CHAPTER 5 GAS BAGS

THE USE OF GAS BAGS for the storage and handling of gases is well over 200 years old. Henry Cavendish described the use of a "bladder" for gas manipulation in his 1766 publication ***On Factitious Airs*** (Figure 1) and Carl Scheele used the a large gas bag when he produced "fire air" (oxygen) in 1772.[1] (Figure 2)

A century later, gas bags were still common. In the 1872 text by Storer and Lindsay,[2] a gas bag was used to make a mound of soapy bubbles containing a hydrogen-oxygen mixture (Figure 3).

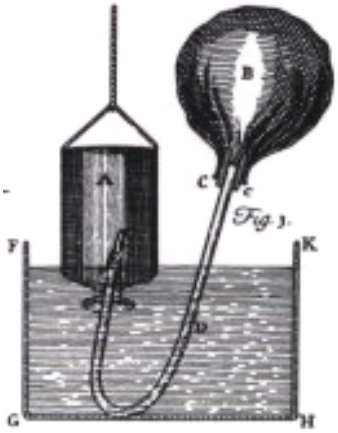

Figure 1. Gas bladder used by Henry Cavendish

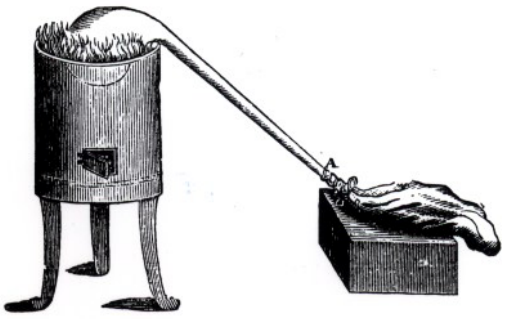

Figure 2. Gas bladder used by Carl Scheele

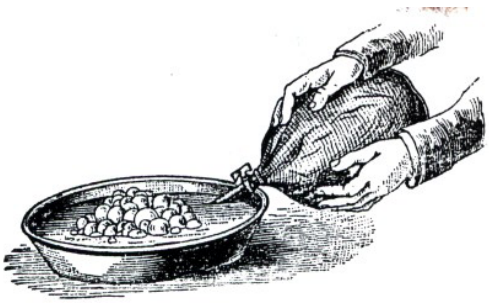

Figure 3. A 19th century gas bag experiment

And now, another century later, gas bags are still used, although plastic has replaced animal organs. Courneya and McDonald described the use of a plastic bag to

[1] ***A Short History of Chemistry***, J. R. Partington, 3rd edition, (1957)

[2] ***An Elementary Manual of Chemistry***, F. H. Storer and W. B. Lindsay, American Book Company, 1872.

store gases in 1978.[3] A modification of this can be purchased from S17 Science Supplies and Services.[4]

In this chapter we describe the use of 1 L (1 qt) household food storage bags such as Ziploc® bags for transferring gases and temporarily storing gases. The gas bag can be used to fill syringes for use by students. One gas bag will fill at least twenty 60 mL syringes. The technique is exceedingly convenient in situations such as

- ❖ obtaining oxygen from a mechanical or welding shop
- ❖ obtaining helium from a grocery or flower shop
- ❖ collecting natural gas which has enough pressure to inflate a bag but not enough to push a plunger outward
- ❖ preparing large quantities of a gas such as carbon dioxide, hydrogen or oxygen (inside the 1 L bag) for use in multiple experiments
- ❖ discharging a gas such as CH_4, H_2 or CO at a constant, controlled rate in order to sustain a small flame.

Basic materials needed

60 mL plastic syringe
1 L (qt) freezer-quality food storage bag, for example, Ziploc
tubing, 1/8 inch (3.175 mm) ID, 15 cm length
plastic hemostat or pinch clamp
dish soap

Suitability

The use of gas bags is intended for use by teachers. Gas bags can save time and provide a useful method for delivering larger quantities of gas at constant flow.

