VALVE REGULATED LEAD-ACID BATTERY

FLL 6V-12V SERIES

OPERATION MANUAL

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Please carefully read all instructions in this manual before you proceed with installation. And please keep the manual for reference during operation.

It is forbidden to overcharge battery shortly and short circuit shall be avoided. Please do not attempt to dismantle the battery if some abnormal phenomena happen. You should contact us immediately and our technicians will handle the problems or replace the battery in time.

The manufacturer reserves the right to make alterations without prior notice concerning the operation manual.

Contents

I. Brief Introduction

Features

Basic Characteristics

Adopts the design of barren-electrolyte and utilizes AGM (microporous glass fiber) separator. Thus there is a path existing between the positive and the negative. Also non-Sb alloy grid is chosen to increase vent hydrogen over-potential on the negative plate, which prevent generation of Hydrogen, finally reaches the goal of no water losing. So during the operation life, there's no need to add acid and water, neither to adjust the gravity of the solution.

Reliable seal performance, not emission of acid mist, not erosion to equipment.

Long life and low self-discharge.

Compact structure, shock-proof and high energy density design.

Reliable Seal Technology

Container and lid made of ABS flame retardant FV class V-0. Adopt heat seal technology of ABS container and lid. The technology conquers epoxy's weaknesses of aging and brickle. And the amalgamation of the same ABS material ensures no leakage of solution.

Explosive proof valve with an acid filtering structure. If the pressure inside the battery exceeds a certain value, the safety valve will automatically open to decrease the pressure. And it will close till the pressure is normal. The acid filtering structure in the safety valve prevents emission of acid mist when the safety valve opens.

Excellent resist characteristics of mechanical impact and heat impact, prolong the corruption distance of sulfuric acid.

Excellent high rate discharge performance

Unique multiple-segment radial grid

Copper insert pillar, the copper insert's diameter is as long as 20mm, suitable for high rate discharge

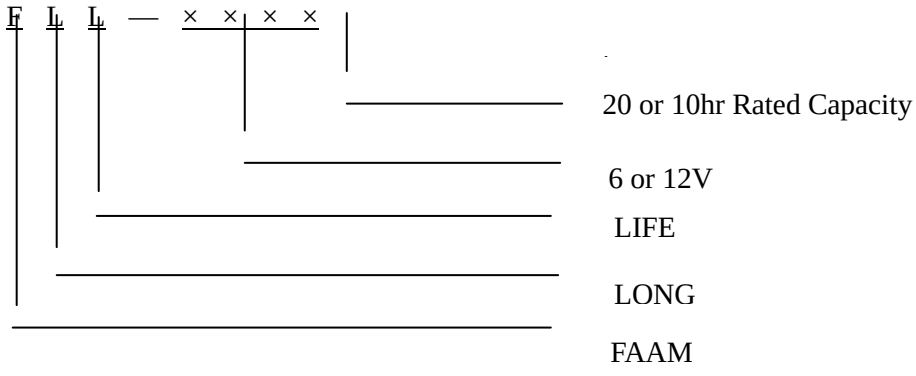
Silver-coated flexible connector, good electric performance and low voltage-decrease.

Extremely equalized float charge voltage

A unique homogeneous working procedure ensures homogeneous float charge voltage of FAAM FLL batteries.

