environmentally friendly. The dry ice method is described in the journal article "A new quantitative method for testing performance of in-use laboratory chemical fume hoods" in the Journal of Chemical Health & Safety, 2016, 23, 4, 32-37.

These instructions describe how to visualize airflow in fume hoods using dry ice and warm water.

Safety Precautions / Personal Protective Equipment (PPE)

Dry ice is extremely cold (−78.5 °C or −109.3 °F);

- **Contact Hazard:** At -109 °F (-79 °C), skin contact with dry ice can lead to severe frostbite; skin cells freeze and become damaged very quickly.
    - **NEVER** handle dry ice with bare hands.
    - Proper thermal gloves and goggles should be worn while performing the test.
    - Use tongs or other appropriate tools for handling the dry ice.

- **Asphyxiation Hazard:** Dry ice will sublime (change from solid to gas) at any temperature above -109 °F. This releases potentially substantial volumes of CO_2 (1 pound solid = 250 liters gas) causing dizziness, headaches, difficulty breathing, loss of consciousness and death. This is especially of concern in nonventilated or confined spaces.
    - **ALWAYS** store dry ice in a well-ventilated place.

- **Over-pressurization Hazard:** Due to the rapid emission of large volumes of CO_2 gas, any dry ice that is stored in a closed container can pressurize the container. Given enough time at normal room temperature, such a container may violently rupture if the gas is not able to escape.

- **NEVER** store dry ice in a tightly sealed container or any container with a screw-top lid that will not vent.

Materials Needed

- 200 g of dry ice pieces (approximately ½ cup of pellets)
- 2.8L (3 qt.) stainless mixing bowl with 23.8 cm (9.75 in) outer diameter and 10.2 cm (4 in.) height
- 1 L of warm water (~43°C)
- CO_2 detector (if escaped CO2 is to be measured)

Test Procedure

1. Set the sash to the indicated safe operating height.
2. Fill the stainless-steel bowl about 3/4 full with warm water.
3. Put dry ice (about ½ cup) into the bowl so that vapors are rolling out of the bowl.
4. Place the bowl on the fume hood bench at various locations, around equipment, to observe directional flow of the water vapor.
5. Observe the airflow at the face and inside of the hood. The patterns across the bench can be described as:
    a. If the fog moves forward toward the front of the hood, the air flow is described as "reverse flow."
    b. If the fog remains on the work surface without smoothly flowing to the back baffle, the air flow is described as "lazy."
    c. If the fog moves outside the plane of the sash, the observation of such is described as "escape."

6. DISPOSAL, if there is any dry ice left over:
    a. Place in a well-ventilated location, such as a fume hood, to allow the remainder of the ice to sublimate. Place a hazard sign on the container to warn others.
    b. Never dispose of dry ice in a trash can or chemical waste container.
    c. Never dispose of dry ice in a sink, toilet or other fixture; the temperature difference can damage the plumbing.

Corrective Actions

If any observations other than effective airflow are made as shown in Figure 2 of the Images section, action must be taken.

Reverse Airflow

1. Immediately shut down the fume hood and post a sign "Do not use."
2. Have a qualified technician service the hood.

Lazy Airflow

1. Check to make sure baffles (slotted panels at the rear of the hood) are not blocked. Remove the objects from the hood or move them away from the baffles.
2. Check for clutter or poor placement of objects inside the hood. Declutter the work surface and move the objects away from the front.
3. Ensure that laboratory room pressure is negative. This can be done by opening the door slightly and observing air rushing from the hallway into the room. If room air is not negative, have Facilities adjust room ventilation.
4. Perform the visualization test again.
5. If fumes appear to be exhausted effectively, follow up with face velocity measurement to confirm that the hood is running within the specification of 100 +/- 10 fpm.
6. If airflow is still lazy, have a qualified technician service the hood. Determine if the fume hood is safe to use at a lower sash height temporarily until service is done.
    a. Try the visualization test at a lower sash height that is still practical for use.
    b. If fumes appear to be effectively exhausted through the baffles, then test face velocity at the new (lower) sash height.
    c. If the hood runs within specifications of 100 +/- 10 fpm at the lower sash height, post a sign indicating the temporary safe sash height.

Escape

1. Follow Steps 1-5 for Lazy Airflow.
2. If fumes are still escaping, shut down the fume hood and post a sign “Do not use.”
3. Have a qualified technician service the hood.

Emergency Procedures

First Aid

- If dry ice comes in contact with the skin or eyes, flush the affected area with generous quantities of cold water. Never use dry heat. Splashes on bare skin cause a stinging sensation, but, in general, are not harmful.
- If clothing becomes soaked with liquid, it should be removed as quickly as possible and the affected area should be flooded with cold water as above.
- Where clothing has frozen to the underlying skin, cold water should be poured on the area, but no attempt should be made to remove the clothing until it is completely free.
- If inhalation of the cold vapors has occurred, move the person to warm, fresh air. In this case, the person may be suffering from frostbite of tissue in their throat and lungs, but also asphyxia.
- Do NOT rub frostbitten skin as tissue damage may occur. Place in a warm bath that is not above 105°F (40°C).

