

Topic 7b Batteries

- Battery Types
- Comparison
- NiCads in detail
- Versapaks
- Demonstration

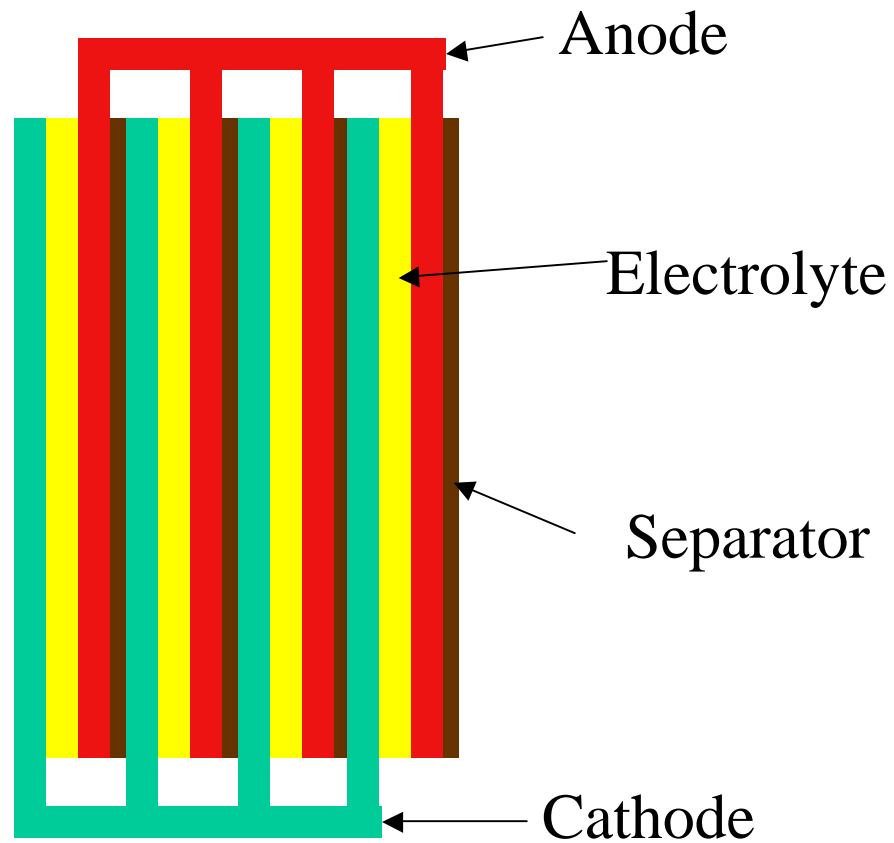
Battery Types

- Primary
 - Use ‘em and toss ‘em
 - Carbon-Zinc, Mercury-Oxide, Alkaline-Manganese
- Secondary
 - Rechargeable
 - Lead-Acid, Nickel-Cadmium, Nickel-Metal-Hydride, Lithium-Ion
- Fuel Cells
 - Consumable active material

What is a “Battery”

- Really called a “Cell”
- A battery is a pack of cells
- Each cell has:
 - Anode
 - Cathode
 - Electrolyte
- Different types have different characteristics
 - Operating voltage, power density, resistance, etc.

