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Development of a new design of valve-regulated lead–acid battery (new Model YT4B) for motorcycle use

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Abstract

In response to the demand for a smaller and lighter valve-regulated lead–acid (VRLA) battery for motorcycle use, and which retains the performance of the present model, Yuasa has developed a new YT4B model battery. Although this battery is lighter, it possesses similar or even better performance than the two present version in terms of high current drain, capacity retention during standing at high temperature, and recovery by charging after overdischarging. The new battery uses thinner plates, made possible with an expanded grid for better performance. It also features a wet (electrolyte-filled) and charged design for easy handling when installing, and has the same level of safety as the standard YT4B technology. © 2000 Elsevier Science S.A. All rights reserved.

Keywords: Capacity retention; Expanded grid; Motorcycle; Valve-regulated lead–acid battery; Wet charged design

1. Introduction

Since Yuasa started to manufacture valve-regulated lead–acid (VRLA) batteries in 1983, 10 million of the units have been sold. Today, more than 90% of the batteries fitted to new models of motorcycle in Japan are VRLA types.

Presently, the engines of motorcycles are being changed from two-cycle to four-cycle in order to reduce exhaust gases and save fuel. Given this trend, there is a requirement for batteries with higher performance, smaller size, and less weight. This paper reports the characteristics of a new YT4B model battery, which has higher performance and lighter weight. The battery has thinner plates with expanded grids — the first application of such technology in the world — and also has a wet and charged design.

2. Experimental

2.1. Design of new YT4B battery

The design of the new YT4B battery was based on using the same dimensions and same terminal structure as the dry type in order to maintain compatibility. The first requirements were higher power and lighter weight. This equated to a 30% improvement in cold-cranking amps (CCAs) per kilogram with respect to the dry YT4B. The second requirement was a change to a wet battery. The purpose of this change was to improve handling, since there would no longer be a need to add electrolyte when installing original equipment or replacement batteries. The third requirement was to maintain safety in battery operation.

The designs of dry (present type) and new YT4B batteries are shown in Fig. 1. The new YT4B type features modifications to the plates and the sealing structure. Expanded grids were employed to decrease plate thickness and increase the number of plates in order to obtain higher performance with less weight. Thickness data for the components of new and dry YT4B batteries are shown in Table 1. All the components of the plate-group in the new YT4B battery are thinner than in the dry type, but the total group thickness is unchanged. This can be achieved only by using expanded grids. The upper cover of the new YT4B battery is sealed without sealing plugs. Bottles of electrolyte are not required because the battery is filled with acid and charged. Finally, safe designs of terminals and safe materials are used.

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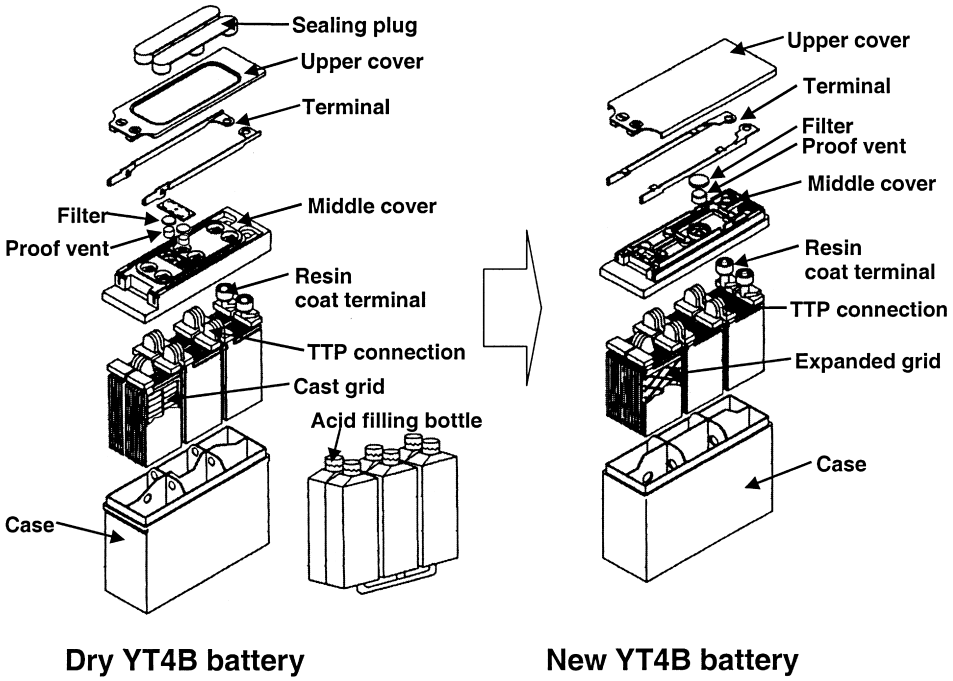

