pbq®

Introduction LiFePO4

Frank Buirma

pbq®

After this presentation

- You should have a good understanding of LiFePO4 batteries.
- You will increase your knowledge about the general specifications as well as the limitations
- You should be aware of the advantages of the batteries
- You will also get information about the end of life of the battery and how it can be recycled.

General technology overview

- Main advantages of LiFePO4 (LFP)
  - Cycles 2.000 to 3.000
  - Temperature range -20 to 60°C
  - High discharge current 10C
  - High charge current 1C
  - High energy density 125 KWh/Kg
  - No heavy metals in the battery
  - Does not suffer from "thermal runaway" .
    - Due to a special component called PTC insertion (Positive temperature Coefficient). When temperature gets too high, PTC refrigerates by augmenting its resistance, then current steps down until interior temperature gets normal.

General technology overview

- Main advantages of LiFePO4 (LFP)
  - Cycles 2.000 to 3.000
    - Lower cost of ownership
    - Lower maintenance costs
  - Temperature range -20 to 60°C
    - No additional measures for outdoor applications
  - High discharge current up to 10C
    - If discharge time < 1h High capacity (95%) is available. Vs. VRLA 60%;
  - High charge current 1C
    - Shorter charge time → higher availability
  - High energy density 125Wh/Kg
    - Smaller housing
    - Smaller weight
  - No heavy metals in the battery
    - “Green battery”

Chemical reaction

Discharge :$Li(1-x)FePO_4 + xLi + xe = LiFePO_4$

Charge : $Li_xC_6 = 6C + xLi + xe$

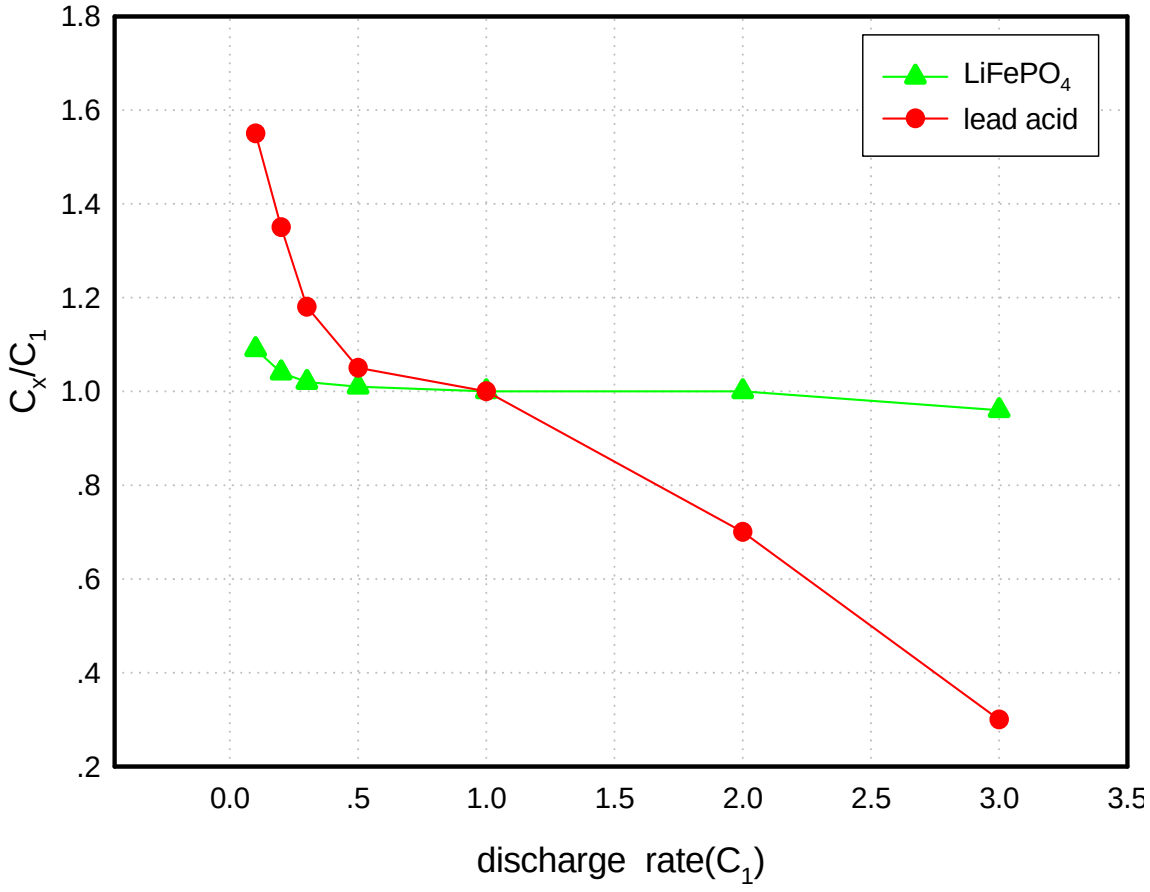
Construction (1)