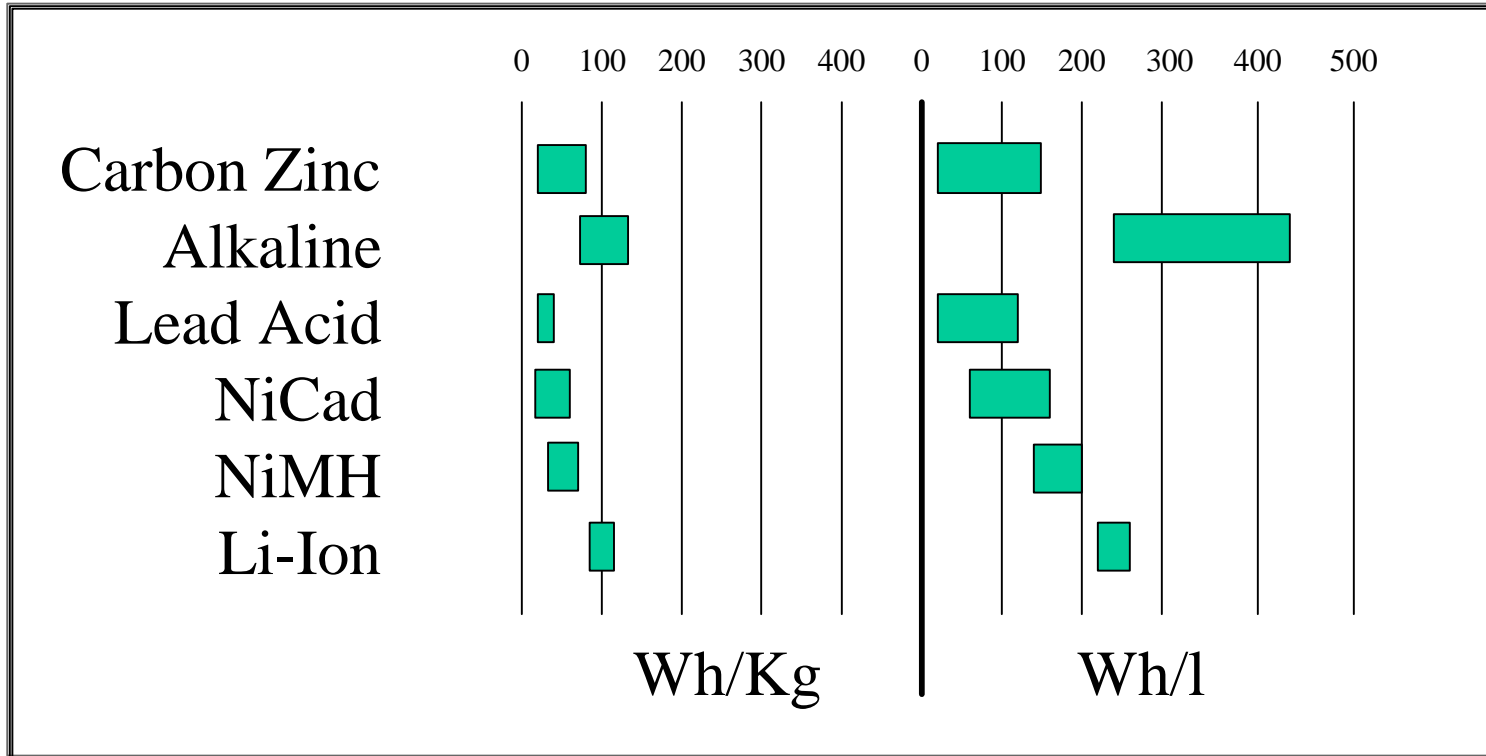
Battery Schematic



Comparison

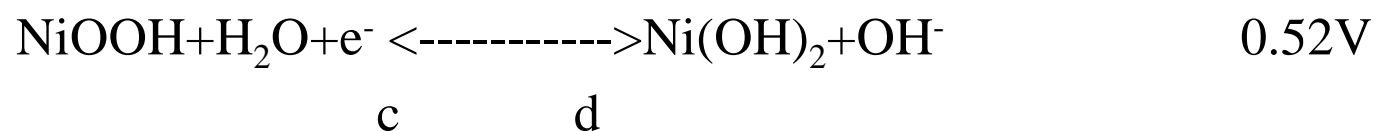
Type	+ve	E'lyte	-ve	V	% dis	I-out
Carbon-Zinc	MnO ₂	NH ₄ ClZnCl ₂	Zn	1.5	10/yr	Lo
Alkaline	MnO ₂	KOH	Zn	1.5	7/yr	Lo
Lead-Acid	PbO ₂	H ₂ SO ₄	Pb	2	20/mo	Med
NiCad	NiOOH	KOH	Cd	1.2	20/mo	Hi
NiMH	NiOOH	KOH	Fe	1.2	20/mo	Med

Energy Density

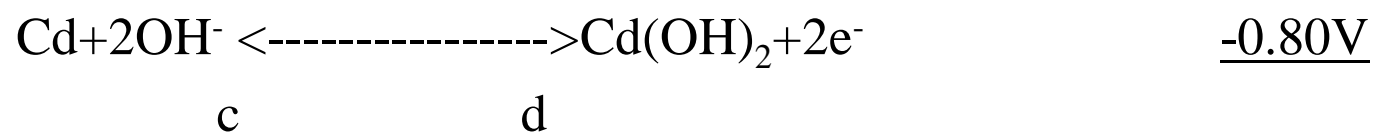


Nickel Cadmium Theory of Operation

- At the positive electrode:

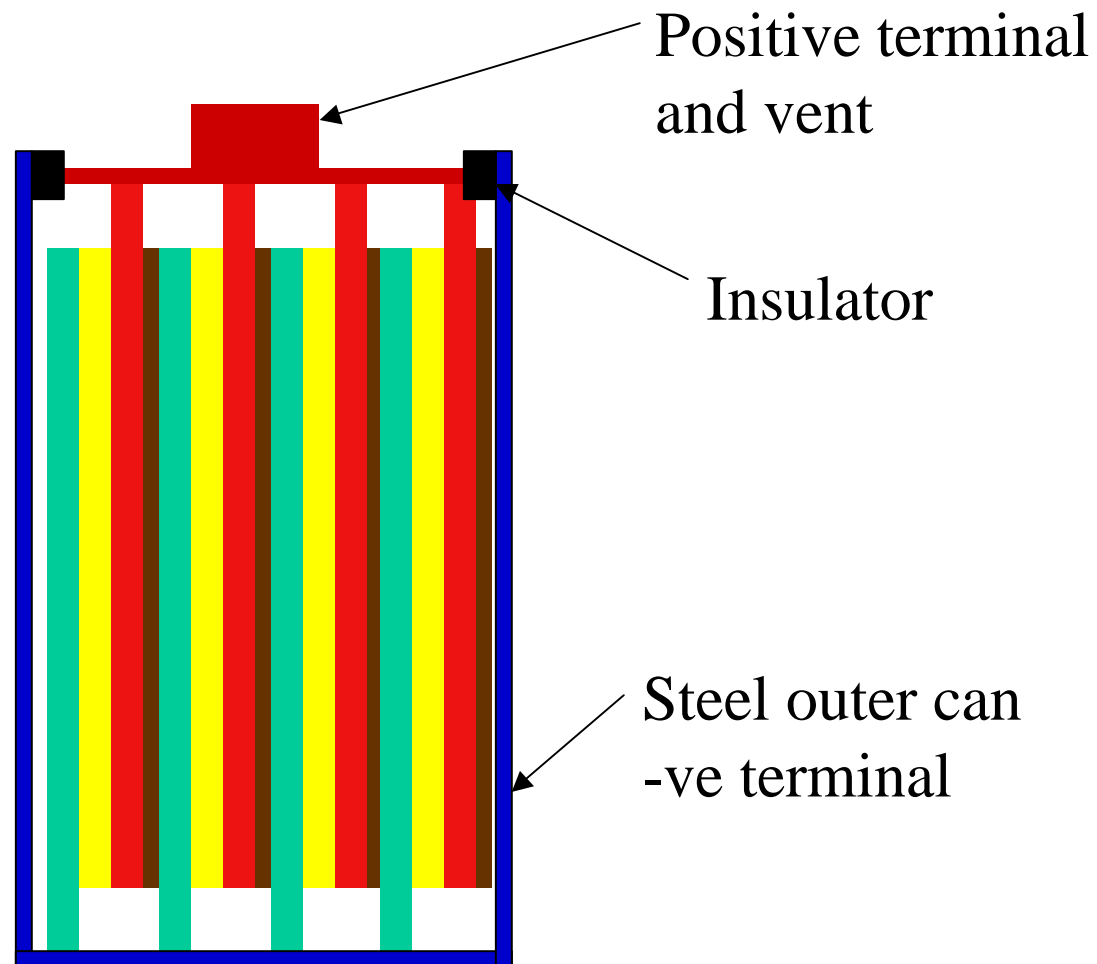


- At the negative electrode:



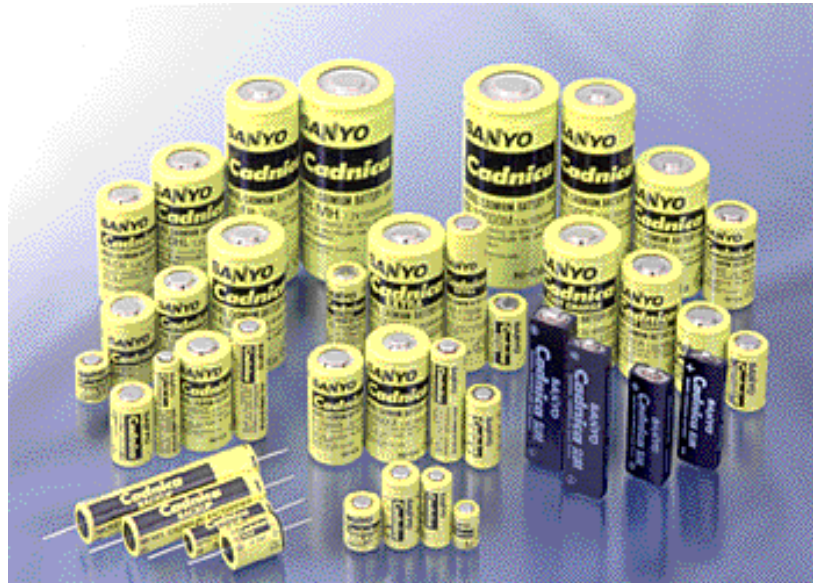
1.32V

Typical NiCad Construction

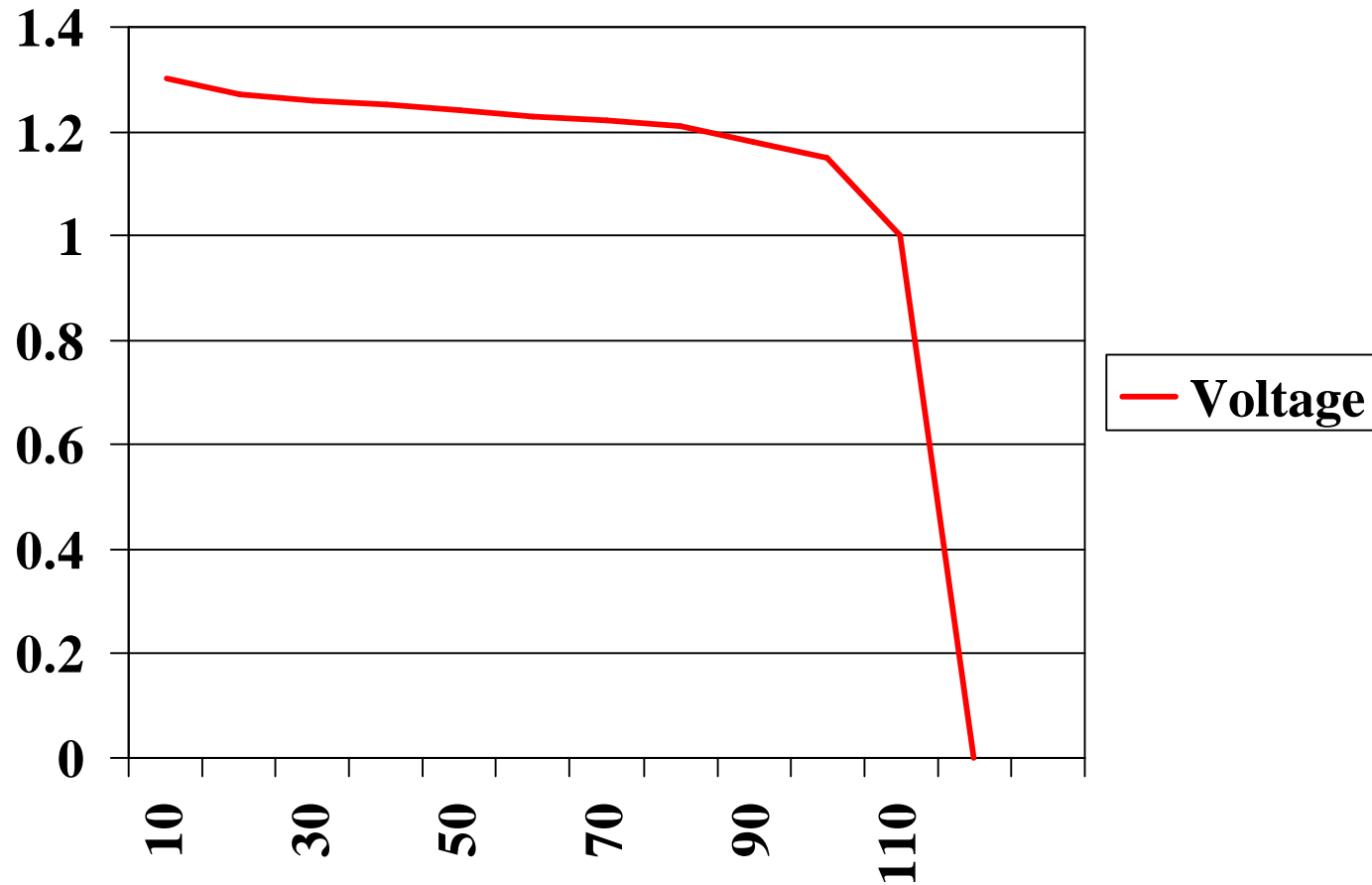


NiCad Models

Size	Dia	Height	Capacity mAh
AA	14	50	600
SC	23	26	650
C	26	50	2000
D	34	61	4000



Discharge Characteristics



Charge and Discharge Rate

- “C” is the capacity of the cell in Amp-Hrs
- The charge and discharge rate is measured in multiples of “C”
- e.g. For a 4 Amp-Hr cell, $0.1C = 400mA$
- Typically Charging and discharging at $0.1C$ results in no heating problems
- Charging at greater than $0.3C$ requires an “intelligent controller”
 - Charging is cut off by “-ve deltaV”, or +ve temperature rise
 - Requires voltage or temperature sensing (or both)