Fig. 1-1 Battery image

Indication of Type



Types and Dimensions

Cell Type	Rated Voltage (V)	Rated Capacity (Ah)				Dimensions(mm)				Weight (Kg)
		$C_{10\ Vf}$ 1,80V	C_{5Vf} 1,80V	C_{3vf} 1,7V	$C_{1\ vf}$ 1,6V	Length	Width	Height	Overall Height	
FLL 12-17	12	15	12,95	11,55	9,21	181	77	167	167	5,6
FLL 12-24	12	22	19,00	16,95	13,50	166	176	125	125	8,5
FLL 12-31	12	25	21,60	19,05	15,35	194	133	172	172	11,2
FLL 12-42	12	37	32,00	28,50	22,70	198	166	172	172	14,2
FLL 12-60	12	50	43,25	38,50	30,70	259	168	208	220	23
FLL 12-70	12	65	56,20	50,04	39,90	350	167	178	178	22,8
FLL12-100	12	85	73,50	65,43	52,18	331	176	214	218	30,5
FLL 12-120	12	100	86,45	76,98	61,38	407	174	209	233	38,0
FLL 12-150	12	135	116,70	103,95	82,87	485	172	240	240	46
FLL 12-200	12	180	155,60	138,60	110,50	521	269	203	208	62,5
FLL 6-100	6	100	86,45	76,98	61,40	195	170	206	213	15,5
FLL 6-150	6	150	129,70	115,50	92,08	260	180	247	254	24,5
FLL 6-180	6	180	155,60	138,60	110,49	306	168	222	229	28
FLL 6-200	6	200	172,90	153,99	122,77	323	178	224	231	30,5
FLL 6-225	6	225	194,50	173,22	138,11	260	180	247	254	31

II. Technical Characteristics

Capacity and Influence Factor

Capacity of Battery

The capacity of battery is the capacity that battery can be discharged on the established conditions, expressed as signal C. The usual unit of capacity is ampere hour, shortened as AH.

The capacity can be expressed in Rated Capacity or Actual Capacity. The Rated Capacity of FAAM FLL battery please see Table 1-1. The Actual Capacity is the product of the discharge current and the discharge time, the unit is Ah.

The Influence Factor of the Actual Capacity

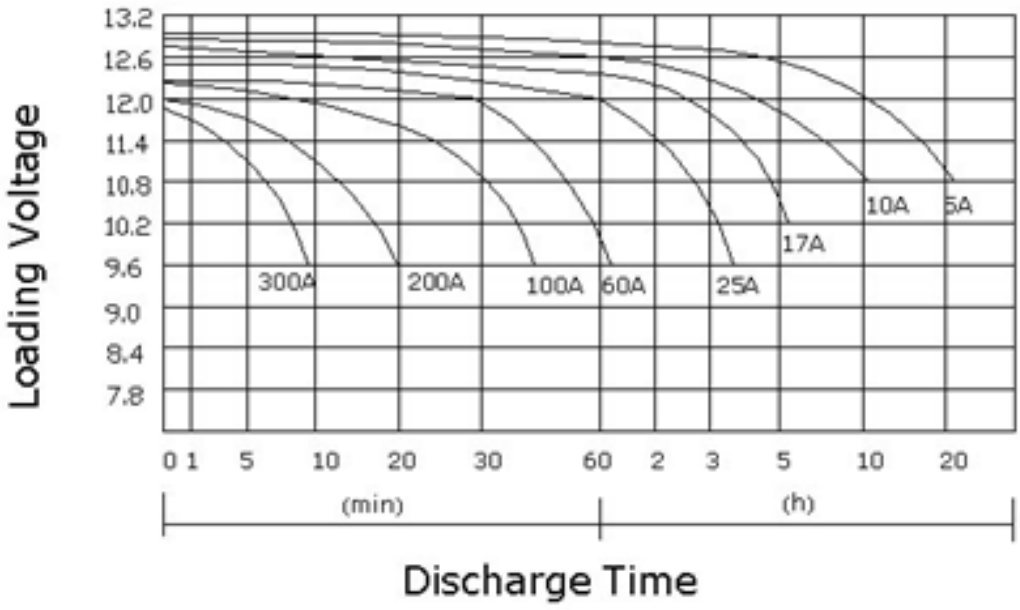
The actual capacity is mainly related with the positive and negative active materials and their utilization rate. The utilization rate of the materials is mainly influenced with the DOD, the structure of the battery and manufacture technology. In using process the factors that influence the actual capacity are discharge rate, discharge modality, end voltage and temperature.

Discharge Rate

The discharge rate is often described as hour-rate and multiple rates.

Figure 2-2 is the discharge characteristics curves at different discharge rates. From the figure we can see that when we adopt same type battery to discharge, if the discharge rate is higher and the discharge current is larger, then the discharge time is shorter, and the capacity which can be discharged is less.