Construction (2)

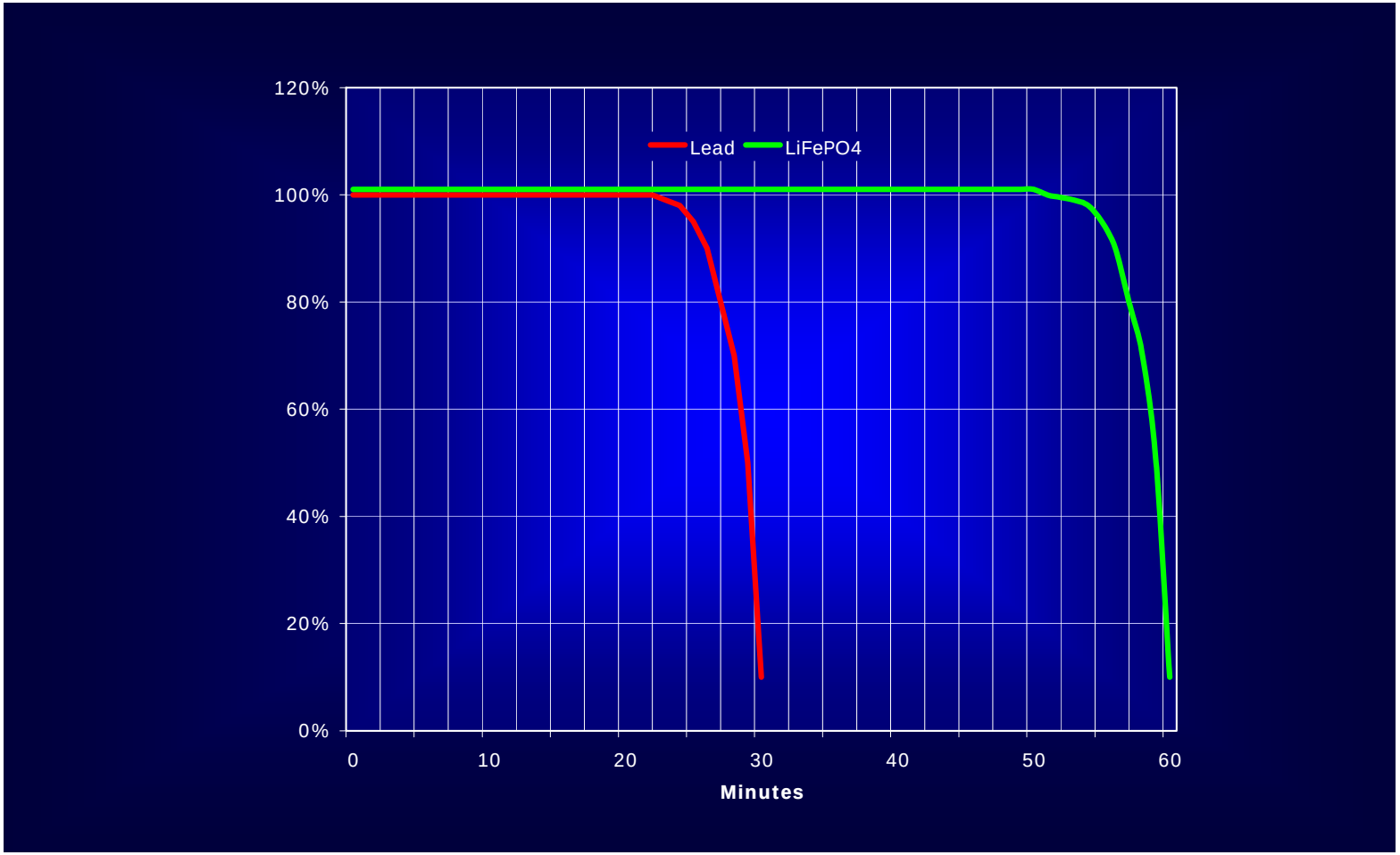
Comparison of VRLA and LiFePO4

		VRLA	LFP
General			
	Capacity	20Hr	1Hr
	Cycles 100% DoD	300	2000~3000
	Temperature [°C]	0~50°C	-20~60°C
	Imax [A]		10C / 3C
	I Charge	1/3 C	1C
Cell			
	U nom [V]	2V	3,2
	U charge (Cyclic)[V]	2,45	3,7
	U discharge [V]	1,6	2
12Volt system			
	U nom [V]	12	12,8
	U charge [V]	14,7	14,8
	U discharge [V]	9,6	8,0
	Selfdischarge	3-5%	3-5%
Construction			
	Size	100%	75%
	Weigth	100%	35%
Battery managenment system inside			
	Safety	NA	Included
	Cell ballancing	NA	Included

