Principle : **Ionization of Electrolyte**

Area of Study : **Chemistry, Electricity**

Equipment : **Pickle electrocution apparatus, Spare 20 or 30 amp fuses, Pickles (Dills are Preferable).**

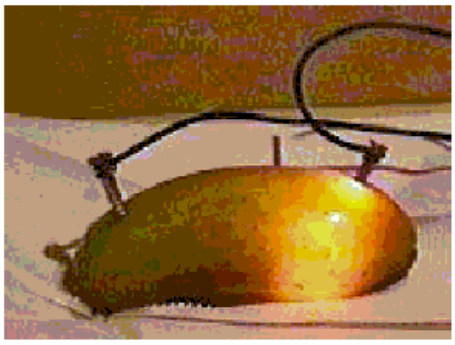
Procedure : **Insert the two elevated copper wires into the ends of a pickle. THEN PLUG IN THE UNIT !!! Turn the On/Off switch to the On position. The 40 or 50 watt bulb will come on. This light acts not only as the indicator that the circuit is armed, but also as a current shunt and current spike protector. When ready HOLD DOWN the button on the hand switch. Depending on the size of the pickle, after about 10 seconds the pickle will start to emit steam and then will start to glow quite spectacularly. This is a good approximation of what happens to an electrocution victim as the electric current follows the electrolyte streams (Arteries and Veins) of the body. NOTE: ALWAYS UNPLUG THE UNIT BEFORE INSERTING OR REMOVING THE PICKLE.**

Zijn er nog gelijkaardige lichtbronnen mogelijk, gebaseerd op emissie van licht door natriumionen?

De augurklamp

Opgelet: als je het uitvoeren van dit experiment zou bijwonen, de grootste voorzichtigheid in acht nemen omwille van het gevaar van hoge spanning.

Als we een spanning van 170 volt (AC) op een gepekelde (= zoutzure) augurk zetten, zal deze augurk na enkele seconden een geel licht beginnen uitstralen.



Een verklaring is dat de Na-ionen die, na het pekelen, in de augurk achterblijven hetzelfde proces doormaken als de Na-ionen in een natriumdamplamp.

Vuurwerk

Re: Why does only one half of the electric pickle light up?

Date: **Thu Aug 24 20:43:09 2000**
Posted By: **William Beaty, Electrical Engineer / Physics explainer / K-6 science textbook content provider**

Area of science: **Chemistry**
ID: **962461521.Ch**

Message:

Oh boy, pickle engineering analysis!

This effect is most probably caused by the different wattage intercepted by the nail which is suspended from the pickle and is arcing through space, versus the nail which is contacting the salty pickle directly. If the electric arc presents a large electrical resistance, while the direct contact between the nail and the pickel presents a small resistance, then a "flip-flop" situation exists, and the system is most stable when only one nail is arcing. If true, then AC or DC makes no difference, and the effect is caused by the instability of two electric arcs connected in series.

Let's try assigning some crude numbers to this. Suppose the pickel runs at about 50 watts, and suppose the electric arc has 100x more resistance than the direct metal/pickel contact. Knowing that W=V^2/R, we can calculate that 120 volts at 50W gives a total resistance of nearly 300 ohms, and if the resistance ratio is 100:1, then the electric arc has about 300 ohms while the direct metal/pickel contact has about 3 ohms.

What happens when we first plug the pickel into the wall? Well, if both nails make contact with the pickle tissue at 3 ohms resistance, then the total power is V^2/R, (120*120)/(3+3) or 2400 watts! Each nail would experience half the total, or 1200 watts. With such a high wattage concentrated at the surface of the nails, the water in contact with the nails would fairly explode! At this point a "random decision" would be made, because one nail would generate gas a bit faster than the other, and an electric arc would develop at one nail first. The resistance of the arcing nail would rise to the 300 ohms we calculated before, and the total wattage being used by the pickle would fall drastically. The total resistance of both nails in series goes from the 6 ohms of direct contact to the 303 ohms of one electric arc in series with one direct contact. The total energy goes back down to around 50W again, with almost all of it dissipated by the single electric arc, and the non-arcing nail loses the race. The direct contact gets about 0.5 watt, while the electric arc gets the remaining 49.5 watts, and as a result, the nail with the direct contact stays cool and does not trigger an arc, while the electric arc self-heats, maintaining its own existance. Once the arc appears at one end of the pickel, it tends to stay there.

