Product Engineering Processes

Battery Primer

A short battery primer

Handbook of batteries, Linden and Reddy

Short Primer on Batteries

Types

Primary (dry cell): non rechargeable

- low power applications
- infrequent use

Secondary: rechargeable

- high discharge rates
- frequent use

Short Primer on Batteries

Selection considerations

Physical characteristics: size, shape weight

Voltage: nominal, maximum, minimum, discharge profile

Load current: rate, constant power, constant resistance, pulsed

Duty cycle: continuous, intermittent, cyclic

Charge/discharge cycle: cycling (float), deep cycle, efficiency of charging

Temperature range: maximum, minimum and nominal

Service life: required operation time

Safety: failure rates, leakage, off-gassing, toxicity, disposal

Environment: vibration, acceleration, orientation

Maintenance: regular upkeep, replacement

Cost: initial, life-cycle cost

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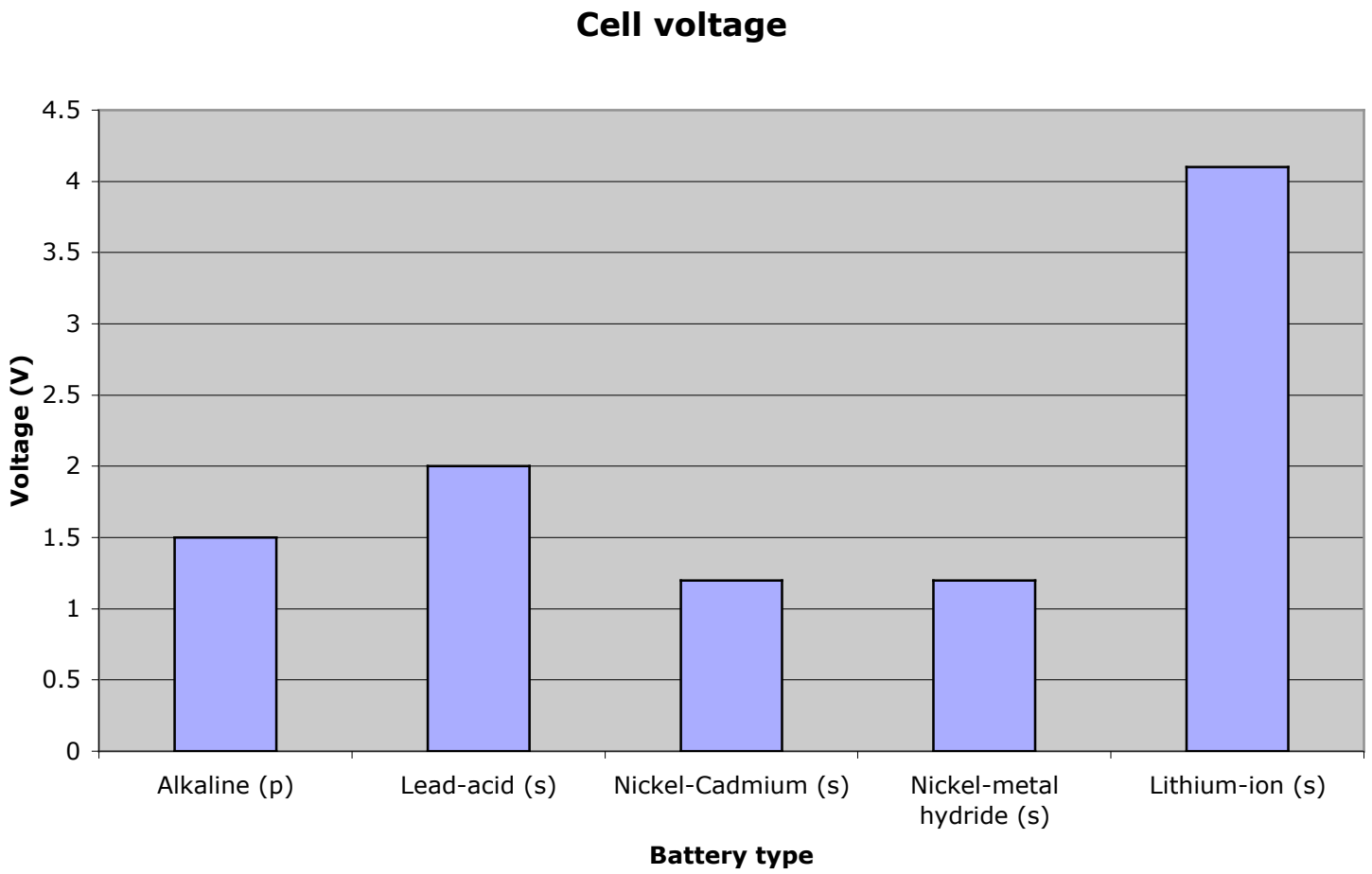
Cell voltage