Construction of the gas bag from a food storage bag

Use a pencil or similar round, sharp object to poke a hole through the plastic bag in a position similar to that shown in Figure 4. The hole must be of smaller diameter than the tubing so that the tubing forms a tight fit wwhen inserted. Moisten one end of the piece of tubing with dish soap in order to facilitate pushing it through the hole in the bag. The gas bag is now ready for testing. Fill a large pail (10 L) with water. Inflate

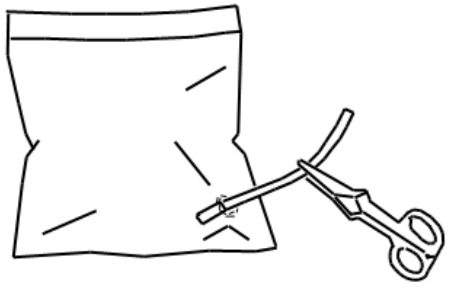

Figure 4. A 1 L Gas Bag

[3] Courneya, D and McDonald, H; The Science Teacher 45(6), 43, September 1978. The article is reprinted in Irwin Talesnick's Idea Bank Collation, A Handbook for Science Teachers, Volume 1; 1984, Part Number CB 066, S17 Science Supplies and Services. Link to the S17 website is provided at our microscale gas website.
[4] Part Number EQ 059, S17 Science Supplies and Services.

the gas bag with air. Hold the point of connection between the gas bag and the tubing under the water and check for leaks (or place some water in the bag and let it pool near the tubing and then check for leaks on the outside of the bag). We have found that there are seldom leaks. The seal, however, often leaks slowly, but in most cases slow leaks are of little consequence.

Possible uses for the gas bag

- The gas bag is a time-saving device when used as a large reservoir to fill syringes for use in microscale gas experiments by students.

- Use the gas bag to transfer oxygen from a mechanical or welding shop to the lab. Connect the tubing from the gas directly to the cylinder of compressed oxygen. Squeeze all of the air out of the bag before connecting to the cylinder. After the bag is full, clamp the tubing shut with the hemostat or pinch clamp. Avoid overfilling the gas bag.

- Use the gas bag to transfer helium for from a grocery or flower shop. Same instructions as above, however it is also possible to buy a helium balloon from a store (not overfilled) and transfer the gas from the balloon to the bag: Near the mouthpiece, but 3 cm away from the knot, twist the balloon to make a new temporary seal. Cut a small slit (2 mm) with a scissors between the twist and the knot. Work the tubing into the hole (use soap, as before). Open the hemostat and slowly release the twist seal. Gas will start filling the gas bag. (We have used helium in the molar mass experiment (Chapter 6), but better results are obtained with gases having large molar masses.)

- Use the gas bag to collect natural gas or propane. These gases have enough pressure to inflate a gas bag but not enough to push a plunger outward. Simply connect the tubing to the gas jet. For propane from a propane torch tank, remove the nozzle from the propane torch and slip rubber tubing of suitable diameter over the brass fitting on the torch. The tubing can be "reduced" in diameter by slipping it over a smaller diameter piece of tubing connected to the gas bag. Use tape to achieve an air-tight seal if necessary. Gas bags filled with flammable gases should be in the custody of the teacher at all times.

- Use the gas bag to prepare large quantities of a gas such as carbon dioxide, oxygen or hydrogen.
    - **Carbon dioxide:** Place 3 g $NaHCO_3$ inside a gas bag. Squeeze out most of the air, zip the bag shut and remove the remaining air by withdrawing it via the tubing using a 60 mL syringe. Use a 60 mL syringe to transfer 50 mL of vinegar to the bag. The reaction will commence upon

contact between the two reagents. After the reaction is complete, samples of CO_2 can be withdrawn for various experiments.

- **Hydrogen** is prepared in a similar fashion using 1 g powdered magnesium (inside the bag) and 50 mL 1 - 2 M HCl(aq) admitted via the tubing. The reaction becomes quite warm and is complete within one minute. Other forms of magnesium (turnings, ribbon) also can be used.
- **Oxygen** is prepared using 0.5 potassium iodide (inside the bag) and 60 mL 3% H_2O_2 (aq) admitted via the tubing. The reaction is considerably slower; it takes about 5 minutes.