Note that I'm picking these numbers out of the air, and making informed guesses as to what's occurring. I think the general idea is correct, but the actual values might be quite different than I've speculated above.

Why would the arc move from one end to the other? Well, have you noticed that the electric arc tends to carve a large hollow inside the pickel? In industrial settings this is called "electric discharge machining" and is used to carve odd-shaped holes in metal parts. The arc is extremely hot, and it vaporizes any pickle tissue that it touches. For this reason the arc tends to attack any bit of pickle tissue that protrudes, and when that part of the pickle is destroyed by the arc, the arc wanders to the next highest section of pickle-stuff. After a moment the nail would have no supports, and would fall down and touch the pickle directly. At this point the wattage would rise enormously again (because the two 3-ohm direct contacts in series present only 6 ohms load to the power supply). Again the 2400 watts would blast the pickle, the "random decision" would occur, and one of the nails would heat its way into an electric arc state.

As time went on, the nails would chew down through the pickel, randomly taking turns at supporting an electric arc, or at making direct contact with the pickle tissue. And while the arc was staying at one end, it would continuously move along the nail, creating a strange flickering/crawling light pattern.

I've always been meaning to make an "artificial pickle" that was transparent inside. Cast a block of unflavored Jello with lots of salt added, then use it as a "pickle." The clear surface would give us a window on the mysteries taking place inside. This might make a good student project, eh?

The Pickle Light Bulb

Take a nice Kosher dill pickle, stick a nail or needle into it from from each of the long ends (with nail/needle tips not even close to touching each other).
Somehow figure out how to (safely, if that is even possible) attach 120 volts AC to the two nails/needles. If the lights are low, you will see a nice greenish glow coming from inside the pickle. The accompanying smoke and strench are not as bad as you might imagine (at least not at first). Have some spare fuses standing by, or know where your circuit breakers are!

Write what you observed while the pickle was plugged into the electrical outlet.
OBSERVATIONS:

Questions:

1. Did an electrical current travel through the pickle? How do you know?

2. Do you believe a chemical reaction occurred in the pickle? What did you observe that led you to believe this?

3. What substance do you think caused the “mini explosions” that you saw in the pickle. (Hint: it is a very reactive gas)

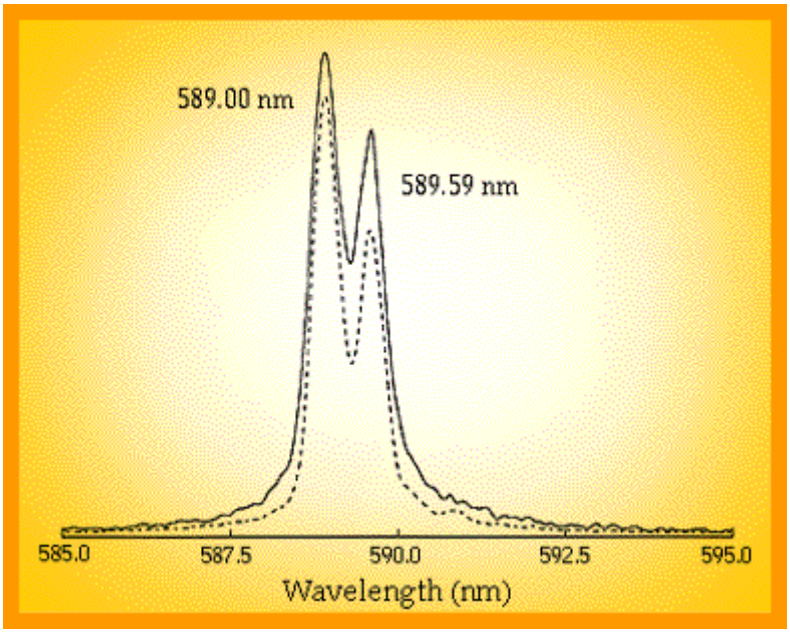
EXTRA CREDIT (WORTH AS MUCH AS 5-10 POINTS IN HOMEWORK PACKET)

1. There is an element in solution that is found in dill pickles This substance is what allows the pickle to conduct electricity. What is this element in solution? *(Hint: Read the Notes on Chemical Bonds for some hints and refer to the Electrical Conductors Lab)*