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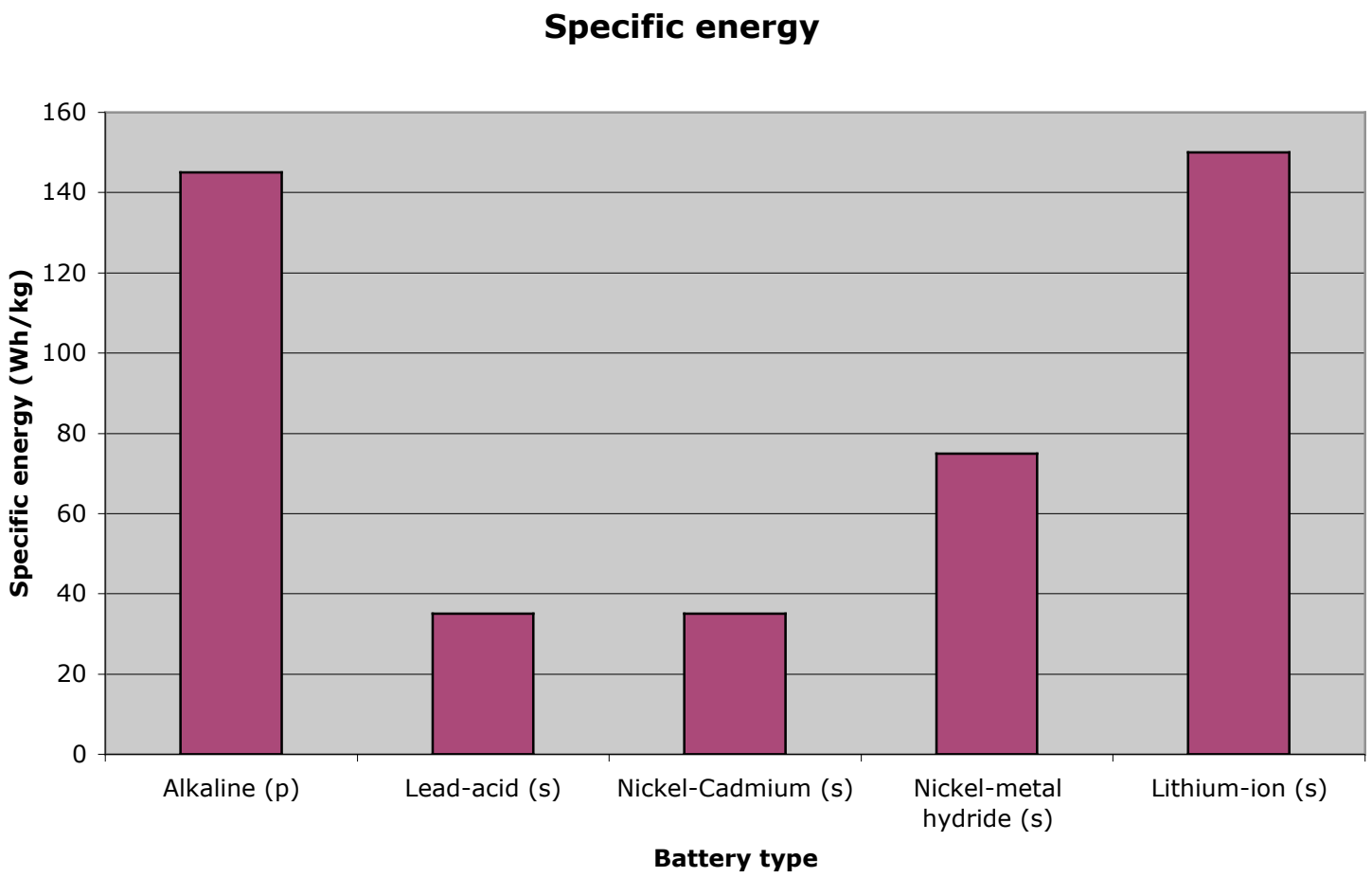
Specific energy



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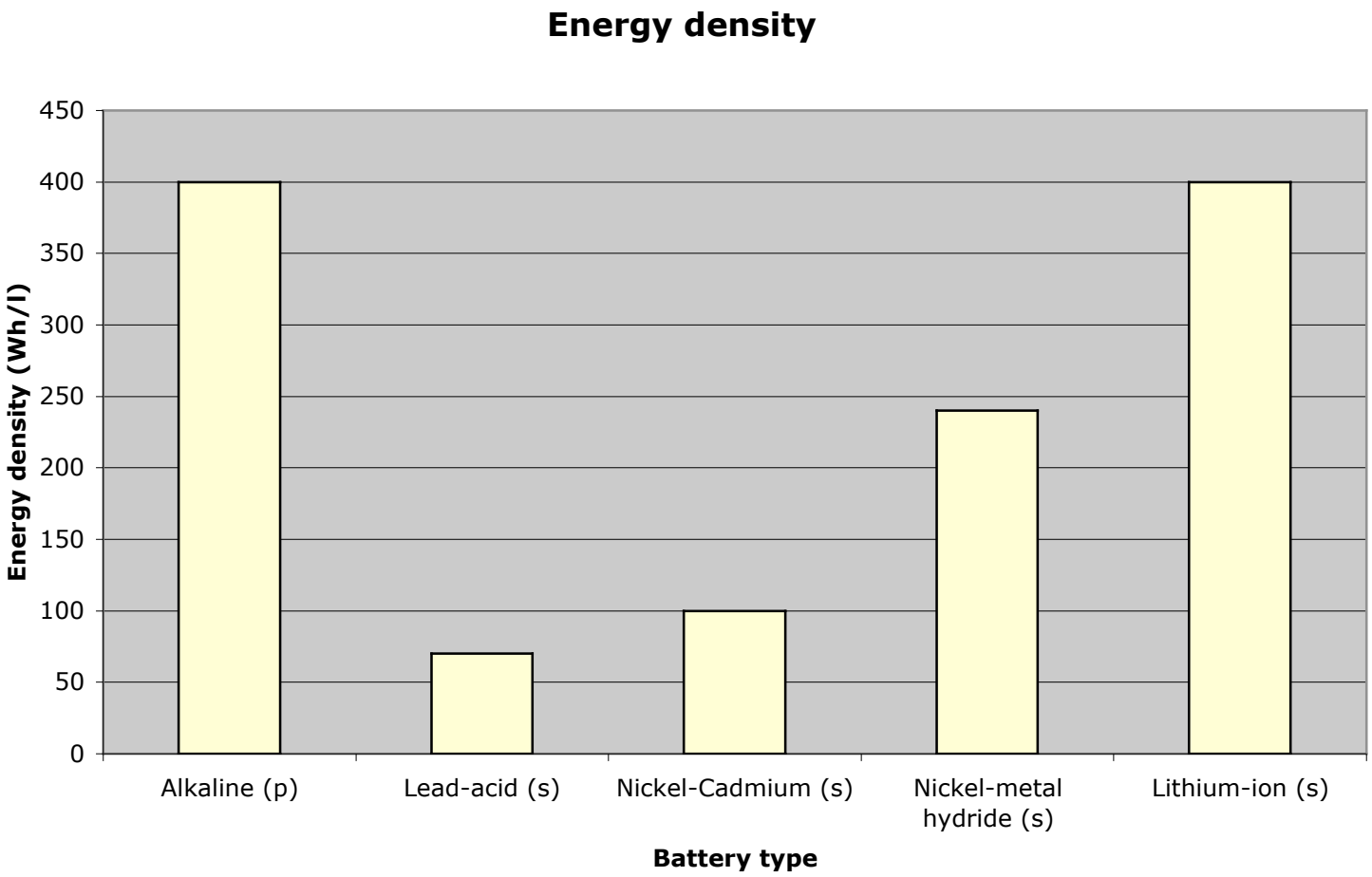
Energy density