❖ Use the gas bag to discharge a gas such as CH_4, H_2 or CO at a constant, controlled rate in order to sustain a small flame. Assemble the apparatus as shown in Figure 5. Use a 15 cm length of tubing to connect the gas bag to a glass pipet. (The tubing will form a snug fit inside the pipet.) Keep the gas bag away from flames. Open the pinch clamp and ignite the gas issuing from the pipet. Gently press down on the gas bag to control and sustain the flame. To stop the combustion, pinch the tubing shut.

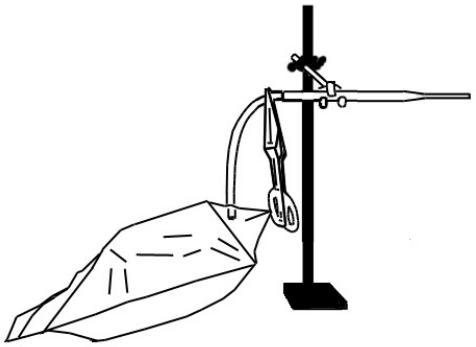

Figure 5. The gas bag being used to discharge a flammable gas at a constant rate.

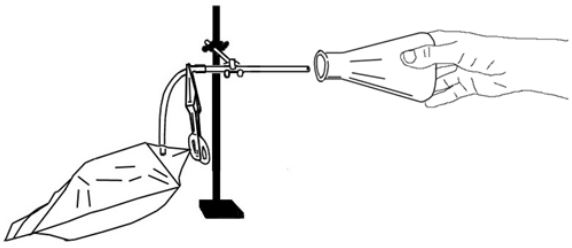

Figure 6. The gas bag used to generate strange musical sounds.

Combustion of hydrogen in oxygen demonstration. A flask as a musical instrument?

Generate oxygen and hydrogen in separate gas bags and label them. Fill a 250 mL Erlenmeyer flask with oxygen from the gas bag and stopper it until needed. Refer to Figure 6 for a pictorial representation of the apparatus and procedure: Connect the hydrogen gas bag's tubing to a 5 mm OD, 15 cm piece of glass (a pipet will not work) held in position with the aid of a ring stand and clamp as per the figure. Keep the gas bags away from flames. Remove the clamp/hemostat and immediately ignite the hydrogen issuing from the glass tubing. If necessary, gently press down on the gas bag

to control and sustain the flame. Slip the flask of oxygen over the burning hydrogen and move the flask over the flaming glass tube. As the glass tube/flame moves deeper into the flask, the pitch will drop. Move the flask "on and off" to cause the pitch to vary. The flask will become hot. To stop the combustion, remove the flask and pinch the tubing shut. Note the water vapor in the flask!

We have posted a video of this musical demonstration on YouTube: (http://www.youtube.com/watch?v=mPj6u4X5dHE).[4]

Website

This chapter is available on the web at website:

http://mattson.creighton.edu/Microscale_Gas_Chemistry.html

Instructions for your students

For classroom use by teachers. Copies of all or part of this document may be made for your students without further permission. Please attribute credit to Professors Bruce Mattson and Mike Anderson of Creighton University and this website.

Clean-up and storage

We have reused gas storage bags several times without problems.

Content for this chapter first appeared as "Microscale Gas Chemistry, Part 22. Ziploc® Bags for Temporary Gas Storage and Transfer"; Bruce Mattson, B.; and Meyer, A., ***Chem13 News***, **311**, April, 2003, 13 – 15.

SUMMARY OF MATERIALS AND CHEMICALS NEEDED FOR CHAPTER 5. GAS STORAGE BAGS.

Equipment required

This list summarizes all of the equipment necessary for the construction and use of a gas bag described in this chapter.

Item	For Demo
Microscale Gas Chemistry Kit (See Chapter 1)	1
tubing, 1/8 inch (3.175 mm) ID, 15 cm length	1
plastic hemostat or pinch clamp	1
Erlenmeyer flask, 250 mL	1
pyrex glass tubing, 15 cm, 3 mm I.D.	1

Materials required

Item	For Demo
1 L (qt) freezer-quality food storage bag, for example, Ziploc	1
dish soap	1