Fig. 2-1 Discharge Performance Curves at Different Discharge Rates (20°C) for FLL12-100 as example



Temperature

Temperature affects capacity of the battery. Fig. 2-2 is the available capacity curve vs. ambient temperature. If the ambient temperature is not 20°C, it's necessary to change the measured capacity to actual capacity C_e at 20°C according to following formula:

$C_e = C_T /(1 + K (T-20))$

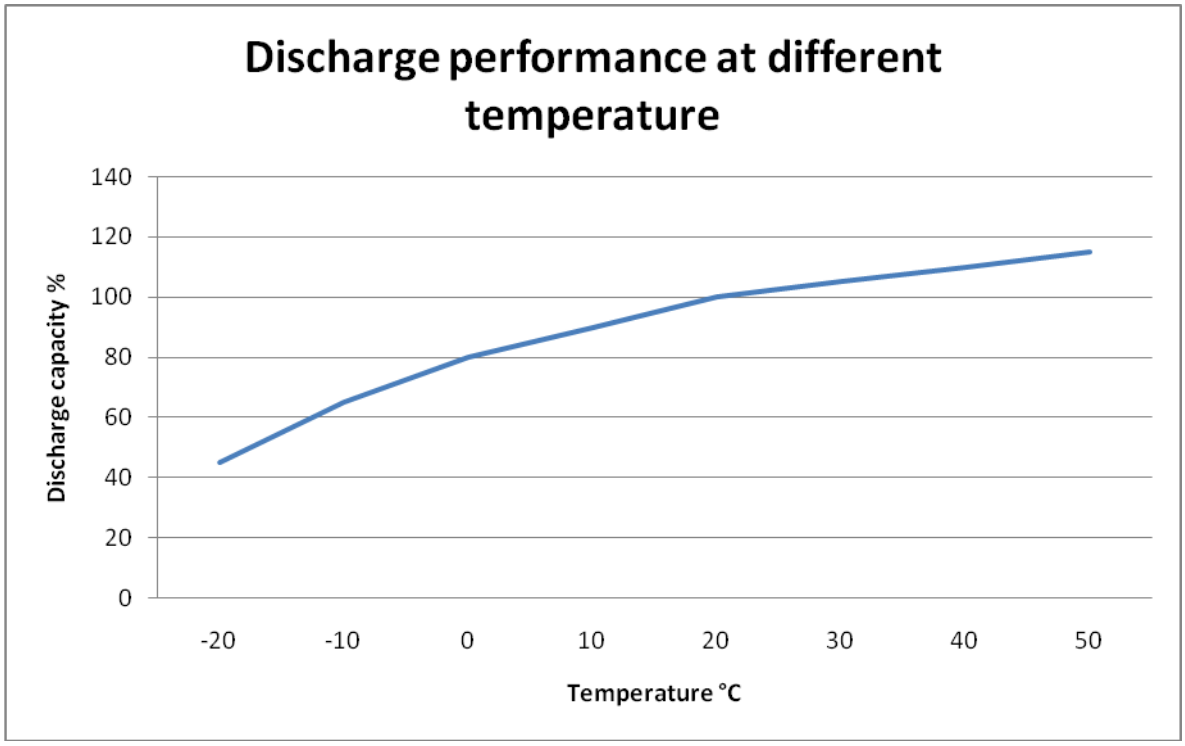
T = the ambient temperature

K = temperature modulus, 10hr rate capacity test K=0.006/°C

3hr rate capacity test K=0.008/°C

1hr rate capacity test K=0.01/°C

Fig. 2-2 Available Capacity VS. Ambient Temperature



End voltage

The end voltage is the lowest working voltage below which the battery can't be discharged any more. Usually the 10hr rate end voltage of lead-acid battery is 1.80V, and 1hr rate end voltage are 1.6V, under the CEI IEC 60896-21 & 22

2 Temperature and Floating Voltage

2.1 Ambient Temperature

The best ambient temperature of using FAAM FLL battery is 20° C. At 20° C, FAAM battery can be discharged 100% of its capacity. If the ambient temperature is different, it can be improved with methods as follows:

Change the environment, such as adopting cooling system, changing the position of the batteries, and improve ventilation.