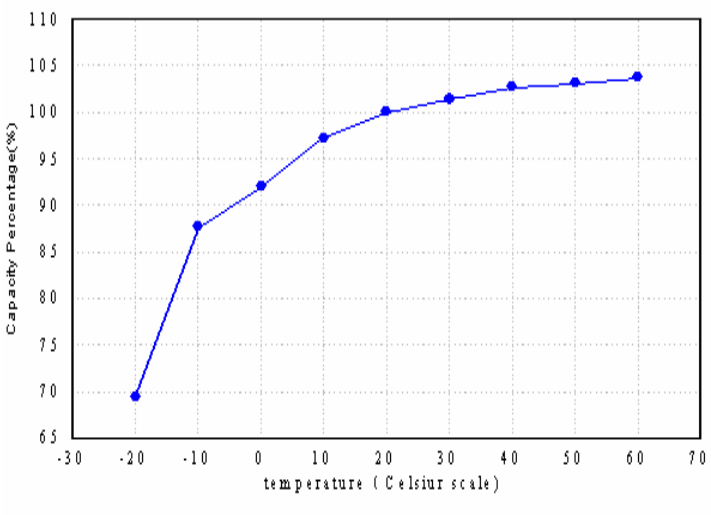
Comparison of VRLA and LiFePO4

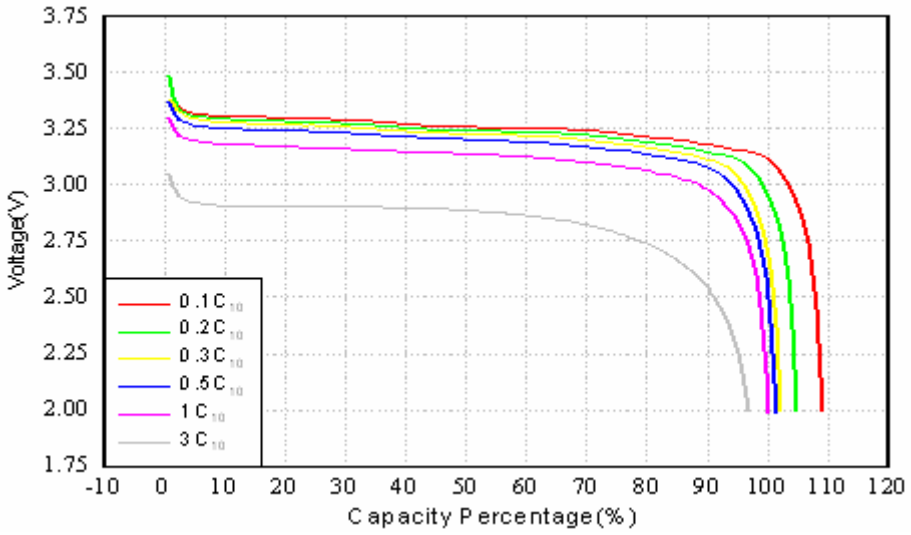


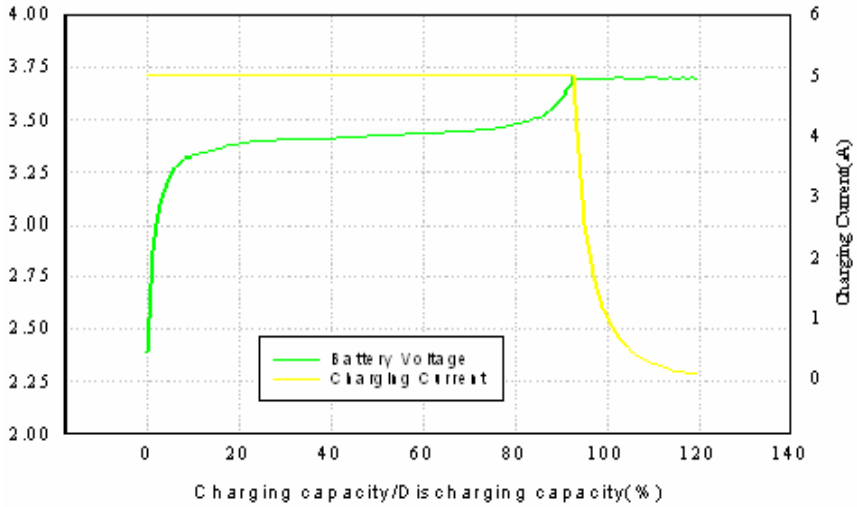
1 C Discharge



Limitations







pbq®

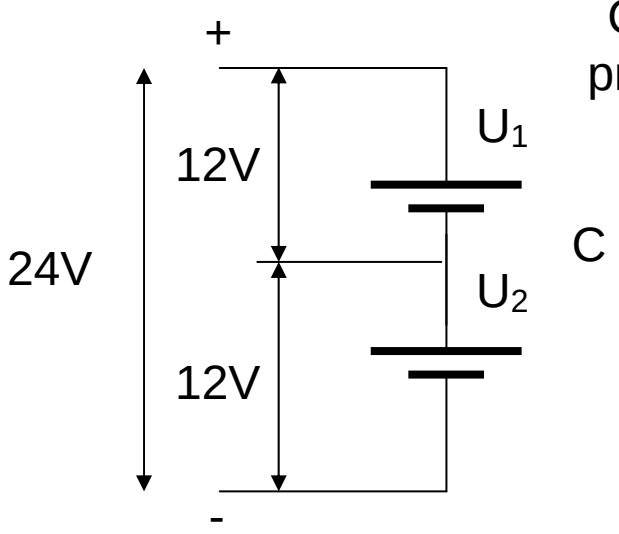
Application examples

- Weight and Volume
  - Patient elevator
  - Racing motor bikes
- Temperature range
  - Windmill in desert
- Lower cost of Ownership
  - Buoy
  - Linear drives
- Green
  - Government
  - Scandinavia

Installation

- Keep a space between the batteries for ventilation and heat dissipation
- Keep batteries dry
- Temperature range is the same for storage, charge and discharge

