The Leading Edge Green-Technology for Battery Regeneration Solution

B&F GROUP

ICT Dept.(Power Division)

CONTENTS

1. B&F's BRS (Battery Regeneration Solution)

1) B&F "BRS" is using a special electric-pulsing technology to dissolve sulfate into electrolyte effectively and efficiently.

2) B&F "BRS" is not using any other powder or chemical in the process of battery regeneration. Instead, only electricity is being used 100%, which is eco-friendly way of battery-regeneration.

3) B&F "BRS" is regenerating any kind and any size of lead-acid batteries, including SLI, Deep cycle and back-up batteries.

4) B&F "BRS" is doing perfect quality control in battery-regeneration process, so the regenerated batteries with good quality could be provided to customers good warranty service.

5) B&F "BRS" is working with BMS (Battery Monitoring System) which monitoring battery quality and status all the time.

1-a. Why do we have to regenerate old battery?

a) **Normally, the service fee for old battery regeneration is around 30~40% of brand-new battery Price. Then, <u>more than 50% of cost for battery purchasing could be saved as following calculation;</u>**

If we assume the success rate of battery regeneration is 80% in conservative way, and let's say there we have 100 units of scrap-batteries. Then still 20 batteries need to be purchased as brand-new batteries and the remaining 80 old batteries would be regenerated for re-using and the cost for regenerating these 80% would be 28 (=80*0.35) with assumption of regeneration service fee being 35% of brand new price.

<u>Then the total cost is 48(20+28), which results in saving 52.</u>

b) **Re-using scrap batteries by regeneration contributes a lot to save environment by reducing CO2 emission.**

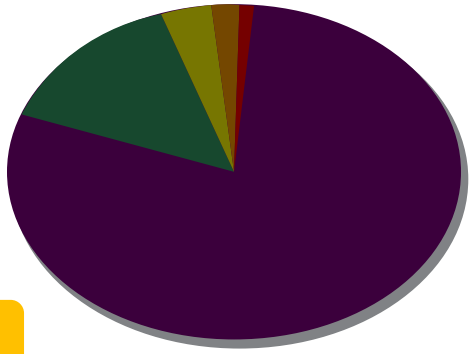
c) **Every year, a lot of batteries are becoming scrap-batteries around the world, and battery-regeneration for re-use is the best way for saving cost and environment.**

- Generally, a Telecom operator scraps around 100~150 mil USD amount of batteries every year around the world.

1-b. Why Lead-Acid batteries becoming bad?

Reasons

- Leakage
- Short-circuit
- Shortage of electrolyte



If de-sulfated, then rejuvenated

80% due to sulfation

Major Reason of battery going deteriorated

•Mostly lead-acid batteries are getting bad, as they are sulfated after repeated process of charging-&-discharging.

$$PbO_2(+) + 2H_2SO_4 + Pb(-)$$

Discharging

Charging

$$PbSO_4(+) + 2H_2O + PbSO_4(-)$$

•These crystal-like sulfation are not returned to electrolyte as sulfuric acid, as they physically block the electrolyte from entering the pores of the electrode plates, so they are making the amount of electricity generation declined over time.

1-c. What is the change after Battery Regeneration?

Old battery: As $PbSO_4$ accumulates during long-time use

- Increase of internal resistance (Ex.: brand-new battery 0.5 mΩ or less → old battery 1 mΩ)
- Decrease of specific gravity (Ex.: 1.26 → 1.15)
- Deterioration of discharging capacity: (Ex.: down to 60, 50, 40% or less)

Regeneration of old battery

Regenerated Battery: by dissolving $PbSO_4$ back into electrolyte

- Decrease of internal resistance (Ex.: down to brand-new level)
- Increase of specific gravity (Ex.: up to brand-new level like 1.26)
- Improvement of discharging capacity: (Ex.: up to 80, 90 or even 100%)

1-d. Regeneration Work Process

Incoming Call

- Measuring Voltage/SG/Impedance (A)
- Discharging test(A)

Regeneration

- Regenerate old batteries
- Working hours different depending on batteries' environment like maker, battery type(Gel or AGM), and oldness.

Testing Regenerated Batteries

- Measuring Voltage/SG/Impedance (B)
- Discharging test(B)

Delivery to Customers

- Evaluation of regenerated batteries and deliver only qualified regenerated batteries to customers.
- The cut-off level is determined by customers and BRM is providing all the quality data to customers after regeneration.
- Some customers want 80% or above and some others want 90% or more.

1-e. Standard Regeneration Working Hours

The regeneration time must be different, depending on each battery's condition and status, even if they are the same model batteries.

Battery type	Battery Capacity	Standard regenerating Hours	Regeneration Method	Battery Type
SLI battery (car battery)	Any capacity (12V)	12~24 Hours	Each 12 Volt battery on one BR-6812 or four batteries on one BR-3648	Mostly wet type (or flood)
Industrial Battery (Deep Cycle Battery for Fork-lifter)	300~700 Ah (48V) Over 700 Ah (48V)	48~72 Hours 60~100 Hours	24 cells (that is 48 Volt) on one BR-3648	Mostly wet type
Industrial Battery (Stand-by Battery like for UPS or Renewable energy system)	Up to 200 Ah (2 or 12 V) 200 ~ 400 Ah (mostly 2V) 400 ~ 600 Ah (2V) 600 ~ 1000 Ah (2V) 1000~3000 Ah (2V)	24~48 Hours 24~72 Hours 48~84 Hours 60~90 Hours 72~120 Hours	6 cells (they become 12 Volt) on one BR-6812 or 24 cells on one BR-3648	Mostly AGM or Gel type

1-f. Success Rate in Battery Regeneration based on 2V cell experience

Criteria to judge the success of battery regeneration

- Generally speaking, when the regenerated batteries could discharge more than 80% of brand-new level and keep the impedance value within 100~105% level of brand-new one, the customers accept them as success.

- So, before starting battery-regeneration service, this success criteria must be agreed on and only the regenerated batteries which pass this success criteria must be delivered to customers after rigorous quality control.