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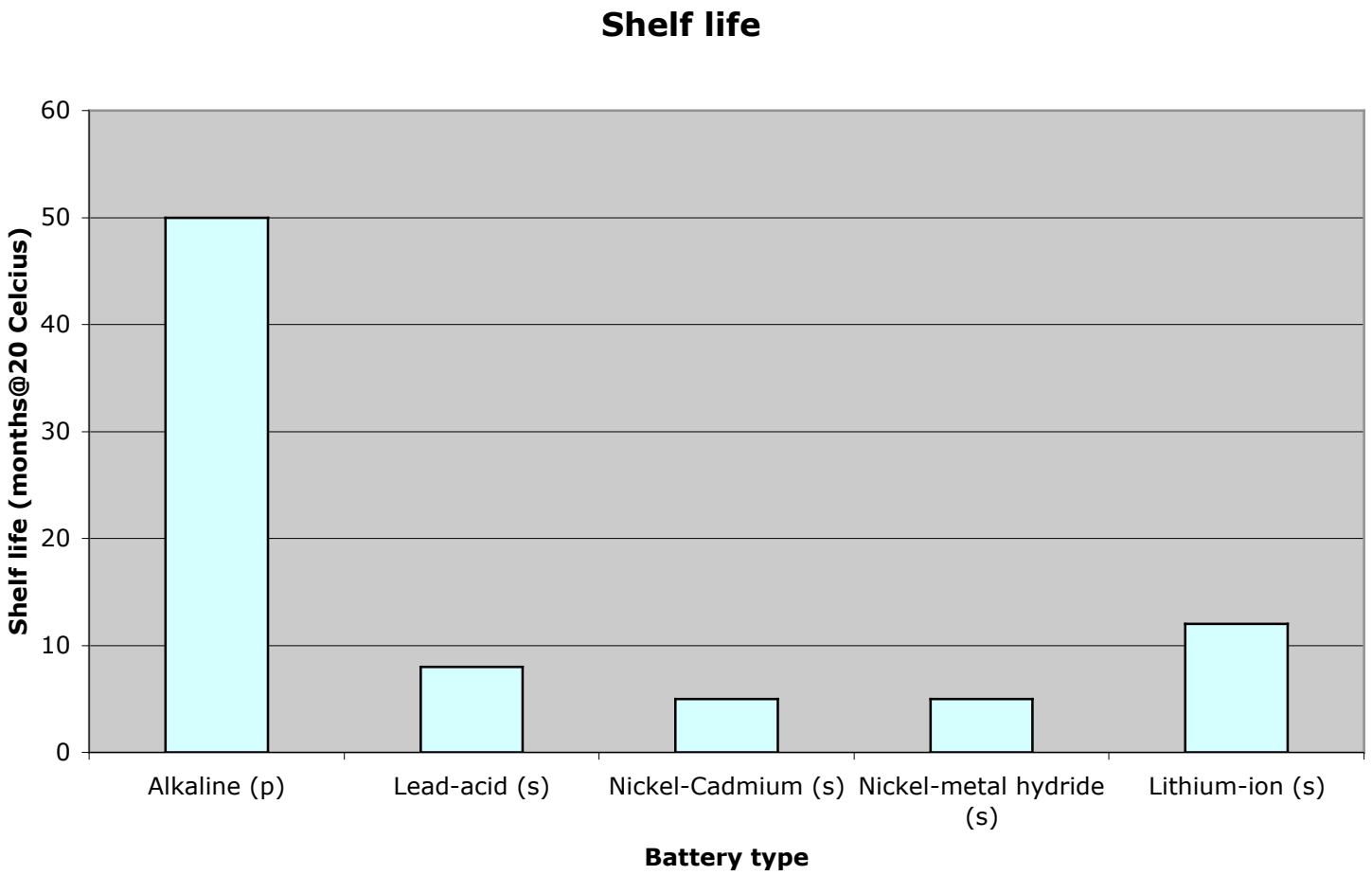
Self discharge