Adopt temperature revising method, if the ambient temperature is higher, decrease the floating charge voltage; if lower, increase the floating charge voltage.

Floating Voltage

The purpose of choosing certain floating voltage is to reach the designed life and rated capacity of the battery. If the floating voltage is higher, then the floating current is also higher, it will accelerate the corruption the grid and shorten the life of the battery. If the floating voltage is lower, the battery can't be kept in full charged state, this will crystallize $PbSO_4$, decrease the capacity, and also shorten the life of the battery.

At 20°C, if the floating voltage is 2.27±0.02V/cell, the designed use life of FAAM FLL battery is over12 years, in accordance with the Eurobat Guide In other degree, please adjust according to Table 4-2.

Internal resistance and short circuit current

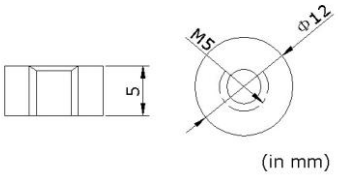
The internal resistance of the battery is a dynamic nonlinear parameter that is continuously changed along with the temperature and discharge state. The internal resistance is the lowest when battery is full charged. The table 2-1 shows the internal resistance and short circuit current of FAAM battery in fully charged state.

Table 2-1. Internal resistance, short circuit current (20°C)±10% Terminal type

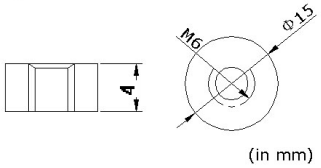
Battery Type	Internal resistance (mΩ)± 10%	Short circuit current (A)±10%	Terminal Type
FLL 12-17	15,3	350	M5
FLL 12-24	10,2	530	M5
FLL 12-31	15,0	800	M6
FLL 12-42	12,0	1050	M6
FLL 12-60	10,0	1260	M6
FLL 12-70	7,5	1720	M6
FLL 12-100	5,0	2150	M8
FLL 12-120	4,7	2380	M8
FLL 12-150	3,8	3200	M8
FLL 12-200	3,4	3500	M8
FLL 6-100	2,1	2600	M8
FLL 6-150	3,2	3100	M8
FLL 6-180	3,1	3800	M8
FLL 6-200	4,4	4100	M8
FLL 6-225	4,1	4300	M8

Note: Short circuit current will decrease the voltage of the battery to 0V, and damage the internal components of the battery.

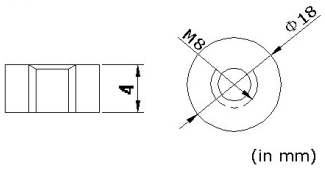
Bolt-and-nut terminal
Bolt Type:M5



Bolt-and-nut terminal
Bolt Type:M6



Bolt-and-nut terminal
Bolt Type:M8



3Type Selection

Please select batteries according to table 3.1 .

First confirm the discharge watt and end voltage.

Confirm the continual working time and ambient temperature.

Select right battery type according to table 3.1

12V Ampere/Monoblock at 20°C 1,65V/Cell

Type	Voltage	Time								
	V	5min	15min	30min	60min	90min	3hour	5hour	8hour	10hour
FLL12-17	12	22,70	16,10	11,27	9,53	7,55	3,86	2,65	1,82	1,58
FLL12-24	12	33,29	23,61	16,53	13,98	11,08	5,66	3,88	2,68	2,31
FLL12-31	12	37,83	26,83	18,78	15,89	12,59	6,43	4,41	3,04	2,63
FLL12-42	12	55,99	39,71	27,79	23,51	18,63	9,52	6,53	4,50	3,89
FLL12-60	12	75,66	53,66	37,56	31,77	25,18	12,86	8,82	6,08	5,25
FLL12-70	12	98,36	69,76	48,82	41,31	32,73	16,72	11,47	7,91	6,83
FLL12-100	12	128,62	91,22	63,85	54,02	42,80	21,86	14,99	10,34	8,93
FLL12-120	12	151,32	107,32	75,11	63,55	50,35	25,72	17,64	12,16	10,50
FLL12-150	12	204,28	144,89	101,40	85,79	67,98	34,72	23,82	16,42	14,18
FLL12-200	12	272,37	193,18	135,21	114,38	90,64	46,30	31,75	21,89	18,90
FLL6-100	6	151,32	107,32	75,11	63,55	50,35	25,72	17,64	12,16	10,50
FLL6-150	6	226,97	160,98	112,67	95,32	75,53	38,58	26,46	18,24	15,75
FLL6-180	6	272,37	193,18	135,21	114,38	90,64	46,30	31,75	21,89	18,90
FLL6-200	6	302,63	214,65	150,23	127,09	100,71	51,44	35,28	24,32	21,00
FLL6-225	6	340,46	241,48	169,01	142,98	113,30	57,87	39,69	27,36	23,63