Success Rate of Battery Regeneration

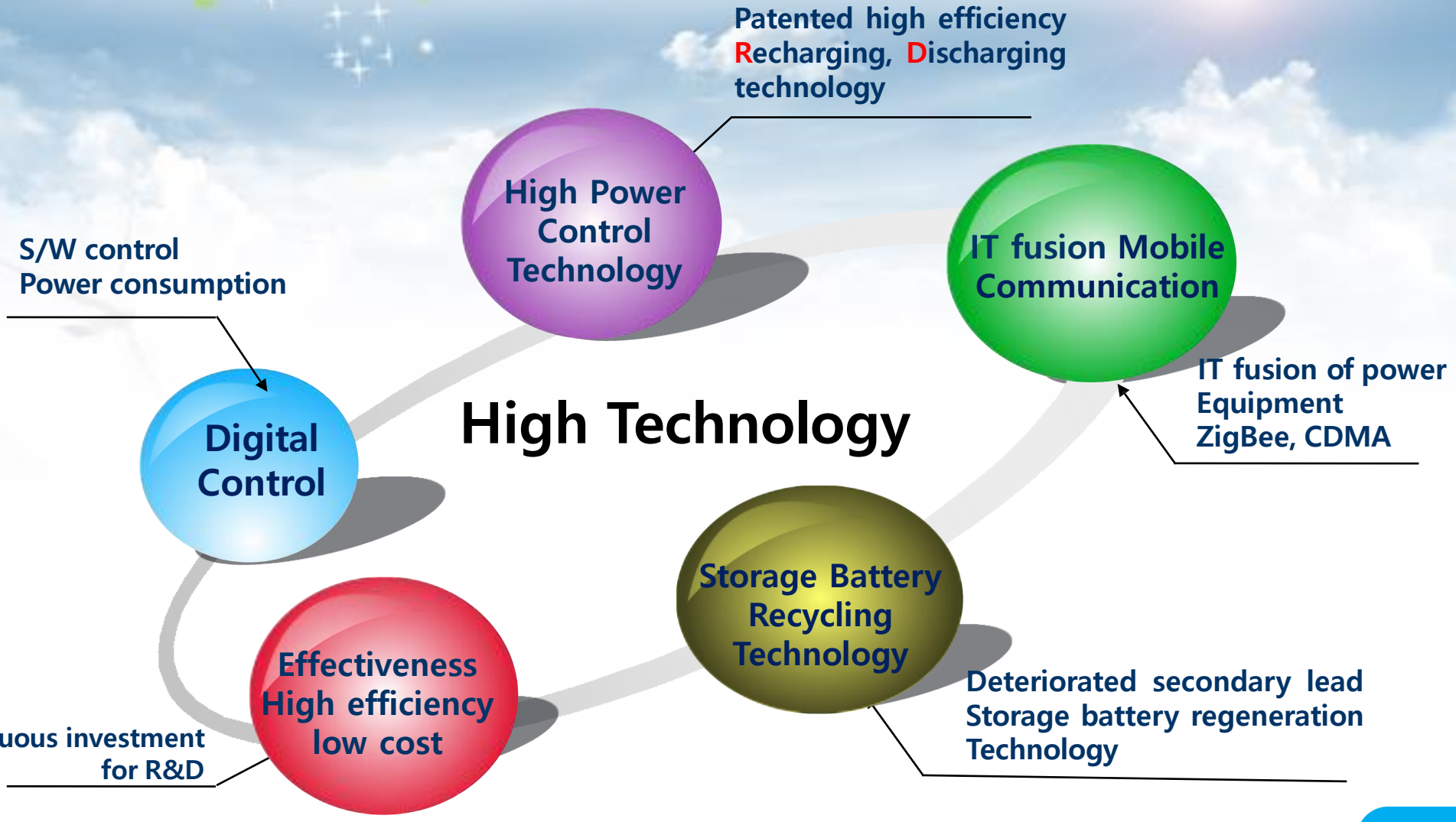
- The following factors must give influence on the success rate
  1) Who is the battery-maker ? (Chinese, Korean, Japanese or Germany)
  2) What kind of battery? (AGM, Gel, flood)
  3) How bad is the old battery? (i.e.; impedance level 130%, 200%, 300%?)
  4) How well is the old battery kept? (i.e.; how long in the storage?)

- Based on B&F's experience during the time, the success rate of battery-regeneration based on the above criteria is between **80~95%.**

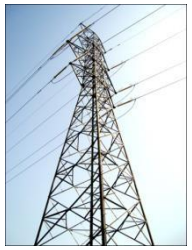
2. B&F BRM (Battery Regeneration Machine)

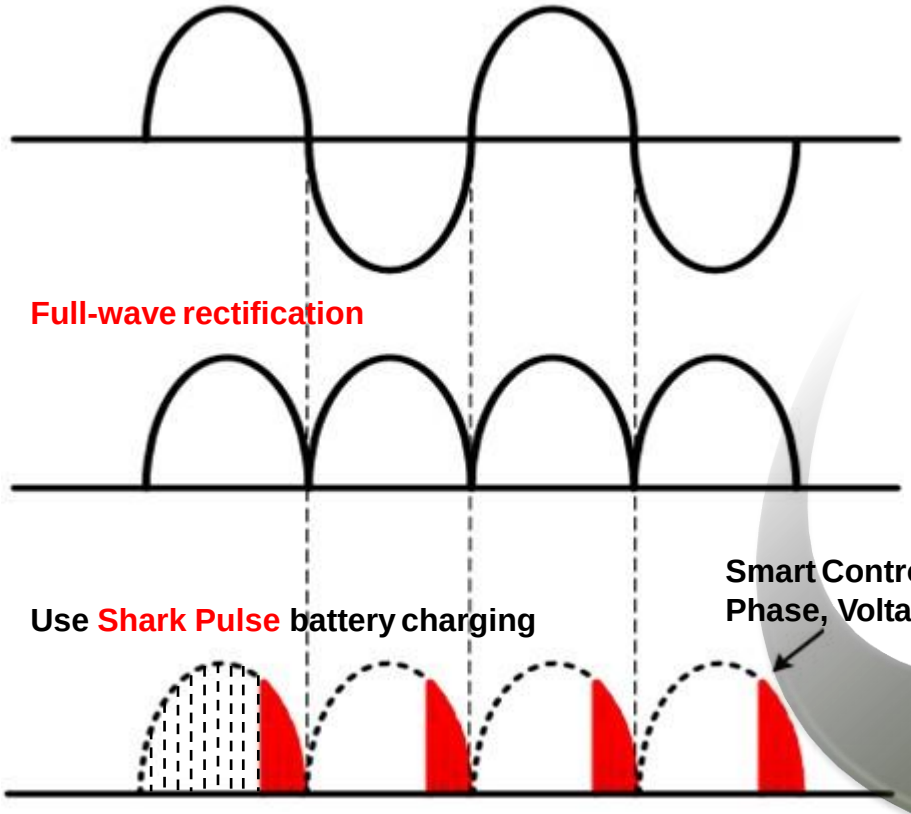
- ✓ Application of patented recycling technology (Patent No. 10-1429608, storage battery recycling equipment)
- ✓ Remove sulfates effectively from deteriorated lead storage battery
- ✓ Supports both Regeneration and Discharging batteries in one unit
- ✓ Quick regeneration time and effective capacity
- ✓ Program mode, easy interface

2-a. Core Technology



2-b. How BRM Work?





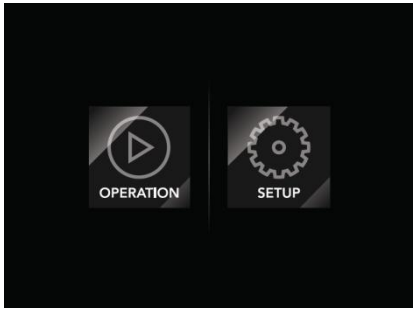
- ✓ Shark pulse made by chopped half cycle (4,000) of input electricity
- ✓ Smart control Phase, Voltage, Current
- ✓ Shark pulse remove attached lead sulfate from electrode plates

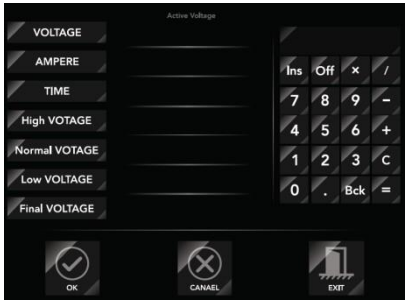
Battery regeneration by removing lead sulfate