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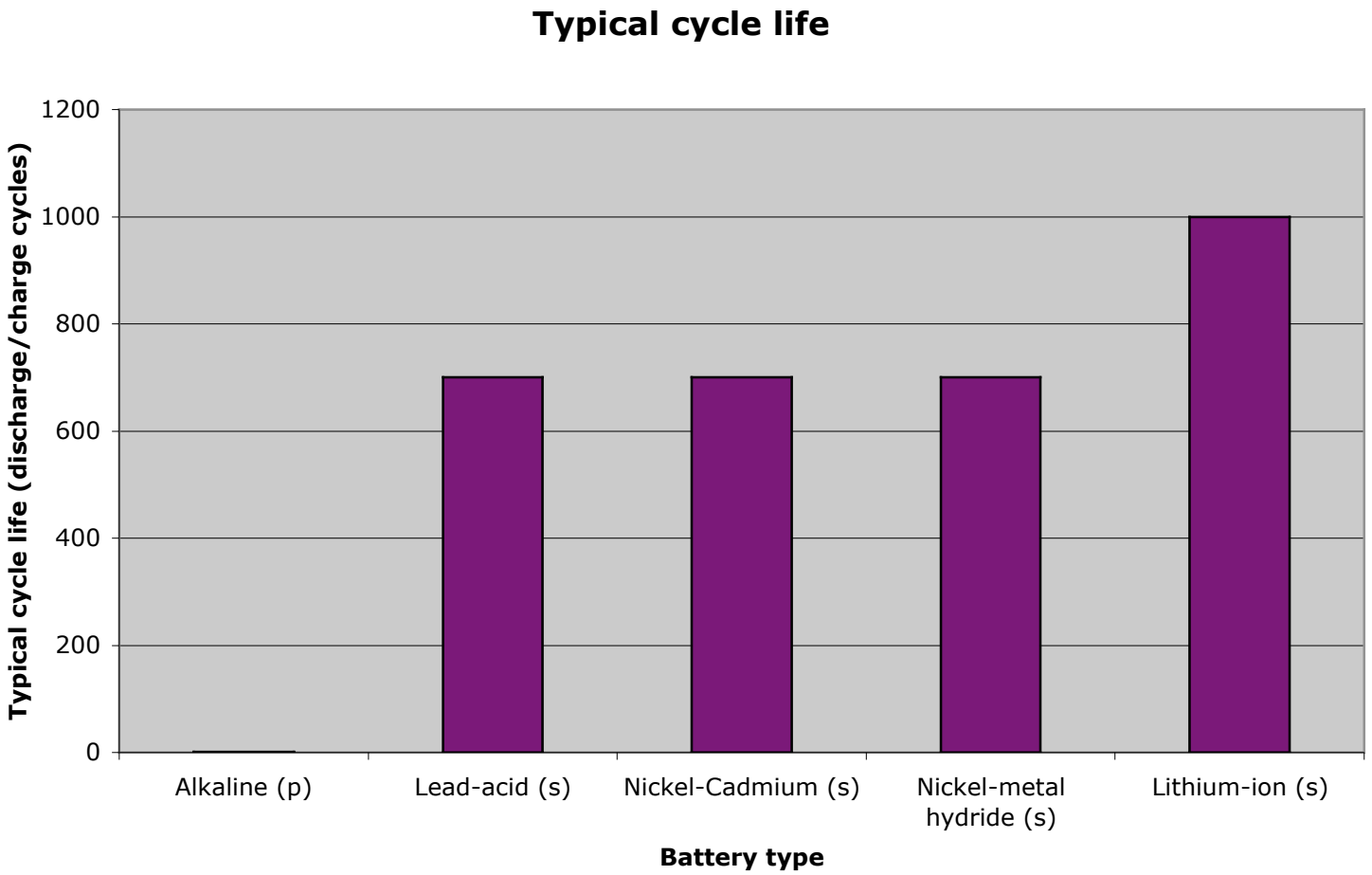
Estimated cycle life



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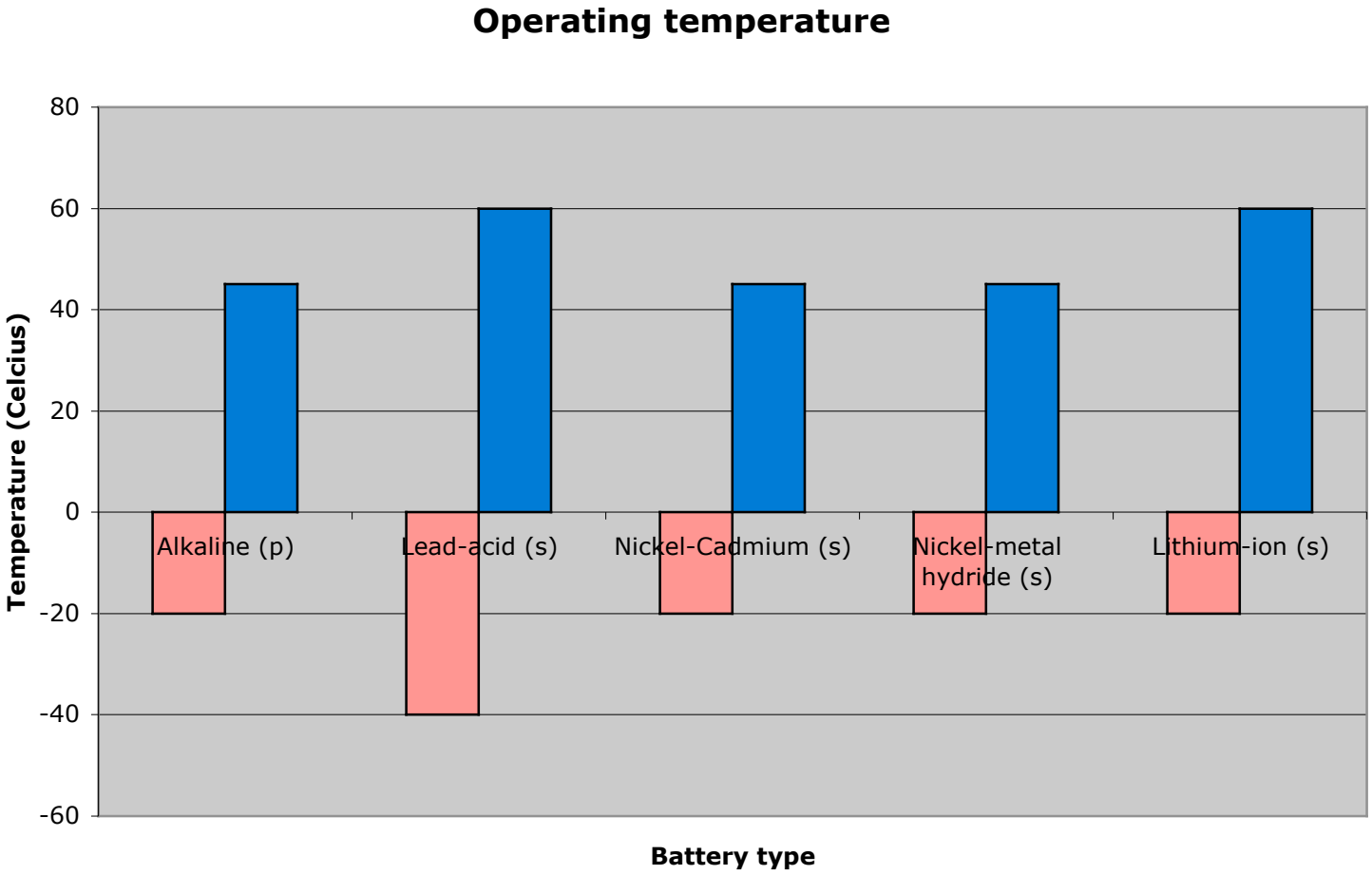
Temperature range