12V Ampere/Monoblock at 20°C 1,70V/Cell

Type	Voltage	Time								
	V	5min	15min	30min	60min	90min	3hour	5hour	8hour	10hour
FLL12-17	12	20,63	15,93	10,93	7,83	6,20	3,85	2,64	1,82	1,55
FLL12-24	12	30,25	23,37	16,03	11,48	9,10	5,65	3,87	2,66	2,28
FLL12-31	12	34,38	26,55	18,22	13,04	10,34	6,42	4,39	3,03	2,59
FLL12-42	12	50,88	39,30	26,96	19,31	15,30	9,50	6,50	4,48	3,83
FLL12-60	12	68,76	53,11	36,44	26,09	20,67	12,83	8,79	6,06	5,17
FLL12-70	12	89,38	69,04	47,37	33,92	26,87	16,68	11,42	7,87	6,72
FLL12-100	12	116,88	90,28	61,94	44,35	35,14	21,81	14,93	10,30	8,79
FLL12-120	12	137,51	106,21	72,87	52,18	41,35	25,66	17,57	12,11	10,35
FLL12-150	12	185,64	143,39	98,38	70,44	55,82	34,65	23,72	16,35	13,97
FLL12-200	12	247,52	191,18	131,17	93,92	74,42	46,20	31,63	21,80	18,62
FLL6-100	6	137,51	106,21	72,87	52,18	41,35	25,66	17,57	12,11	10,35
FLL6-150	6	206,27	159,32	109,31	78,27	62,02	38,50	26,36	18,17	15,52
FLL6-180	6	247,52	191,18	131,17	93,92	74,42	46,20	31,63	21,80	18,62
FLL6-200	6	275,02	212,43	145,74	104,36	82,69	51,33	35,14	24,23	20,69
FLL6-225	6	309,40	238,98	163,96	117,40	93,03	57,74	39,53	27,25	23,28

12V Ampere/Monoblock at 20°C 1,80V/Cell

Type	Voltage	Time								
	V	5min	15min	30min	60min	90min	3hour	5hour	8hour	10hour
FLL12-17	12	16,57	13,88	10,38	7,64	6,06	3,81	2,59	1,79	1,50
FLL12-24	12	24,30	20,35	15,23	11,21	8,88	5,58	3,80	2,62	2,20
FLL12-31	12	27,61	23,13	17,31	12,74	10,10	6,35	4,32	2,98	2,50
FLL12-42	12	40,87	34,23	25,62	18,86	14,94	9,39	6,40	4,41	3,70
FLL12-60	12	55,23	46,26	34,62	25,48	20,19	12,69	8,65	5,96	5,00
FLL12-70	12	71,79	60,14	45,00	33,12	26,25	16,50	11,24	7,75	6,50
FLL12-100	12	93,88	78,64	58,85	43,32	34,32	21,57	14,70	10,13	8,50
FLL12-120	12	110,45	92,52	69,23	50,96	40,38	25,38	17,29	11,92	10,00
FLL12-150	12	149,11	124,90	93,46	68,80	54,51	34,26	23,34	16,09	13,50
FLL12-200	12	198,81	166,54	124,61	91,73	72,68	45,68	31,12	21,46	18,00
FLL6-100	6	110,45	92,52	69,23	50,96	40,38	25,38	17,29	11,92	10,00
FLL6-150	6	165,68	138,78	103,85	76,44	60,57	38,07	25,94	17,88	15,00
FLL6-180	6	198,81	166,54	124,61	91,73	72,68	45,68	31,12	21,46	18,00
FLL6-200	6	220,90	185,04	138,46	101,92	80,76	50,76	34,58	23,84	20,00
FLL6-225	6	248,51	208,17	155,77	114,66	90,86	57,11	38,90	26,82	22,50