2-c. Features of BRM

1. **Application of patented recycling technology**
   (Patent No. 10-093150, storage battery recycling equipment)
2. **Each BRM model has both change & Discharging function**
3. **Low Regeneration Cost**
   Discharging function returns electricity to electric power company.
4. **Large Capacity Battery Regeneration**
   1.2~150V , 3,000 AH Battery regeneration
5. **Automation program mode support**
   99 hours, 5 type program mode supports

2-c. Features of BRM





6 **Large 8 inch LCD & Touch Screen**
BRM Status information, user friendly interface, voltage/current graphical representation

7 **SD Card Application**
Easy Software upgrade, charging & discharging data backup

8 **Remote Control PC Program Support**
BRM Remote control in PC for charging & discharging data backup

9 **Interior design**
Plug-in type design, Easy service parts exchanging

10 **Patent**
Regeneration and Regeneration Method

2-d. Issues of Legacy Methods

Using chemistry

- ✓ **Making hole** outside battery
- ✓ **Chemicals addition** cause increasing cost
- ✓ **Long time** for battery regeneration
- ✓ **Many** process & Many manpower
- ✓ **Low** efficiency

Using electrical pulse

- ✓ **High price** equipment
- ✓ **Long time** for battery regeneration
- ✓ **Low** efficiency

2-e. BRM Models

Model	BRM130
Power	AC 3PH, 200~440V, 50/60Hz
Output	1.2 ~ 150V, 0A ~ 100A
Battery Volume	1,000 AH/10H
Transformer	20 kW

Model	BRM124
Power	AC 3PH, 200~440V, 50/60Hz
Output	1.2 ~ 120V, 0A ~ 30A
Battery Volume	500AH/10H
Transformer	8 kW

Model	BRM115
Power	AC 3PH, 200~440V, 50/60Hz
Output	1.2 ~ 75V, 0A ~ 300A
Battery Volume	3,000 AH / 10H
Transformer	50 kW

2-f. SRS(Small Regeneration System)

SRS play the efficient role and excellent battery performance by Optimization . It supplying fine pulse current to the electrode plate which makes screen to prevent PbSO4 creation. “SRS” can use for permanent battery solution.

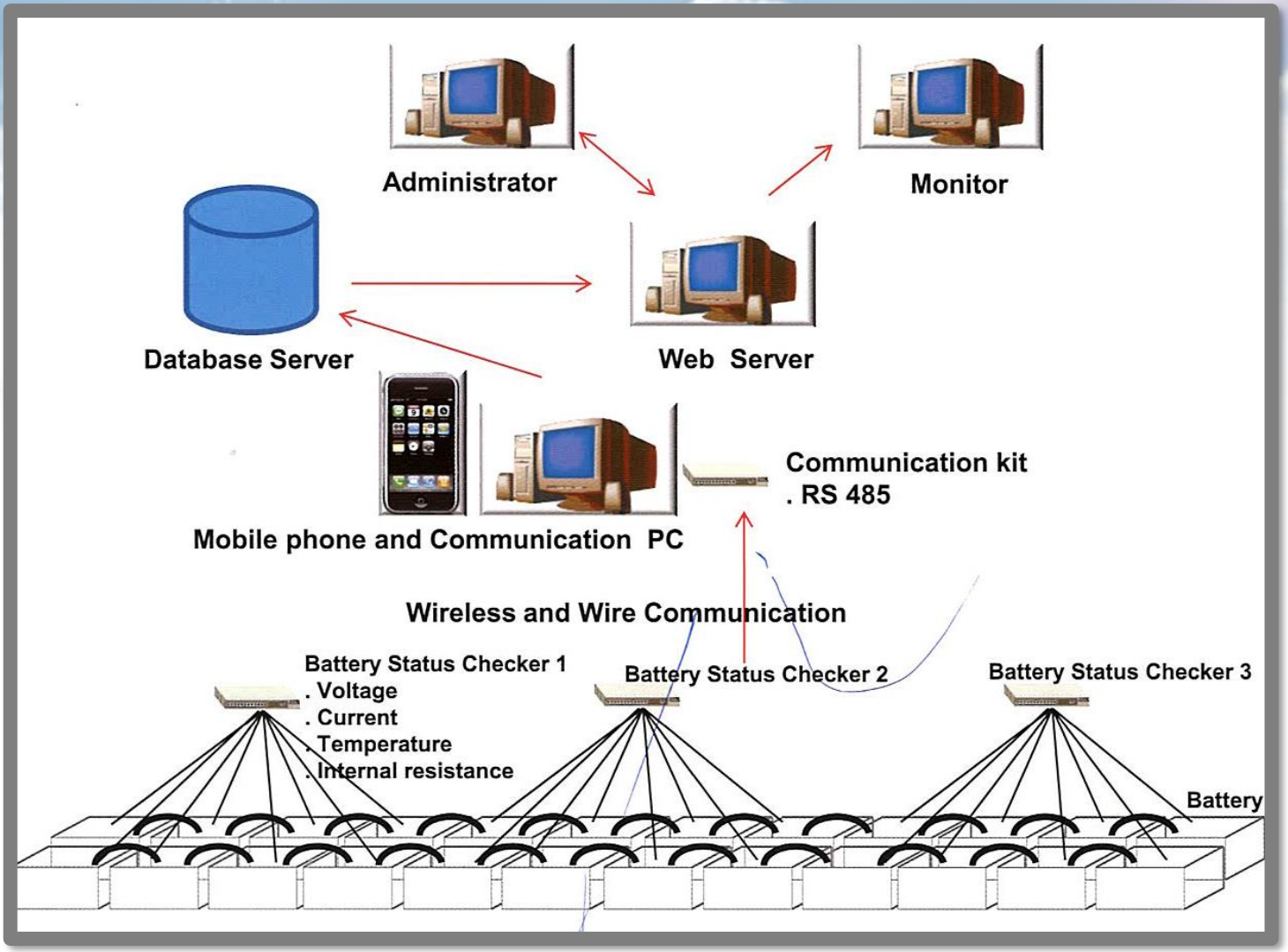
SRS Product Detail

Product type	**2V, 6V, 8V, 12V, 24V**
How it works	One (01) Regeneration System Connect one(01) battery.
Current consumption	30mAH more
Frequency	5 ~ 20 KHz
Operating temperature	-40°C ~ 90°C
Product Size	68 x 49 x 14 mm

SRS Effects

- **Extended battery life (typically 2.3 times longer than life)**
- **Maintain battery capacity more than 90% continuously**
- **Prevent battery deterioration**
- **Save time for replacing batteries (increase work efficiency)**
- **Battery overload, overvoltage, over discharge protection**
- **Improve fuel efficiency by more than 5%**
- **Reduced engine load due to overall efficiency increase**
- **Engine, ignition, light, headlight, horn, radio power rise**
- **Smooth engine start**
- **CO2 reduction**

2-g. BMS(Battery Monitoring System)



3. Comparison with major Competitors

Model	BRM150	BRM130	BRM124	MCS M-1001I	MIDI	BRT-100	BRT-20	ZBR-101	ZBR-201
Maker	B&F BRM / KOREA			MAROO MCS / KOREA	MACBAT / SWEDEN		Batterie Plus /FRANCE	RepowerTEK / KOREA	
INPUT Power	3Wire 3Phase 380~440V			2Wire 1Phase 220V	3Wire 3Phase 380~400V			1 Phase 210-~250V	
BATTERY VOLTAGE (V)	1.2~75	1.2~150	1.2~120	1.2~100	①12~48 ②48~80	12~120	12~120	2~96	2~96
BATTERY CAPACITY (AH)	3,000	1,000	500	300	1,000	1,000	1,000	1,000	1,000
CONTROLL FREQ.	150/180Hz	150/180Hz	150/180Hz	100/120Hz	15KHz	15KHz	15KHz	15KHz	15KHz
TIME [h]	24	24	24	48	72	72	72	72	72
TRANSFORMER	50kVA	20kVA	10kVA	7.5kVA	①15kVA ②20kVA	16kVA	16kVA	7.5kVA	7.5kVA
SIZE(cm) W×D×H	80×80×130	60×60×120	60×60×120	40×61.3×133	66×55×120	80×55×195	80×55×100	50x50x100	50x50x100
CONTROL	Each battery Data Receive			Total Data	Total Battery Data Receive			Total Battery Data Receive	
Discharging	O	O	O	O	X	X	X	X	O

B&F BRM SERIES

MAROO MCS

Macbat MIDI


Macbat BRC-100

Batterie Plus BRC-20

RepowerTEK ZEUS ZBR-101,201

3-a. What is the Differences ?