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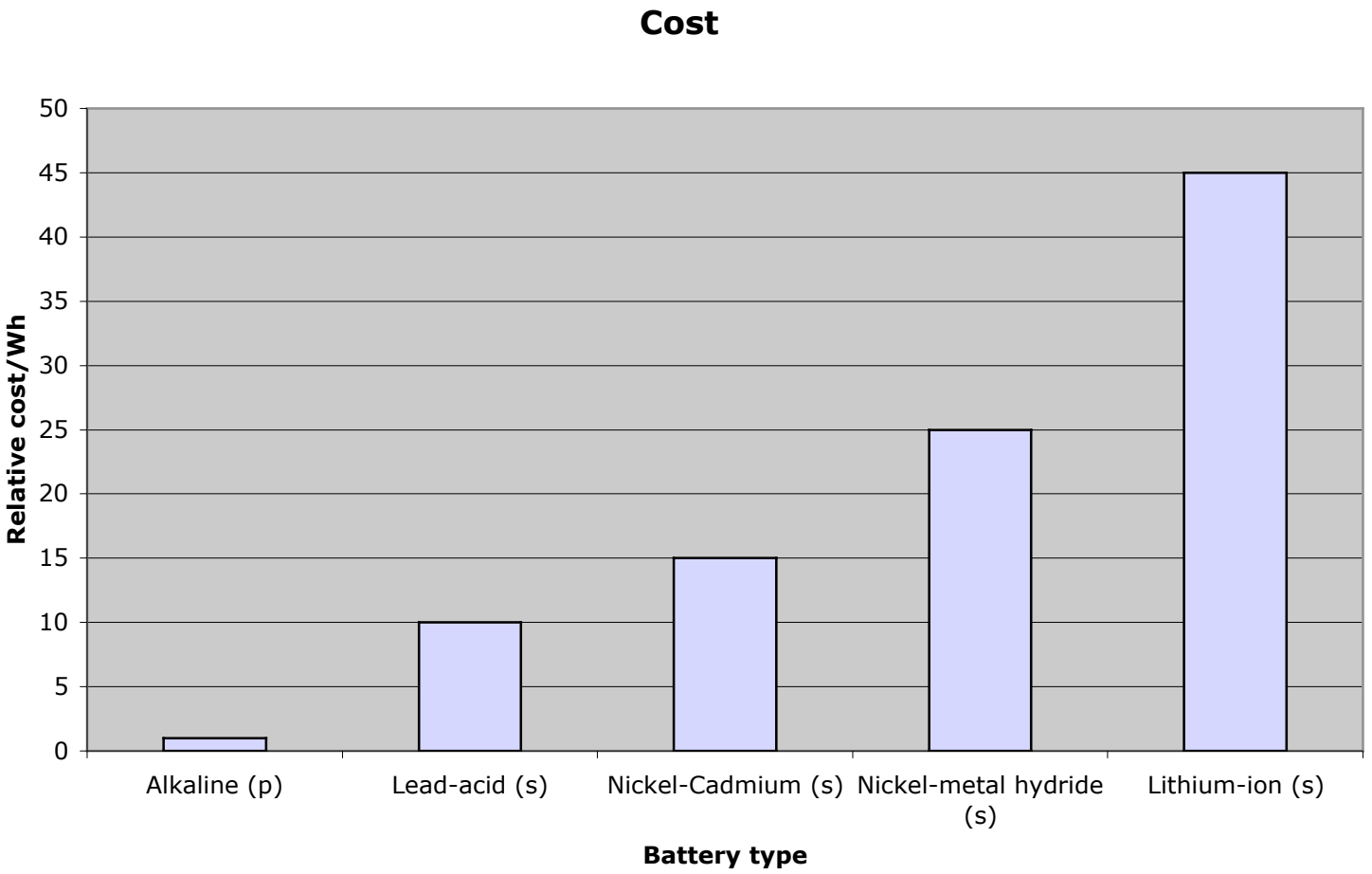
Relative cost



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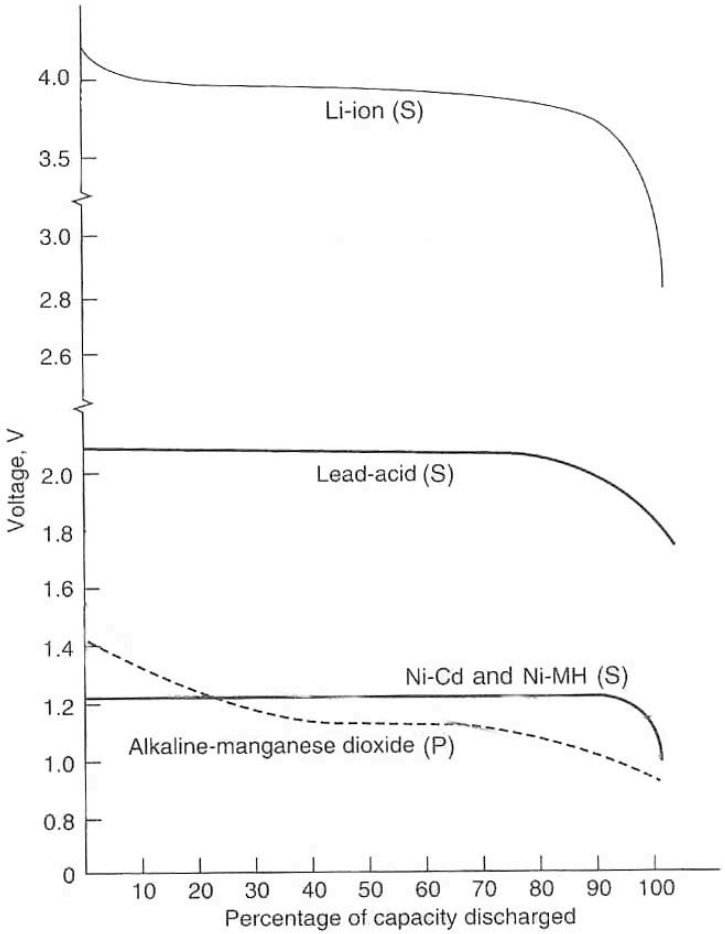
Voltage and state-of-charge