4 Installation

1. Installation Precautions

The customer can adopt flexible installation methods according to the condition of installation area. However detailed requirements about installation shall be submitted when placing the order so that best connection scheme can be determined and installation drawings can be provided

Please strictly refer to installation drawings when make serial and connection.

Batteries of different capacity and performance can not be connected together.

Batteries must be strictly series-wound or shunt-wound connected according to installation drawing.

Use insulating instruments during installation.

Do not use large torque to connect batteries.

Installation of abnormal batteries is prohibited.

Batteries are of sealed structure, in normal condition, there's no danger of cauterization of sulphuric acid. But if batteries are broken in transportation or unloading, wash cauterized skin and/or eyes with plenty of water immediately, and the person should be sent to hospital as quickly as possible.

The batteries system should be installed nearer to the load as possible as it can, in orders to avoid voltage drop of the wire.

After installation, check again the system voltage, the polarity of positive and negative post to ensure the correct installation

Follow the installation instruction and maintenance that are sending with the battery

5 Operation

Condition

The FAAM FLL battery can be used from –15° C to +45° C of the ambient environment.

The best ambient temperature is 20° C.

Floating Operation

FAAM FLL battery can be either floating used or cycle used.

Floating using is the best operation condition of the battery. The battery is all the while fully charged in operation, in this condition battery can be used for longest life. During floating operation, please adjust the charge voltage according to environmental temperature, see Table 4-1:

Table 4-1 Floating Voltage VS. Ambient Temperature

Environmental Temperature (° C)	Floating Voltage (V±0.02V/Cell)
0—10	2.32
11—15	2.30
16—25	2.27
26—30	2.25
31—35	2.24
36—40	2.23

Equalized Charge

FAAM FLL battery need to be equalized charge on conditions as follows:

After installation of the battery system, the batteries need to be supplemental charged.

Floating operation over three months, and the voltage of at least two batteries are lower than 2.23V.

Storage over three months.

Floating operation for three months.

The method of equalized charge is suggested as follows:

Charge with 2.35V–2.40V/Cell for 24 hours.

Note: Above-mentioned charge time is on condition that temperature changes from 20° C to 30° C. If the ambient temperature decreases, it's better to increase the charge time; otherwise, decrease the charge time.

Charge

After discharge, the batteries should be charged in time. The method is recommended as follows:

The batteries first should be charged on the constant current of $0.1C_{10}A$ till the average voltage of the batteries increases to 2.35–2.40V, then the batteries should be charged with constant voltage of 2.35–2.40V/Cell, till the charge is finished.

Whether the batteries are fully charged can be decided according to any one of two standards as follows:

The charge time is 18–24 hours (the charge time can be shortened when the batteries weren't deep discharged, e.g. , the charge time of 20% DOD batteries can be shortened to 10hours.)

On condition of constant voltage, the value of charge current hasn't varied for continuous three hours.

On special condition, the batteries need to be fully charged as soon as possible, then fast charge should be adopted: the value of limit current should not be longer than $0.25C_{10}A$, and the charge voltage should be 2.35–2.40V per cell.

Fig. 4-1 shows recharge characteristics curve of 100% DOD FLL12-100 batteries with $0.1C_{10}A$ current and limit voltage 2.35V/Cell (25°C). It can be found the fully discharged batteries can be charged 100% capacity in 15 hours. Fig. 4-2 shows recharge characteristics curve of 100% DOD FLL12-100 batteries with $0.1C_{10}A$ current and limit voltage 2.27V/Cell (25°C). It can be found the fully discharged batteries can be charged 100% capacity in 24 hours.