1. Discharger included in one BRM equipment

- BRM returns electricity to electric power company during discharging. It turns analog electric power meter backward.
- Competitors use separated heating discharger.

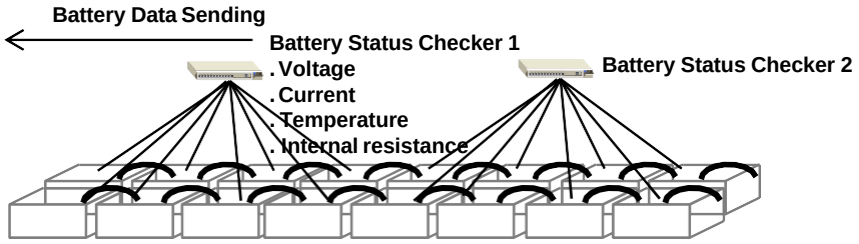
3-a. What is the Differences ?

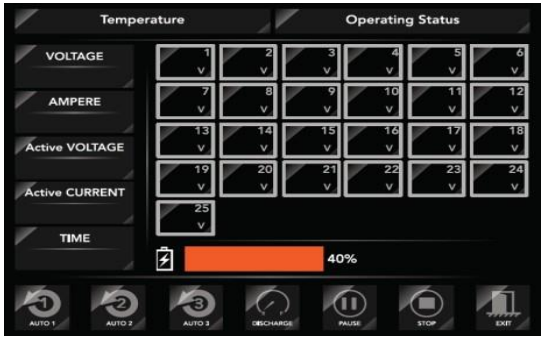
2. Regeneration of large-capacity battery

- ❖ **BRM regenerates many batteries at a time**

3. BSC (Battery Status Checker)

- ❖ **Easy to diagnose bad batteries, efficient monitoring discharge & charge status**





3-a. What is the Differences ?

4. High regeneration efficiency
   - ❖ 90% UP: Large capacity UPS Battery
   - ❖ 80% UP : Forklift Battery & Small capacity UPS battery
5. No use any Chemicals
   - ❖ No Extra cost for regeneration due to chemicals
   - ❖ Competitors use chemicals for cooling during regeneration
6. The other regeneration systems make a lot of heat inside battery
   - ❖ Have to wait 1~2 days until cool down
   - ❖ Heat causes deterioration
7. The others can regenerate batteries with at least 50% remaining capacity
   - ❖ They cannot regenerate less than 40% remaining capacity
8. Easy software upgrade
9. Turnkey solution provider
   - ❖ Battery regeneration biz consulting
   - ❖ Technical support and training

3-c. Other Competitors

There are many Companies of Battery Regenerator…..BUT

Puma PRH-3030
(JAPAN)

X-Charge/X-Tester
REGENTECH
(KOREA)

ECOTAIN
(KOREA)

ONE by ONE !
Separated Discharge Unit !
Use Chemicals ! Small Capacity !

VS

Many batteries at a time !
Discharge & Charge in One Unit !
No Chemicals ! Big Capacity !

5. B&F's Success Experience

-BRM exported its technology to more than 30 countries around the world.
-In some countries, B&F started to provide commercial service of battery regeneration to the major customers like telecom operators.

Country	Customer/battery type/working history
Korea	K-Telecom: 2v, 420, 600Ah Gel, 1800Ah Gel, 2000Ah Gel (3 years 4 months) L-Telecom: 2v, 300, 600Ah Gel (1 year 6 months) S-Telecom: 2v 600Ah AGM (6 months)
Indonesia	I-Telecom 12v, 100Ah AGM, 2v, 600Ah Gel (1 year 3 months) T-Telecom: 12v, 200Ah, AGM (1 year)
Mexico	T-Telecom: 200 Ah, AGM, 2000 Ah, Gel, 3000Ah, PS (1 year 3 months) BT-Telecom: 150Ah AGM, 600Ah Gel (1 year)
Iran	I-Telecom: 12v, 150Ah AGM, 2v, 2000Ah AGM
India	A-Telecom: 2v, 330Ah AGM (1 year)
Sri Lanka	M-Telecom: 2v, 300Ah AGM (1 year)
Tanzania	V-Telecom: 12V, 200Ah AGM, 2v, 2000Ah Gel (1 year 5 months)
Australia	T-Telecom: 2v, 500Ah AGM (1 year 10 months)
Ivory Coast	M-Telecom: 6v, 200Ah AGM (7 months)
Romania	Solar power company: 2v, 4000Ah Gel (1 year)
Bangladesh	R-Telecom: 2v, 400Ah AGM, Gel, (1 year 2 months) B-Telecom: 2v, 400Ah Gel, (6 months) G-Telecom: 2v, 400Ah GEL, (3 months)

6-a. Case Study of Old Battery-Regeneration

Tested battery: Korean VGS 600Ah, 2 Volt Gel battery

Nov. 12, 2012

Cell	Before value			After value			Discharging Result	
	Voltage (V)	Imped. I (mOhm)	mped. (%)	Voltage (V)	Imped. (mOhm)		Imped. (%)	
1	2.090	0.876	199.09	2.17	0.369		83.86	A
2	2.070	0.903	205.23	2.15	0.371		84.32	A
3	2.100	0.496	112.73	2.17	0.337		76.59	A
4	2.030	0.612	139.09	2.14	0.363		82.5	B
5	2.080	0.360	81.82	2.16	0.346		78.64	A
6	2.100	0.460	104.55	2.18	0.325		73.86	A
7	2.050	0.529	120.23	2.17	0.346		78.64	A
8	2.100	0.566	128.64	2.2	0.368		83.64	A
9	2.050	0.835	189.77	2.14	0.367		83.41	B
10	2.110	0.571	129.77	2.2	0.352		80	A
11	2.040	0.503	114.32	2.17	0.339		77.05	A
12	1.820	4.247	965.23	2.03	0.459		104.32	F
13	1.980	0.676	153.64	2.11	0.353		80.23	D
14	2.110	0.744	169.09	2.18	0.335		76.14	A
15	2.050	0.489	111.14	2.17	0.34		77.27	A
16	2.050	0.590	134.09	2.18	0.336		76.36	A
17	2.110	0.642	145.91	2.18	0.338		76.82	A
18	2.050	0.643	146.14	2.18	0.344		78.18	A
19	2.050	0.466	105.91	2.18	0.497		112.95	A
20	2.050	0.592	134.55	2.18	0.346		78.64	A
21	2.050	0.576	130.91	2.17	0.345		78.41	A
22	2.110	0.597	135.68	2.2	0.34		77.27	A
23	2.060	0.590	134.09	2.18	0.348		79.09	A
24	2.100	0.786	178.64	2.19	0.345		78.41	A
					(aver.)	(aver.)		
		Original: 0.44			0.3587		81.525	