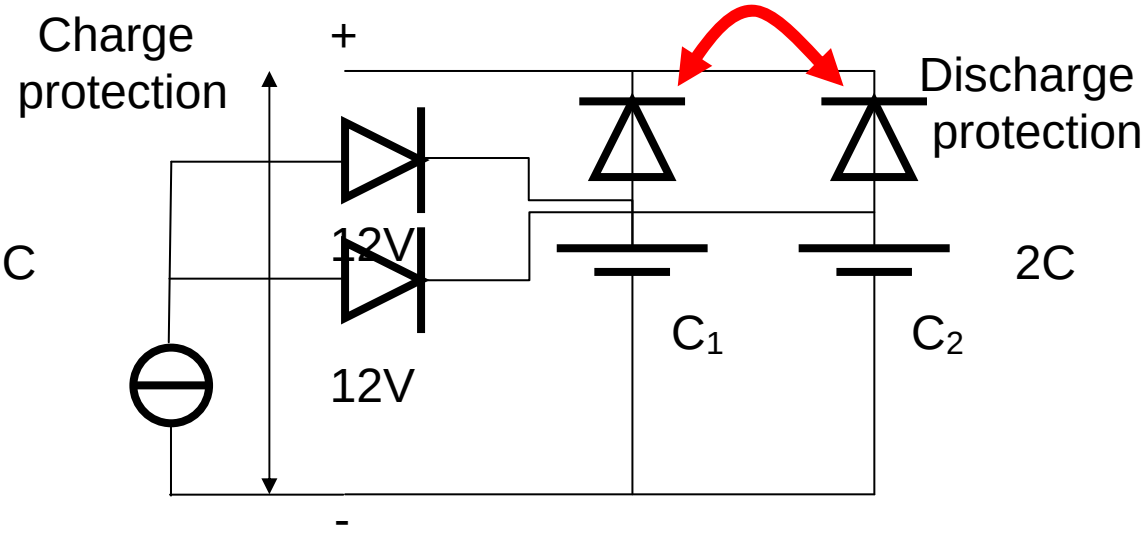
Connecting batteries



Serial connection

$U_{tot} = U_1 + U_2$

$C_{tot} = C_1 = C_2$



Parallel connection

$U_{tot} = U_1 = U_2$

$C_{tot} = C_1 + C_2$

UN 38.3

- Transportation regulations.
- http://www.youtube.com/watch?v=zvTRKKS0wpo&feature=related

UN 38.3

Test T.1: Altitude simulation

Test T.2: Thermal test

Test T.3: Vibration

Test T.4: Shock

Test T.5: External short circuit

Test T.6: Impact

Test T.7: Overcharge

Test T.8: Forced discharge

UN38.3

When testing rechargeable cells and batteries under tests 1 to 5 the following shall be tested:

(i) ten cells, at first cycle, in fully charged states,
(ii) ten cells, at first cycle, in fully discharged states,
(iii) four batteries, at first cycle, in fully charged states,
(iv) four batteries, at first cycle, in fully discharged states,
(v) four batteries after fifty cycles ending in fully charged states, and
(vi) four batteries after fifty cycles ending in fully discharged states.

Available models

LiFePO4	Nominal Capacity	Nominal voltage	Nominal Energy	I(Discharge) max	I(charge)	Dimensions			Weigth	Terminal
						H	W	D		
	[Ah]	[V]	[Wh]	[A]	[A]	[mm]	[mm]	[mm]	[Kg]	Type
pbq 3-12LiFe	3	12	36	20	3	76	195	47	0,8	Faston 250
pbq 5-12LiFe	5	12	60	20	5	107	98	56	1,0	Insert M5
pbq 7.5-12LiFe	7,5	12	90	20	7,5	100	151	65	1,3	Insert M5
pbq 10-12LiFe	10	12	120	20	10	100	151	65	1,5	Insert M5
pbq 12-12LiFe	10	12	120	20	20	100	151	98	1,7	Insert M5
pbq 15-12LiFe	15	12	180	20	15	100	151	98	2,0	Insert M5
pbq 20-12LiFe	20	12	240	30	20	125	175	166	3,0	Insert M5
pbq 40-12LiFe	40	12	480	40	20	165	197	170	6,0	Insert M6

- Technical limitations due to protection electronics

End of Life

- Recycling is made easy by dismountable top
  - Label and colour different from VRLA and GEL batteries

Charging

- A LiFePO4 battery can be charge with the same Voltage as a VRLA
- A LiFePO4 battery can be charge with the a current 3 times larger as a VRLA
- CC/ CV should be used for LiFePO4;
  - Not CC only
  - Current will have to be limited
  - No trickle charger

pbq®

Summary

- LiFePO4 offers the following advantages
  - More Cycles
    - Up to 10 times more
  - Bigger temperature range -20 to 60°
    - No heather No cooling
  - Lower weight (1/3) and size (3/4)
  - Short charging time

  - “Green” battery
  - Safe alternative

pbq®

You now have

- Increased your knowledge about LiFePO4
- A good understanding of LiFePO4 batteries.
- Increase your knowledge about the general specifications as well as the limitations
- Increased you awareness of the advantages of the batteries
- Knowledge about the end of life of the battery and how it can be recycled.

pbq®

Thank you