Fig. 4-1 Recharge Characteristics Curve of 100% DOD FLL12-100 Batteries with 0.1C_{10}A Current and Limit Voltage 2.35V/Cell (25° C)

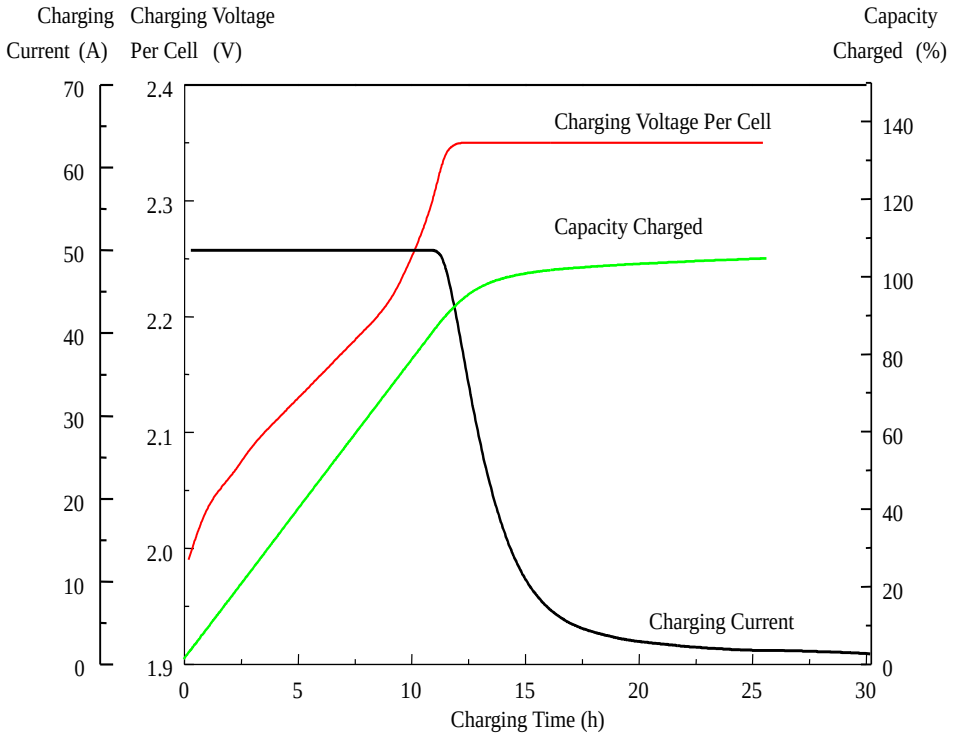
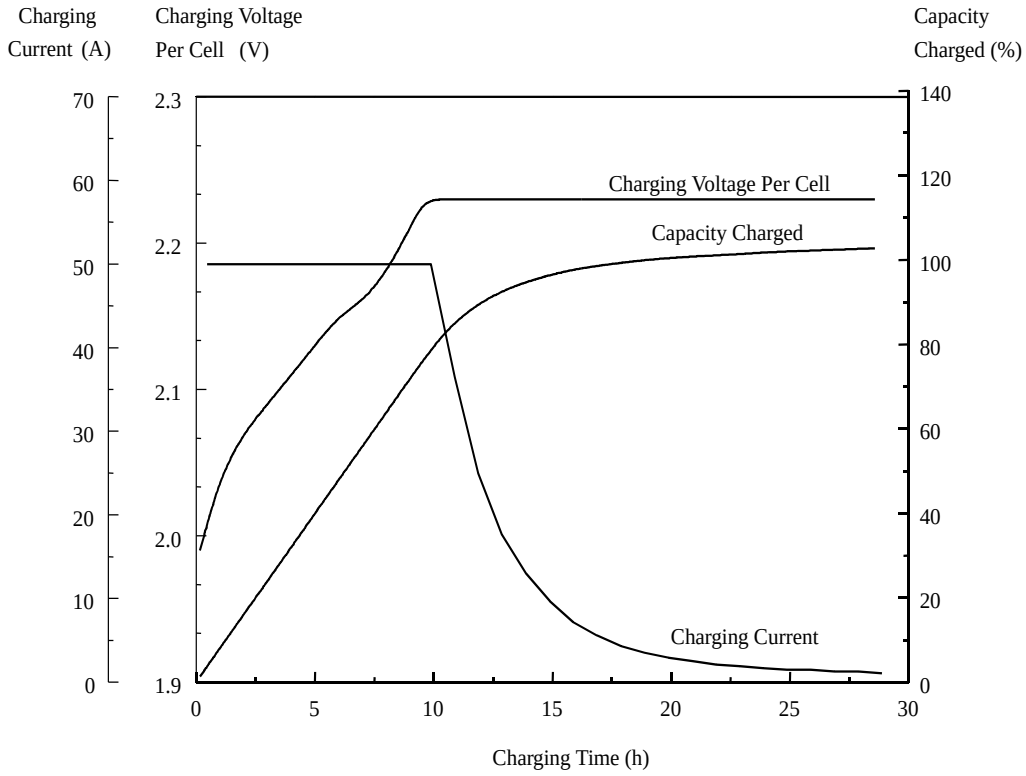