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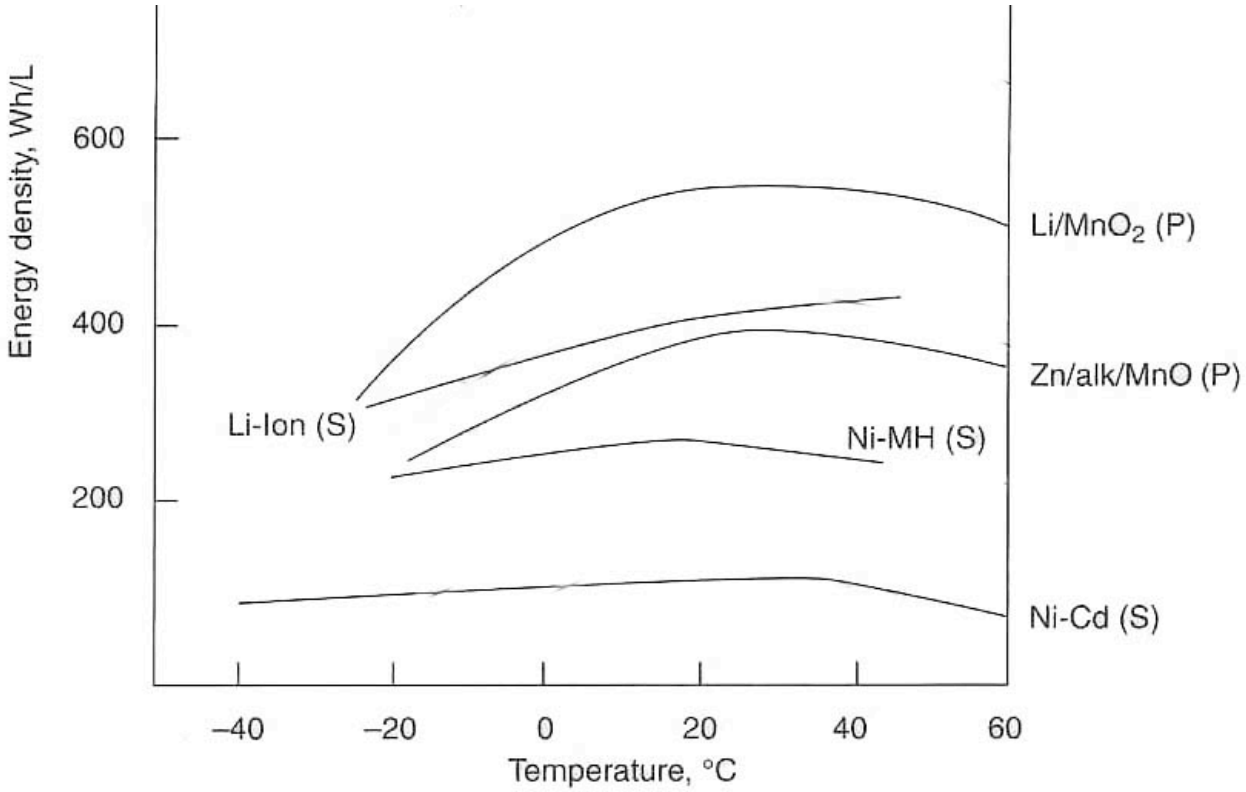
Temperature and energy density



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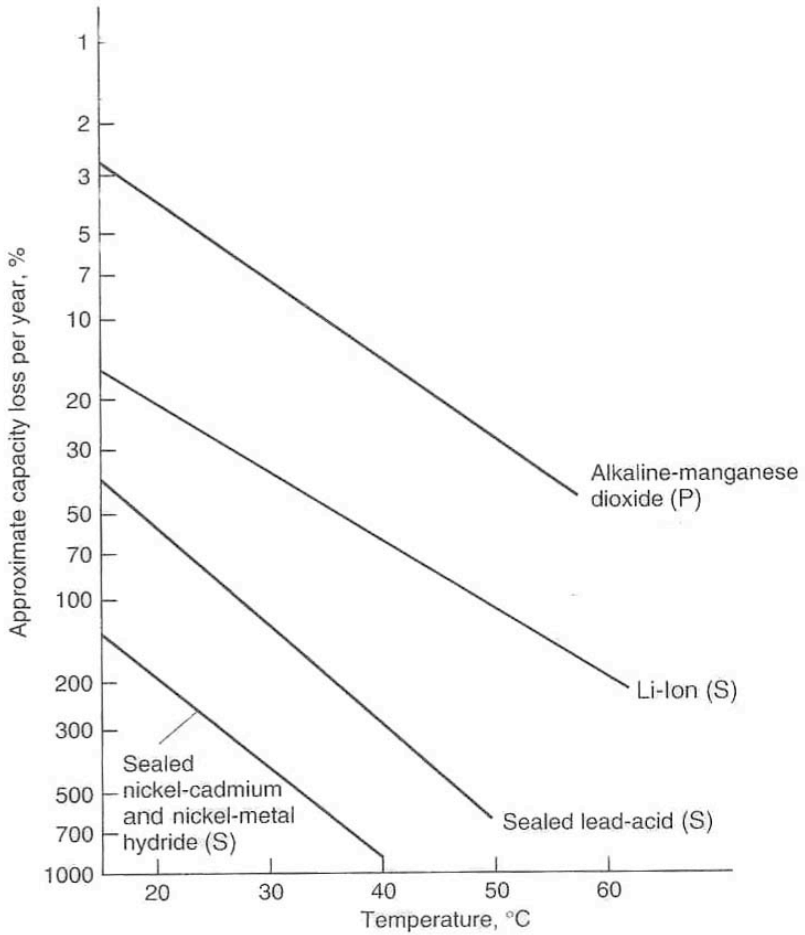
Temperature and shelf life