Spill Response

If spilled, dry ice will sublimate to carbon dioxide. The gas is heavier than air and is extremely cold. It will briefly accumulate in low areas until it warms and equilibrates with the air. Open the room, or increase ventilation by opening the fume hood sash, if a large amount has spilled or if the room is un-ventilated.

Images of Dry Ice Visualization Tests

Fume Hood running within face velocity specifications (100 +/- 20 fpm)

Figure 1: Dry ice pellets in small ice chest.

Figure 2: Sash opened to safe opening height (at sash stop) – Fumes are effectively exhausted.

Figure 3: Sash Closed – Fumes are contained and effectively exhausted.

Figure 4: Sash slightly open – Fumes are effectively exhausted.

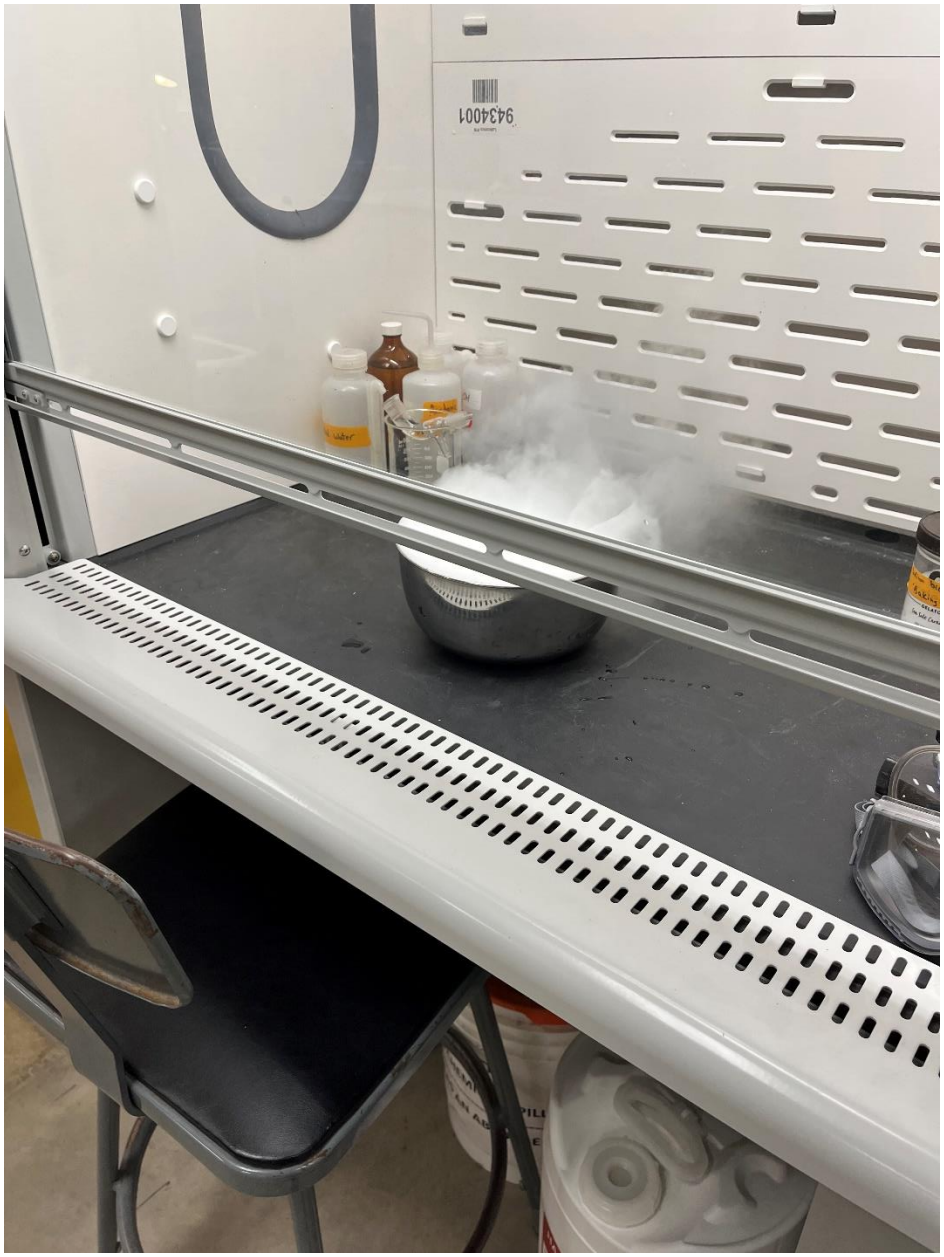

Figure 5: Sash all the way open (past stop) – Fumes are considered “lazy” and are not effectively exhausted. This is why the sash should never be opened past the sash stop during hazardous operations inside the fume hood.