Evaluation after discharging test

1. **Evaluation criteria based on 5 hours discharging rule**

- A-class: more than 4 hours 30 minutes (more than 90%)
- B-class: 4 hours ~ 4 hours 30 minutes (80 ~ 90%)
- C-class: 3 hours 30 minutes ~ 4 hours (70 ~ 80%)
- D-class: 3 hours ~ 3 hours 30 minutes (60 ~ 70%)
- F-class: less than 3 hours (less than 60%)

2. **Opinion on the discharging result**

In summary,
- Twenty cells are regenerated to A-class
- Two cells are regenerated to B-class
- One cell are regenerated to D-class
- One cell fails to be regenerated.

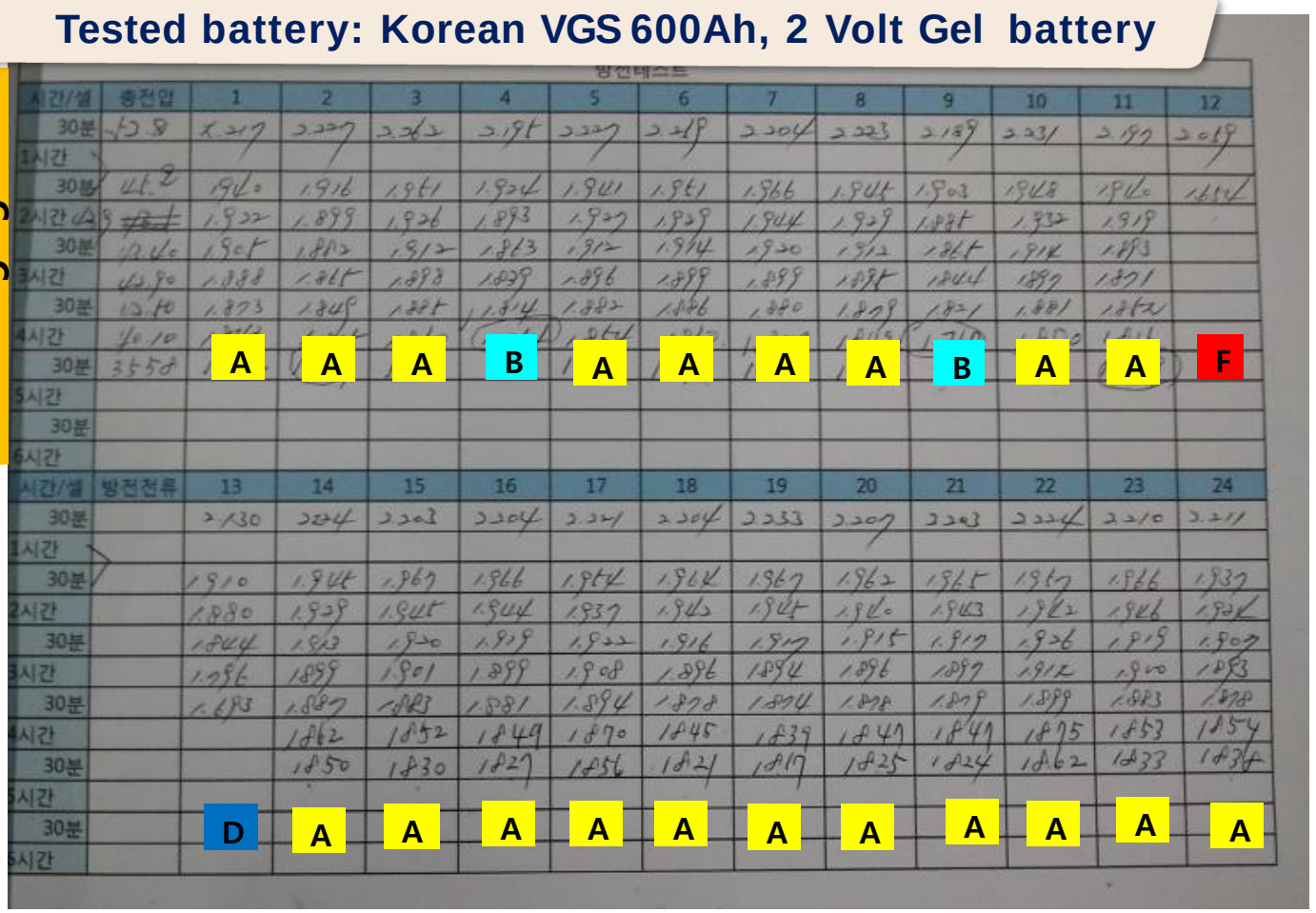
12 cell is not recovered even though its impedance approached to near brand-new level, while #19 is recovered near to brand-new level after regeneration. This mean that #12 has some problem inside.

Now, when we consider the impedance and discharging data, we can strongly recommend 21 cells with A or B-class except #19 which has relatively higher impedance than brand-new level among 24 cells for reuse. Even #19 could be reused but we will try more to reduce the impedance level.

6-a. Case Study of Old Battery-Regeneration

Tested battery: Korean VGS 600Ah, 2 Volt Gel battery

Discharging Data



시간/셀	충전압	1	2	3	4	5	6	7	8	9	10	11	12
30분	12.8	2.217	2.227	2.262	2.194	2.227	2.218	2.204	2.223	2.189	2.231	2.197	2.219
1시간													
30분	12.2	1.940	1.916	1.961	1.934	1.941	1.961	1.966	1.944	1.903	1.948	1.940	1.944
2시간	12.8	1.932	1.899	1.926	1.893	1.927	1.929	1.904	1.929	1.884	1.932	1.919	
30분	12.60	1.904	1.882	1.912	1.863	1.912	1.914	1.920	1.912	1.864	1.914	1.893	
3시간	12.50	1.888	1.864	1.898	1.859	1.896	1.899	1.899	1.894	1.844	1.899	1.871	
30분	12.50	1.873	1.845	1.884	1.854	1.882	1.886	1.880	1.879	1.821	1.881	1.852	
4시간	12.10												
30분	12.58	A	A	A	B	A	A	A	A	B	A	A	F
5시간													
30분													
6시간													
시간/셀	방전전류	13	14	15	16	17	18	19	20	21	22	23	24
30분		2.130	2.224	2.203	2.204	2.224	2.204	2.233	2.207	2.203	2.224	2.210	2.211
1시간													
30분		1.910	1.944	1.967	1.966	1.944	1.962	1.967	1.962	1.965	1.967	1.966	1.937
2시간		1.880	1.929	1.945	1.944	1.937	1.943	1.944	1.940	1.943	1.962	1.946	1.934
30분		1.844	1.913	1.930	1.919	1.922	1.916	1.917	1.915	1.917	1.926	1.915	1.907
3시간		1.796	1.899	1.901	1.899	1.908	1.896	1.894	1.896	1.897	1.912	1.900	1.893
30분		1.693	1.887	1883	1.881	1.894	1.878	1.874	1.878	1.879	1.899	1.883	1.878
4시간			1862	1852	1849	1870	1845	1839	1841	1841	1875	1853	1854
30분			1850	1830	1827	1856	1821	1817	1825	1824	1862	1833	1834
5시간													
30분		D	A	A	A	A	A	A	A	A	A	A	A
6시간													

