Mid-Sized Rechargeable Battery Chemistry Comparison
For EVs and home power
Updated 10/17/2023

category	parameter	unit	lithium manganese cobalt (LMC)	(Valence are solid state) lithium-iron phosphate (LFP)	sealed lead-acid (SLA)	flooded lead-acid (FLA)	nickel-iron (NiFe)	sodium-ion (NIB)	solid state (SSB, lithium)	notes
Availability	battery availability		production	production	production	production	original is obsolete, but there is some off-grid resurgence	prototype	research	need something that is available
	material availability		- cobalt rare - lithium limited	lithium limited	lead limited	lead limited	nickel limited	salt high	lithium limited	need something that is available and will be servicable in the future and does not cause social disparity
	examples in EVs		- Chevy Bolt EUV - Tesla long range	- VW e-Golf - my Mustang EV conversion - Recent Tesla Model 3 short range	1990s		1910s	Chinese protos	none yet	Working and shipping examples show they are more viable
Safety	safety risk		high - fire risk if one cell shorts internally or externally, or overcharged or discharged	moderate - fire risk if one cell overcharged or discharged; BMS helps with this since shorting won't burn	moderate - hydrogen outgassing	moderate - hydrogen outgassing	moderate - hydrogen outgassing	high - fire risk if one cell shorts internally or externally, or overcharged or discharged	risk of fire lower	don't want these to burn or cause an explosion during charge or discharge
Cost	capacity cost	$/kWh	$132	$250-1000	$143	$56	$151-667	$40-77	still high	need something that is affordable up front
Performance	energy density	Wh/l	250-693	325	80-90	80-90	30	250-375	~2x LMC	need to have enough capacity for a given volume for EVs, not so much for home power
	specific energy	Wh/kg	100-265	90-160	35-40	35-40	19-25	75-200	~2x LMC	need to have enough capacity for a given weight for EVs, not so much for home power
	specific power	W/kg	250-340	200	180	180	100	***TBD***	~2x LMC	need to have enough power for a given weight for EVs, not so much for home power
	DC round-trip efficiency		80-90%	90%	50-95%	50-95%	65%	up to 92%	***TBD***	we have an energy crisis so efficiency has a direct effect
	optimal temperature range max	C	35	45	45	45	46	60	***TBD***	Phoenix averages 41C (106F) in July, so batteries below 60C max need air conditioning
	optimal temperature range min	C	15	0	-35	-35	-40	-20	***TBD***	Phoenix averages 41C (106F) in July, so batteries below 60C max need air conditioning
Maintenance	electrolyte		sealed liquid	sealed solid or liquid	sealed gel	flooded liquid	flooded liquid	solid or sealed liquid	solid	liquid is harder to contain, and flooded needs watering maintenance
	self discharge	% per month	.35 to 2.5%	1 to 3%	3-20%	3-20%	20-30%	low	***TBD***	high self discharge only a problem when not in regular use, so backup battery or extra vehicle needs to be charged
Durability	cycle life at 80% depth of discharge	cycles	400-1200	2750-12000	<350	<350	unlimited	100s to 1000s	***TBD***	need something that will last long enough to be sustainably manufactured and affordable over its life
	lifetime	years	up to 10	10+	3 to 5 years	15 to 20	30-50	***TBD***	***TBD***	ditto
Environmental impact	impact on environment		lithium extraction is energy intensive	lithium extraction is energy intensive	lead is toxic	lead is toxic	nickel smelting toxic	sea salt extraction can be low impact	lithium extraction and battery production processes are energy intensive	need environmentally sustainable manufacturing, containment, recycling and disposal
	refurbishable?		no	no	no	no	yes - only needs potash electrolyte replacement every 20-30 years	***TBD***	***TBD***	refurbishable products are easier on the environment and cost of ownership
	recyclable?		under development	under development	yes	yes	yes	***TBD***	***TBD***	this is a must for sustainability
Miscellaneous	nominal cell voltage		3.7	3.2	2.1	2.1	1.2	2.3 - 2.5	***TBD***	

Not included above
NiCd is toxic and was obsoleted ~2000, replaced with NiMH.
NiMH is common in small batteries but was obsoleted for big ones by Lithium-ion once it became safe enough in the 2000s and now LiFePO4 that is safer and lasts longer.
LiPo used in phones is unsafe in large battery packs.
Li-air didn't make it out of the laboratory.
Primary single-use dry batteries not sustainable for large packs.
Zinc-air has been experimented with but does not sem to be under active
Zinc-air and flow batteries are under development, but for large scale grid use only.

Sources

Li-ion	https://en.wikipedia.org/wiki/Lithium-ion_battery
LiFePO4	https://en.wikipedia.org/wiki/Lithium_iron_phosphate_battery
SLA, FLA	https://en.wikipedia.org/wiki/Lead%E2%80%93acid_battery
Ni-Fe	https://en.wikipedia.org/wiki/Nickel%E2%80%93iron_battery
Na-ion	https://en.wikipedia.org/wiki/Sodium-ion_battery