Application Example



Monorail Vehicle,
4A-Hrs @14.4V



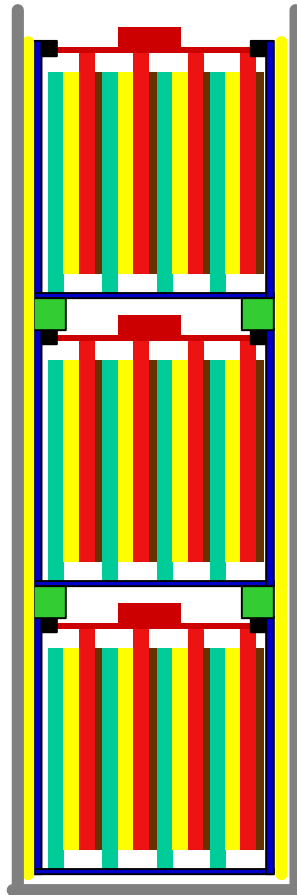
Monorail Hoist,
4A-Hrs @19.2V

Charge @ 1C,
Discharge @ .25C
7b-12

Versapak Characteristics

- 3x SC Cells
- Nominal 3.6 volts
- 650mAh
- 6 m-ohms/cell

Versapak Construction



Care and Feeding of NiCads

- Temperature Kills
- Overcharging Kills
- Reverse Charging Kills
 - No two cells are exactly the same
- Conditioning is Good
- Don't put them in your pocket
- DO NOT MODIFY THEM

Batteries are dangerous

The batteries you have been given are Nickel Cadmium (NiCd) batteries. When used properly they are extremely safe and reliable. When abused, they present dangers on three fronts: Materials, Explosive Gases, Rapid Energy Release.

Materials: The electrolyte in your batteries is Potassium Hydroxide, KOH. This is a corrosive alkaline material and can cause burns if it contacts the skin. The batteries are sealed, so this should pose no danger. DO NOT cut open or puncture the batteries, or do anything that might break them open (like chucking them into a lathe). The electrodes are made of Nickel and Cadmium, both of which are heavy metals and are hazardous to the environment. Please do not dispose of the batteries improperly. If you have no use for them, return them to us.

Explosive Gases: During the charge and discharge cycles of a NiCd battery, oxygen and hydrogen are created and recombined. During normal use, this is not a problem, however if the cells are charged or discharged at too high a rate, or, if the electrodes are damaged, these gasses may not recombine fully, causing an explosion hazard. DO NOT short the batteries to discharge them (see below) or physically damage them. DO NOT use ANY charger other than the ones provided.

Rapid Energy Release: A fully charged battery has a capacity of 0.65 AmpHours. What does this mean? Well it means that it can discharge at a rate of 650 mA for one hour. Or 1.3 amps for 30 minutes. Or it could blow out 13 amps for 3 minutes. Think about it. At 3.6 volts, 13 amps through a resistive load puts out over 45 Watts. Would you like a 45 Watt heater in your pocket? A small soldering iron puts out 15 watts. Ouch. DO NOT use anything other than the motors provided to discharge the batteries. NEVER put them in your pocket.

Operating Tips

NiCd batteries are finicky, like cats. In spite of what the B&D datasheets say, NiCd's like to be "conditioned" before use. Normally this means cycling them (full charge and discharge) three times. This seems to "set up" the chemistry, and to "blow out" any internal shorts caused by impurities in the electrolyte inside the cells. I recommend charging the cells over night, and then running them in the screwdriver motors to full discharge. You can do this by clamping or taping the button on the screwdriver down. Try to run the battery until the screwdriver starts to slow down (not stopping completely). This might mean taking it to dinner in the evening. If the battery is run down too far, and left alone in a completed circuit, you will "reverse charge" the cells. A bad thing we will discuss in class. Then repeat the process two more times. Each battery should support at least 500 full cycles before there is any loss of capacity, so you will have plenty of power for the contest.

Avoid temperature extremes. Don't store them in your car trunk at night, or on your radiator.

NiCd's lose about 25% of their capacity a month just sitting on a shelf (so say the manuals, I believe this is optimistic), so if you are not using them, and you have already conditioned them, leave them in the charger. Make sure you have tested all of your batteries BEFORE the contest.

Violating the safety warnings on this sheet is: a)dumb, b) a violation of the contest rules, and subject to disciplinary action.