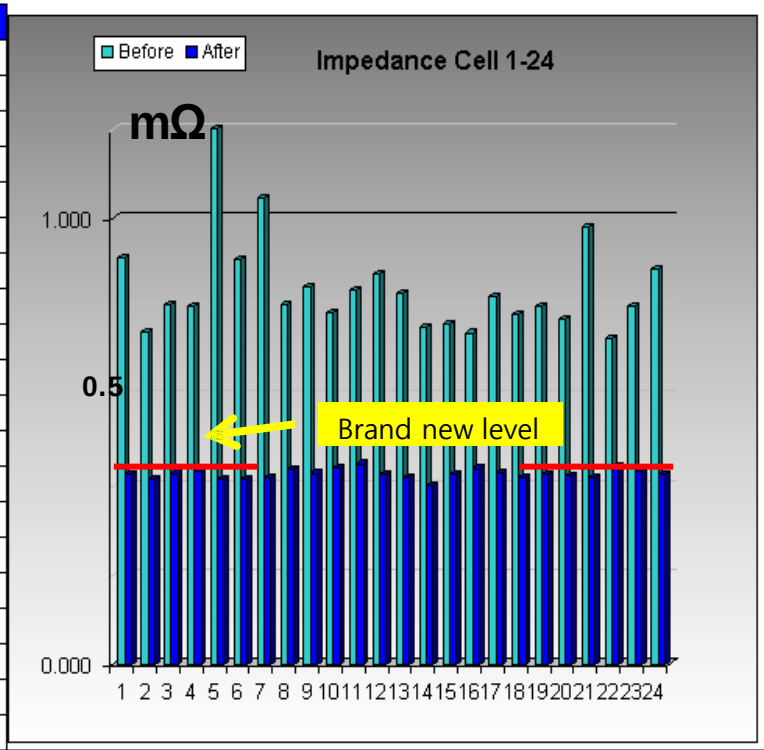
» The finishing voltage of each cell is 1.75Volt.

» The discharging ampere for 5 hours rule is 106 ampere.

6-b. Case Study for Korean Telecom Operator A

Tested battery: Korean VGS 420Ah, 2 Volt Gel battery

Cell	Before	After
Cell 1	0.911	0.425
Cell 2	0.745	0.417
Cell 3	0.807	0.428
Cell 4	0.804	0.435
Cell 5	1.217	0.415
Cell 6	0.909	0.414
Cell 7	1.045	0.419
Cell 8	0.805	0.436
Cell 9	0.846	0.428
Cell 10	0.788	0.442
Cell 11	0.840	0.450
Cell 12	0.875	0.426
Cell 13	0.837	0.420
Cell 14	0.755	0.402
Cell 15	0.764	0.427
Cell 16	0.743	0.439
Cell 17	0.825	0.431
Cell 18	0.783	0.420
Cell 19	0.801	0.425
Cell 20	0.775	0.423
Cell 21	0.980	0.419
Cell 22	0.730	0.444
Cell 23	0.802	0.436
Cell 24	0.886	0.425

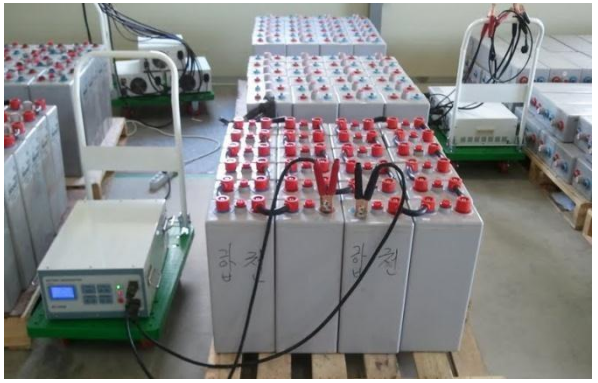


Customer: K

Hee Yeol-Sang

Battery data: Rocket

Impedance of New Battery : 0.5 mΩ or less



Regeneration Result

- The discharging capacity is improved from 59.5% level to 92.1% level by regeneration.

	Before regen.	After Regen.
Discharging time	357	553
Discharging Current	42	42
Total Discharged Ah	250	387
Capacity (%)	59.50%	92.1%

6-c. Case Study for Korean Telecom Operator B

Tested battery: Korean 600Ah, 2 Volt AGM battery

Before regeneration		
Cell No	voltage	Impedance
1	2.120	0.478
2	2.120	0.604
3	2.110	0.599
4	2.100	0.633
5	2.090	0.690
6	2.110	0.480
7	2.100	0.499
8	2.090	0.589
9	2.090	0.556
10	2.110	0.668
11	2.100	0.410
12	2.100	0.508

After regeneration		
Cell No	voltage	Impedance
1	2.190	0.377
2	2.180	0.405
3	2.180	0.405
4	2.180	0.301
5	2.150	0.392
6	2.180	0.311
7	2.180	0.344
8	2.150	0.303
9	2.170	0.305
10	2.170	0.317
11	2.170	0.308
12	2.170	0.310

Impedance of New Battery : 0.35 mΩ or less

Evaluation of regenerated batteries by the Telecom Operator (December 2010)

. Compared with the brand-new cells' level (impedance between 0.2~0.35 mΩ, voltage between 2.2V±0.1v), 17 cells among 24cells (85%) are evaluated to be regenerated to normal cells, which satisfy our standard for use in the field.

6-d. Case Study for Indonesian Telecom Operator A

Tested battery: Power Plus 600Ah, 2 Volt Gel battery

Battery Regeneration Report

Date :

2011-04-07

Customer

Customer	Telecom Indonecia
Responsible staff	Sang hee yeol

Operation

BQR -5450
Regeneration time
54 hours

Battery Specifications

Company	Telecom Indonecia
Model Name	Power Plus
Capacity	600A
Impedance	0.44 mΩ
Voltage.Impedance	2V X 24 =48V

	Before Value	After Value
Discharging time	450 min	564 min
Discharging orruent	52.6	51~54
Discharge capacity(AH)	394.5	530
Battery capacity(%)	75.0%	94.3%

	Before Value			After Value			Discharge Value				After Value		
Cell	Voltage	mΩ	°C	Voltage	mΩ	°C	Cell	Voltage	mΩ	°C	Voltage	mΩ	°C
1	2.120	0.577		2.200	0.450		1						
2	2.120	0.561		2.200	0.459		2						
3	2.120	0.567		2.200	0.455		3						
4	2.120	0.666		2.200	0.459		4						
5	2.120	0.566		2.200	0.429		5						
6	2.120	0.583		2.200	0.445		6						
7	2.120	0.585		2.200	0.452		7						
8	2.120	0.600		2.200	0.457		8						
9	2.120	0.556		2.200	0.455		9						
10	2.120	0.491		2.200	0.452		10						
11	2.120	0.580		2.200	0.462		11						
12	2.120	0.533		2.200	0.447		12						
13	2.120	0.590		2.200	0.458		13						
14	2.120	0.527		2.200	0.461		14						
15	2.120	0.569		2.200	0.457		15						
16	2.120	0.502											
17	2.130	0.536											
18	2.120	0.564											
19	2.120	0.567											
20	2.120	0.517		2.200	0.447		20						
21	2.120	0.539		2.200	0.441		21						
22	2.120	0.526		2.200	0.446		22						
23	2.120	0.541		2.200	0.459								
24	2.120	0.574		2.200	0.448								
25	2.120	0.691		2.060	0.697								
26													
27							27						
							Total	53.01	13.32		52.80	10.36	
							Average	2.120	0.666		2.200	0.453	

Average Impedance before regeneration : 0.584 mΩ (133%)

Average Impedance after regeneration : 0.482 mΩ (110%)

Regeneration Result: The discharging capacity is improved from 75.0% level to 94.3% level by regeneration.