Fig. 4-2 Recharge Characteristics Curve of 100% DOD FLL12-100 Batteries with 0.1C_{10}A Current and Limit Voltage 2.23V/Cell (25° C)



6. Storage

All lead acid batteries self-discharge in open circuit. The result is that the voltage of open circuit is decreased, and the capacity also decreased. During storage please note:

The self-discharge rate is related with ambient temperature. The self-discharge degree is smaller when the ambient temperature is lower, otherwise is larger. The requirement temperature of FAAM FLL batteries' storage environment is from 0° C to 35° C. The storage place must be clean, ventilated and dry.

An important parameter in storage is open circuit voltage, which is related with density of the electrolyte. In order to avoid perpetual damage to the plate caused by self-discharge, the batteries should be supplemental charged if they have been stored for three months. The equalized charge method should be adopted.

During storage, if the open circuit voltage is lower than 2.10V/Cell, the batteries should be supplemental charged before use. The equalized charge method should be adopted.

All batteries, which are ready to store, should be fully charged before storage. It's suggested record the storage time in the periodic maintenance record and record the time when another necessary supplemental charge should be made.

The quality certificates of FAAM FLL batteries record the latest charge time of the batteries, the next charge time can be calculated according to this charge time.

7 Maintenance

In order to assure life, the batteries should be correctly inspected and maintained. The maintenance methods of FAAM FLL batteries is recommended as follows:

Monthly Maintenance

Implement the under-mentioned inspection every month:

Keep the battery-room clean.

Measure and record the ambient temperature of the battery-room.

Check each battery's cleanness, check damage and calorific trace of the terminal, container and lid.

Measure and record the total voltage and floating current of the battery system.

Quarter Maintenance

Repeat monthly inspection.

Measure and record floating voltage of every on-line battery. If more than two monoblocks voltage is less than 13,38V for FLL 12V or 6,69V after temperature adjustment, the batteries need to be equalized charged. If the problem is still existed after adopting such measures, the batteries need to yearly maintenance or even three years' maintenance. should be processed If all methods are ineffective, please contact us.

Yearly Maintenance

Repeat quarter maintenance and inspection.

Check whether connectors are loose or not every year.

Make a discharge test to check with exact load every year, discharging 30-40% of rated capacity.

Three-years' Maintenance

Make a capacity test once every three years and once every year after six years' operation. If the capacity of the battery decreases to lower than 80% of rated capacity, the battery should be replaced.

Operation and Maintenance Precautions

Use insulating instruments in operating and maintaining batteries. Do not lay metal instruments on batteries.

— Do not use any organic cleanser to clean batteries.

Do not dismantle the safety valves of batteries and add anything into batteries.

Do not smoke or use fire near batteries.

Do not use abnormal batteries. (E.g., fast inflation, serious transmogrification and vent valve detonation.)

— All maintenance works should be done by professionals.