2. Write the chemical equation that shows the reaction that takes place in the pickle while it was plugged into the outlet. *(Hint: You have seen this chemical equation before and you have written it down)*

See what happens when you overload your pickle? Why would someone plug a dill pickle into electricity in the first place? A credible story comes from Steve Jacobs, a science educator, creator of the Jake's Attic TV show, and consultant to Mr. Wizard. According to Mr. Jacobs, while attending a garden party during a teacher's conference someone mentioned how they used to cook food in their college dorm with raw electricity (hot plates were either banned or unavailable). Someone at the party then suggested that the host allow a few electrical experiments to various things found around the kitchen. Apparently, glowing dill pickles were the only exciting discovery.

Jacobs worked up the trick for Don Herbert (Mr. Wizard) to perform on The Tonight Show with Johnny Carson on January 24, 1990. On that show Mr. Wizard said he wasn't exactly sure why the pickle glowed yellow when electrocuted. A Discover Chemistry Challenge! Yours truly (J. R. Appling) saw that show and the next morning did an experiment to prove that it is the sodium in the pickle that gives the characteristic yellow glow.



The experiment was performed by taking a visible light spectrum of the glowing pickle, using a Jarrell-Ash spectrograph with a diode array detector. A fiber-optic probe was used to channel the yellow glow to the spectrograph. A calibration spectrum was taken of a sodium chloride flame test. The emission spectra of the two are identical as you can see in the figure (the dashed line is the NaCl flame test, and the solid line is the glowing pickle).

This pair of emission lines at 589.00 nm and 589.59 nm is a characteristic of sodium emission, called the sodium D line doublet. Josef Fraunhofer observed these lines in the emission spectrum of the sun, somewhere around 1817. We know now that it is due specifically to an electronic transition of sodium atoms in the gas phase.

The pickle conducts electricity due to the vinegar (acetic acid) and sodium chloride salt used to make it. Sodium ions in the pickle liquid attach electrons from the flowing current. These ions are neutralized electrically, forming excited sodium atoms in two different excited electronic states (hence the emission doublet).

$$Na^+(aq) + e^- \rightarrow Na^*(g)\left[{}^2P_{3/2}\ {}^2P_{1/2}\right] \rightarrow Na(g)\left[{}^2S_{1/2}\right]$$

Because of the heat and sparks and general pandemonium around the electrodes stuck in the pickle, these sodium atoms are in the gas phase. They emit yellow light as they relax to the ground state. The explanation of the phenomenon was first published by J. R. Appling, F. J. Yonke, R. A. Edgington, and S. L. Jacobs as "Sodium D Line Emission from Pickles" in *The Journal of Chemical Education*, vol. 70, no. 3, p. 250 (1993).

Scot Morris published a description of the Electric Pickle in the Games column of *Omni* magazine. He also appeared in the May 13, 1991 edition of *The San Diego Union* newspaper holding an electrocuting pickle by its tail. Penn and Teller also published a description of the Electric Pickle in their book "Penn and Teller's How To Play With Your Food."

Links

Here are some interesting links for the Electric Pickle:

- Organic Illumination Systems. Those wacky guys at Digital published a report.
- Lori's Chemistry Page. Good pictures of flame tests and a movie of the pickle doing its thing. She doesn't give us credit, and gets the citation to the paper wrong, but hey, she's got the movie (868K) and we don't.
- Bizzare Stuff. A short description, nice site for kookie stuff.

Other relevant links:

- Atoms. The Discover Chemistry topic on Light is in the Atoms section.
- Light. More about light on the Discover Chemistry Light and Energy page.
- Bioluminescence. Learn about light emitted from biological things on the Discover Chemistry Bioluminescence page.
- Kitchen Chemistry. More fun things to do in the kitchen, some less dangerous than the Electric Pickle.

We kennen de natriumlamp als lantaarnpalen langs de snelweg. Het gele licht dat wordt uitgezonden door deze verlichting ontstaat door aangeslagen elektronen die terugvallen naar hun oorspronkelijke positie en energieniveau.
Zoiets gebeurt ook als stofdeeltjes in een vlam terechtkomen en er daardoor lichtflitsjes ontstaan.
Het uitzenden van geel licht komt omdat