Instructions for making a zinc-iodide cell

The zinc-iodide cell or zinc-iodide battery is an ideal model to use at school for understanding how a rechargeable battery works.
The closed container provides greater safety during the experiment, and the ability to reuse the materials protects the environment and goes easy on the wallet.

1 Apparatus and materials

The following materials are needed to make the zinc-iodide cell:

Materials	Supply sources
Distilled water	Home improvement store
2x graphite electrodes, hardness 4B – 5.5/75 mm, smooth	Laboratory supplier
1x plastic screw-top container 50 ml + lid	Laboratory supplier
2x silicone tube, 8/5 mm, 2 cm	Laboratory supplier
Super absorbent/sodium polyacrylate 3.0 g of super absorbent is needed per cell	Chemical supplier
Zinc-iodide [irritant (Xi) R36/S26] 1.5 g zinc-iodide is needed per cell	Chemical supplier

2 Instructions

Proceed as follows to make the zinc-iodide cell:

- Predrill two holes in the polyethylene lid using a metal drill approximately 3 mm in diameter. Then drill out the holes to 7 mm using a sharpened metal drill; see Fig. 1.
- Cut two short pieces (about 2 cm) off the silicone tube and insert them into the drilled holes in the lid.
  Moisten the graphite electrodes and push them through the two pieces of tube until the electrodes protrude about 1.5 cm above the lid.
- Weigh out 1.5 g of zinc-iodide and 3.0 g of super absorbent and add the two substances to the screw-top container.
- Add 45 ml of distilled water to the container, screw the lid with the inserted graphite electrodes onto the container, and gently swirl the container evenly until all the water has thickened into a gel. Caution: Do not shake the container! Doing so will cause gas bubbles to form.

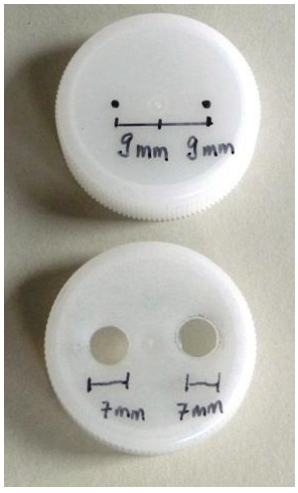

Fig.1: Holes drilled in the lid.

- Label the screw-top container with the description “Zinc-iodide cell – contains zinc-iodide [irritant (Xi) R 36/S 26]” and mark the positive pole (+) and negative pole (-) (see Fig. 2).
- You can now charge the finished battery using a wind turbine (solar motor with dual propeller), a water turbine (solar motor with waterwheel), one or more solar cells, and other direct-current generators (max. 9 V). At the positive pole (anode), you will see a light to dark brown coloring – depending on the state of charge – caused by the iodine that forms.
- You can now connect various loads to the charged battery. The battery provides a current of max. 12 mA at about 0.8 V.
- After the experiment, the two electrodes should be short-circuited so that the remaining iodine is reduced faster and the brown coloring disappears.

Fig. 2: Finished zinc-iodide cell.

3 Safety information

Please point out to the students that the zinc-iodide cell must not be disassembled; otherwise, it will no longer be functional and irritant chemicals could leak out.

4 Electrochemical processes when the zinc-iodide cell is charged and discharged

During **charging** (electrolysis), the supplied electrical energy is used to reduce the zinc ions to zinc and to oxidize the iodide ions to iodine:

Negative pole (cathode):	$Zn^{2+} + 2e^-$	→ Zn	(reduction)
Positive pole (anode):	$2\ I^-$	→ $I_2 + 2e^-$	(oxidation)

The battery’s state of charge is visible based on the brown coloring caused by the produced iodine. The formed zinc is very difficult to recognize at the negative pole.
During **discharging** (galvanic cell), the polarity and thus the motor’s direction of rotation remain the same. Zinc is oxidized again to zinc ions and iodine is reduced to iodide ions. The negative pole becomes the anode due to the oxidation process, and the positive pole becomes the cathode due to the reduction process:

Negative pole (anode):	Zn	→ $Zn^{2+} + 2e$	(oxidation)
Positive pole (cathode):	$I_2 + 2e^-$	→ $2\ I^-$	(reduction)

5 On the regeneration of the zinc-iodide cell

If the zinc-iodide cell is charged, atomic iodine and zinc are formed. The formed iodine is especially highly visible as a brown “cloud” around the positive electrode. This phenomenon is very valuable didactically, since the students can immediately see a result of the charging process. When the zinc-iodide cell is discharged using the electric motor, the brown coloring caused by the iodine does not disappear completely. To speed up the discharging process and thus the decoloration, the students should short-circuit the cell’s two electrodes using an alligator clip connecting cable. Depending on the cell’s charge state, this process will still take from a few hours up to three days at the maximum until the decoloration is complete. The reason for the slow discharge is that the iodine diffuses too far from the electrode to be reduced again to I^- (colorless). This means it takes a relatively long time until the diffused iodine comes into contact with zinc particles (internal short circuit) and reacts with the particles to form colorless zinc-iodide again. If need be, though, it is not necessary to wait for days until the experiment can be repeated. Even if a brown coloring is still present, the cell can be charged and discharged at any time (the class just does without the clear color effect).