6-e. Case Study for Indonesian Telecom Operator B

. **Tested Battery Information:** BAE, Germany/ **Capacity :** 12v 115AH/ **Type:** GEL (UPS) **Original Impedance :** 9mΩ

No.	Voltage (V)	Impedance–before (mΩ)	Impedance-before vs. original impedance (9mΩ) (%)	Impedance–after (mΩ)	Impedance-before vs. original impedance (9mΩ) (%)
1	12.71	11.50	127.778%	6.113	67.92%
2	12.49	17.56	195.111%	6.765	75.17%
3	12.70	12.39	137.667%	6.096	67.73%
4	12.74	11.99	133.222%	6.395	71.06%
5	12.09	37.02	411.333%	14.09	156.55%
6	12.26	32.95	366.111%	17.28	192.0%
7	12.09	15.28	169.778%	12.60	140.0%
8	12.71	16.05	178.333%	6.249	69.43%

REJUVENATION TECHNOLOGY AGAINST NORMAL PRACTISE.

NO. OF BATTERIES : 12 batteries

INITIAL BATTERY CONDITION : All batteries which were taken from the warehouse are already considered as SCRAPED. These batteries are below the usable parameters (not enough capacity to hold current and its way below the expected Discharging Time) and categorized as UNUSABLE.

WITHOUT REJUVENATION

1.**REMEDY/SOLUTION :** To change all the 12 batteries to new ones. This means cost and expenditure.

WITH REJUVENATION

1. **REMEDY/SOLUTION : AFTER APPLYING ECOSAVER TECHNOLOGY**

9 Batteries have been restored & revived and **3** batteries are beyond redemption (Due to severe sulfation and or internal damaged)

6-f. Case Study for Indian Telecom Operator

Battery Regeneration Worksheet for 330Ah, 2V AGM battery

Date: 28-May-12
Customer:
Battery Make: HBL
Battery Type: VRLA
Battery Specs:
Volts 48, 2 V each
Capacity 330AH
Machine Used: BR004
Regeneration Time: 48Hrs
Volt Settings: 48V
Ampere Setting: 33
Discharge Time: 3T

Ohm for new batteries: 0.5 mΩ or less

We can see the improvement of impedance value

All the cells passed discharging test.

Battery Sr. No.	First Measurement before REG		After REG		After Charge - min 2 hrs		Readings on 28/05/2012		Second Reg on 31/05/2012	
	Volts	Ohm (mΩ)	V	Ohm (mΩ)	V	Ohm (mΩ)	V	Ohm (mΩ)	V	Ohm (mΩ)
307 01 01	2.00	1.80	2.183	0.441	2.228	0.464	2.177	0.363		
307 02 02	2.03	1.88	2.169	0.441	2.215	0.508	2.161	0.451		
307 03 03	2.06	0.83	2.166	0.517	2.225	0.630	2.163	0.480		
307 04 04	2.02	1.16	2.180	0.442	2.227	0.482	2.175	0.387		
307 06 05	2.00	1.92	2.180	0.485	2.220	0.553	2.174	0.357		
307 07 06	2.00	1.86	2.180	0.543	2.225	0.565	2.178	0.330		
307 08 07	1.99	0.81	2.185	0.414	2.217	0.520	2.173	0.398		
307 09 08	1.99	1.88	2.179	0.456	2.210	0.605	2.174	0.488		
307 10 09	2.01	1.90	2.180	0.513	2.213	0.560	2.185	0.520		
307 11 10	2.02	0.82	2.190	0.478	2.220	0.536	2.180	0.453		
307 12 11	1.99	1.04	2.185	0.472	2.214	0.520	2.174	0.405		
307 13 12	2.07	1.04	2.180	0.569	2.212	0.620	2.152	0.532	2.236	0.467
307 14 13	1.99	1.99	2.159	0.463	2.210	0.550	2.175	0.388		
307 15 14	2.01	0.77	2.181	0.526	2.215	0.581	2.178	0.460		
307 16 15	2.01	0.84	2.184	0.472	2.223	0.509	2.179	0.470	2.216	0.529
307 17 16	1.99	1.93	2.186	0.570	2.208	0.540	2.171	0.518		
307 18 17	2.00	0.82	2.177	0.404	2.220	0.501	2.178	0.430		
307 19 18	2.01	1.59	2.184	0.536	2.221	0.485	2.177	0.474		
307 20 19	2.01	1.99	2.184	0.556	2.215	0.501	2.175	0.407		
307 21 20	1.98	1.72	2.181	0.458	2.209	0.468	2.171	0.365		
307 22 21	1.99	2.40	2.177	1.896	2.145	1.909	2.114	1.830	2.171	1.829
307 23 22	1.98	0.79	2.123	0.416	2.202	0.430	2.166	0.428		
307 24 23	1.95	1.94	2.161	0.469	2.183	0.482	2.154	0.366		
307 03 24	1.99	1.09	2.177	0.562	2.203	0.519	2.171	0.412		
							52.075		11.712	
TOTAL							2.169792	11.712		
AVERAGE								0.488		

Disch. Test		Date	Meas. After Disc.Test	
Amp	Time(Hrs)		V	Ohm (mΩ)
WL	5	30.05.12	2.104	0.345
WL	5	30.05.12	2.084	0.355
WL	5	30.05.12	2.092	0.513
WL	5	30.05.12	2.105	0.476
WL	5	30.05.12	2.102	0.433
WL	5	30.05.12	2.123	0.410
WL	5	31.05.12	2.133	0.309
WL	5	31.05.12	2.133	0.313
WL	5	31.05.12	2.141	0.401
WL	5	31.05.12	2.140	0.367
WL	5	31.05.12	2.134	0.367
WL	5	01.06.12	2.098	0.430
WL	5	31.05.12	2.136	0.345
WL	5	31.05.12	2.139	0.432
WL	5	31.05.12	2.140	0.460
WL	5	01.06.12	2.135	0.444
WL	5	31.05.12	2.140	0.438
WL	5	31.05.12	2.140	0.425
WL	5	31.05.12	2.138	0.433
WL	5	31.05.12	2.129	0.440
WL	5	01.06.12	2.061	2.493
WL	5	01.06.12	2.120	0.396
WL	5	01.06.12	2.110	0.394
WL	5	01.06.12	2.120	0.377
			50.897	11.796
			2.1207083	0.4915