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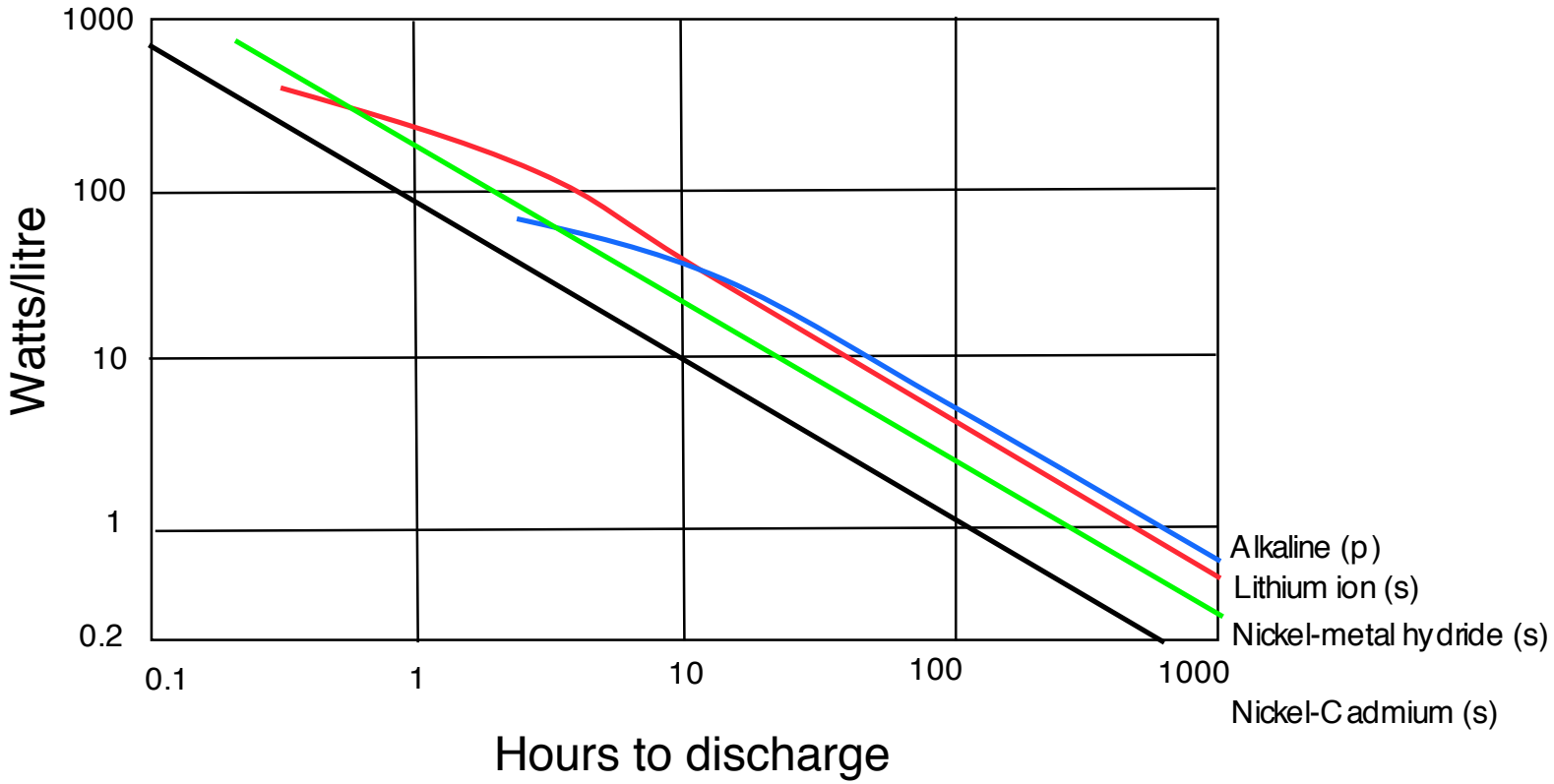
Power and discharge rate



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Secondary battery comparison

	advantages	disadvantages	Cycle life	Life (years)
Lead-acid SLI (starting, lighting, ignition)	low cost, high availability, high current, low temperature, good float service, maintenance free	low cycle life, shallow discharge cycles, low energy density, poor charge retention, hydrogen evolution	200-700	4
Lead-acid traction	lowest cost of deep cycle systems	low energy density, less rugged, hydrogen evolution	1500	6
Lead-acid stationary	designed specifically for float charging cycles	hydrogen evolution		25
Lead-acid portable	maintenance free, long flat service life, low and high temperature, operates in any position	Cannot be stored discharged, lower cycle life, difficult for small batteries	250	8
Nickel-Cadmium (sealed)	rugged, excellent storage, high current, low temperature, operates in any position	high cost, memory effect, poor for float service	500	5
Nickel-metal hydride	rugged, high energy density, high current, operates in any position, good cycle life	high cost (between Nickel-Cadmium and Lithium ion)	600	5
Lithium ion	rugged, high energy density, high specific energy, operates in any position, good cycle life, low self discharge	lower current, very high cost	1000+	

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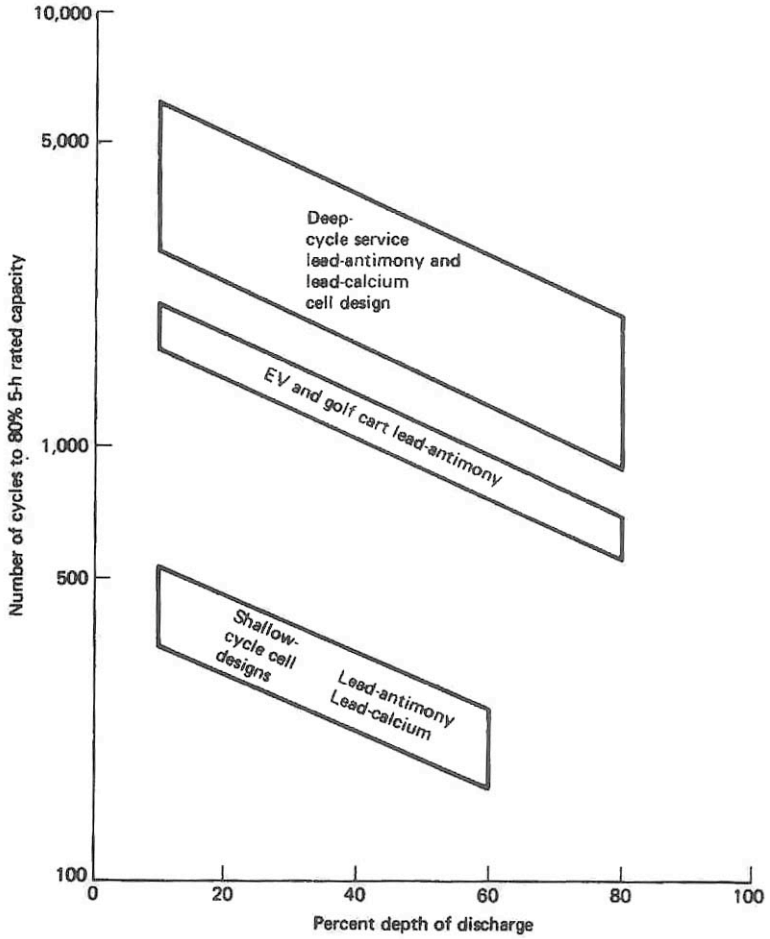
Cycle life and discharge depth (lead-acid)



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Secondary battery charging

	charge method	current rate C(A)	charging energy efficiency
Lead-acid	constant current, constant voltage	0.1	75%
Nickel-Cadmium (sealed)	constant current	0.3	60%
Nickel-metal hydride	constant current, constant voltage	0.1	60%
Lithium ion	constant current, constant voltage	0.2	95%

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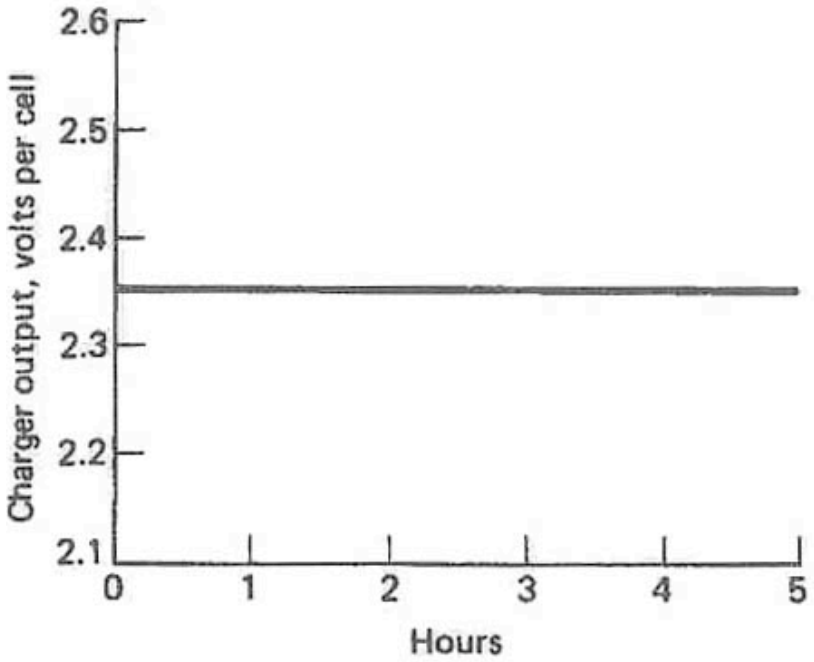
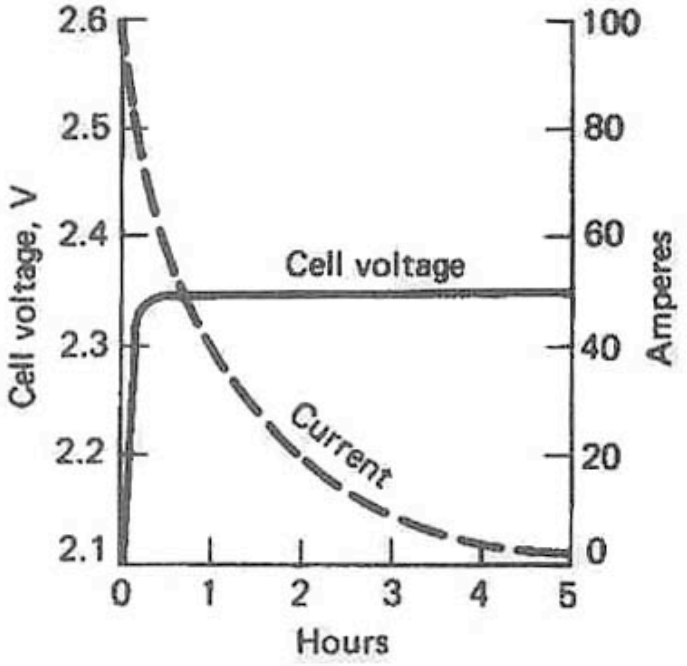
Constant voltage charging (lead-acid)





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Constant current charging (lead-acid)