6-g. Case Study for Australian Telecom Operator

Battery Regeneration Test Result in 2016 June

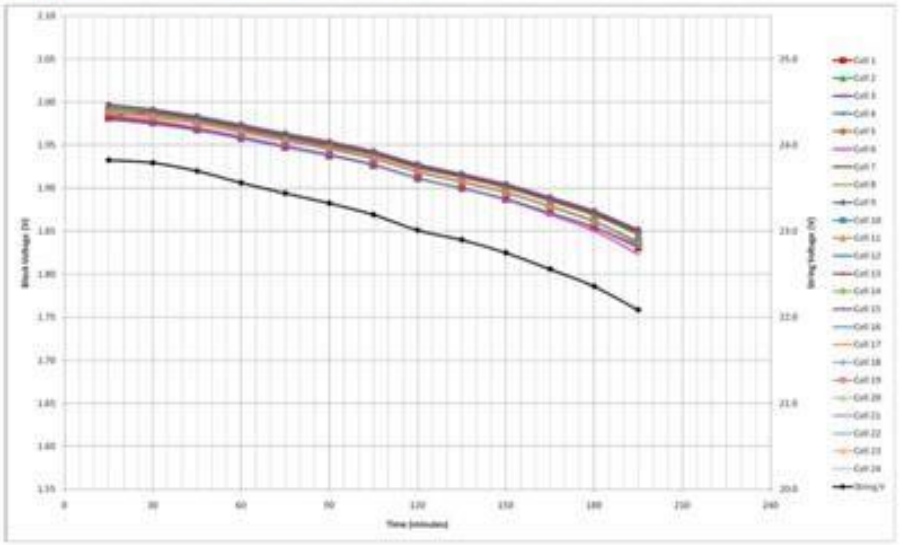
From:
Sent: Wednesday, June 08, 2011 3:02 PM
To:
Subject: Test results

Appreciation e-mail from the battery engineer about regenerated 24 cells of YUASA UXL-550 500Ah, AGM type

Attached are the discharge curves for the batteries we worked on in Landsborough. The cells were discharged at the 3 hour rate with an end voltage of 1.85V per cell. The measured capacity is spot on 100%.
I was particularly happy with the uniformity between cells.

I've only just finished the test today so I haven't had a chance to discuss this internally. The next logical step is to find a 48V string to work on. I'll scout around for a suitable candidate

Regards



6-h. Case Study for Ivory Cost Telecom Operator

Battery Regeneration Test Result in 2012 September

Battery Regeneration Report

Date :

30/09/2012

Customer

Customer	MTN
Responsible staff	

Operation

Battery Specifications

Company	Emerson
Model Name	EB4 6v 200
Capacity	200AH
Impedance	N/A
Voltage	6V

BR-3648
Regeneration time
30 hours

	After Value
Discharging time	No 1: 525m, No 2: 540m, N0 4: 540m, No 5: 510m No 7: 524m No 8: 530m No 9: 524m No 11: 552m
Discharging crruent	No 1, 2, 4, 5, 7, 8, 9, 11 - 24A

	Before Value			After Value				Discharge Value			After Value		
Cell	Voltage	mΩ	˚C	Voltage	mΩ	˚C	Cell	Voltage	mΩ	˚C	Voltage	mΩ	˚C
1	6.16	1.544		6.430	1.263								
2	6.06	1.473		6.460	1.172								
4	6.08	1.457		6.430	1.164								
5	6.1	1.621		6.450	1.186								
7	6.1	1.609		6.470	1.185								
8	6.12	1.453		6.460	1.168								
9	6.04	1.446		6.440	1.160								
11	6.06	1.430		6.450	1.168								

- Place : STA IC office: Date : 30/09/2012
- Battery Model: 8 units of Emerson EB4 6v 200
- Performance Enhancement :
  a. internal Impedance: av. 1.504 (Initial) → av. 1.183 (Final)
  (25% improvement)
  b. DischargingCapacity: average. 87% of new battery.
  Discharging time av. 520min

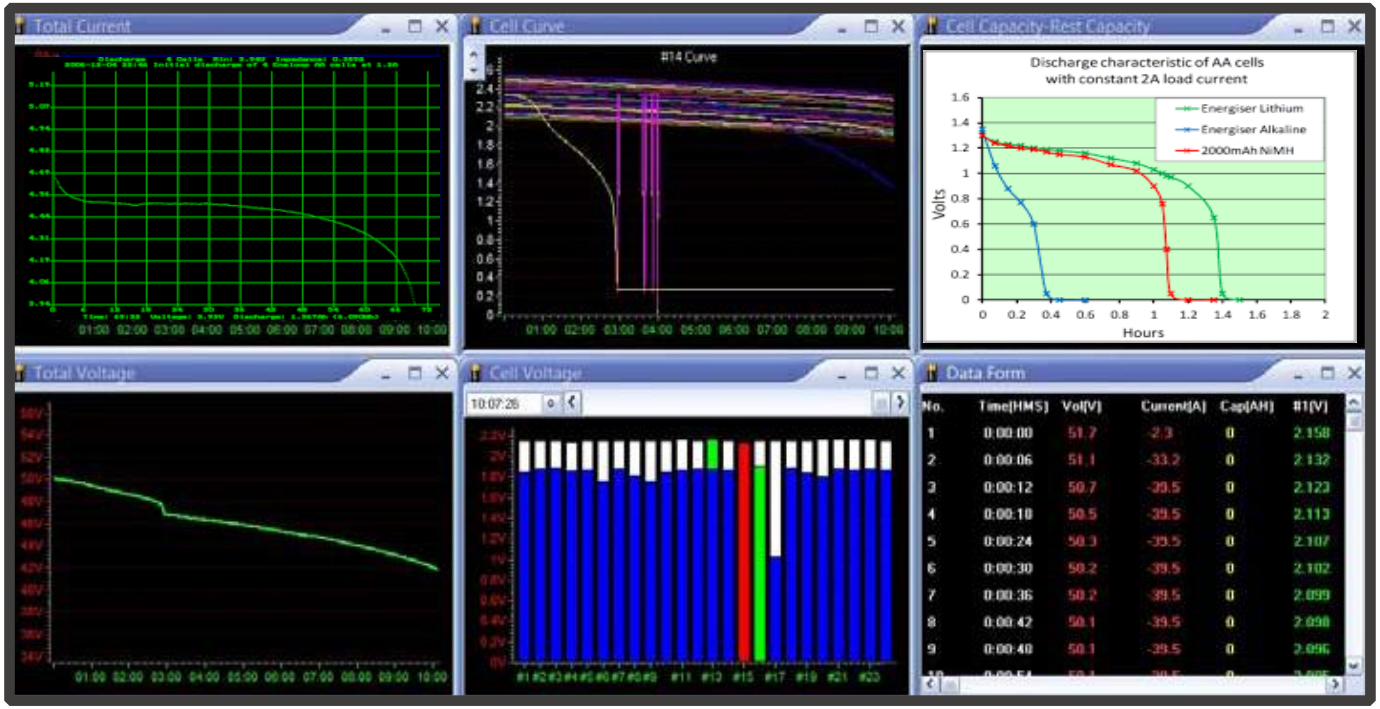
7. Reference Photos

7-a. Battery Regeneration Work Photo

Letter of Award (Robi)

7-b. Battery Discharge Work Photo

Battery Discharge Work Graph

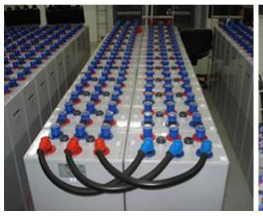


7-c. Project Work Photo

Bangladesh

Indonesia

7-c. Project Work Photo



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