Fig. 1. Structures of dry and new YT4B batteries.

2.2. Performance of new YT4B battery

The following tests were conducted on the new YT4B battery:

(i) C_{10} capacity, i.e., 0.25 A discharge at 25°C;
(ii) high-rate capacity, i.e., 30 A discharge at −10°C;
(iii) cold-cranking performance (CCA kg^{-1});
(iv) self-discharge, by measuring the high-rate discharge (30 A) at 25°C after standing for 12 months at 25°C;
(v) capacity recovery rate, after discharge through a 10-W lamp and standing for 3months; the recovery charge was 0.1 C (0.25 A) for 20 h, and the capacity was checked by discharge at 30 A and 25°C;
(vi) short-circuit investigation, i.e., the current when the terminals were short-circuited was measured with a high-rate discharger.

Table 1
Thickness data (mm) of YT4B batteries

	New type	Dry type
Positive	1.4	1.9
Negative	1.1	1.5
Separator	0.5	0.7
Group	15.7	15.7

3. Results and discussion

The specifications of the new and dry YT4B batteries are listed in Table 2. The C_{10} capacity of the new battery is greater than that of the dry battery, viz., 2.5 vs. 2.3 A h. The high-rate capacity of the new YT4B is improved, both in duration and in voltage. Finally, the new battery delivers 57.7 CCA kg^{-1}, compared with 44.4 CCA kg^{-1} for the dry version, i.e., the target of 30% improvement has been achieved.

Self-discharge performance is shown in Fig. 2. After a storage time, during which the residual capacity decreases to 50%, the new YT4B shows a 20% improvement in charge retention. The capacity is sufficient to start an engine after storage for 1 year.

The rechargeability after deep discharge is shown in Fig. 3. The capacity recovery rate is the same as that of the dry type.

Table 2
Specifications of new and dry YT4B batteries

		New type	Dry type
Nominal voltage (V)		12	12
Capacity (A h, C_{10})		2.5	2.3
Dimensions (mm)	*W*	38.0	38.0
	L	113.0	113.0
	H	85.5	85.5
Weight (kg)		0.92	1.08
Discharged at −10°C, 30 A	Duration (s)	95	85
	5-s voltage (V)	10.4	9.9
CCA (A kg^{-1})		57.7	44.4

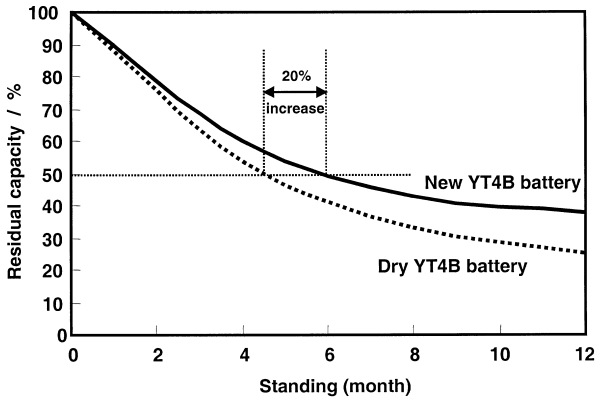

Fig. 2. Self-discharge characteristics of dry and new YT4B batteries at 25°C.

In the design of YT4B batteries, the terminals are close together. Thus, there is a danger of short-circuits. The impedance of the new YT4B battery is smaller (in inverse proportion to the surface area of the plates), and, accordingly, there will be a larger current and more heat generated than in the dry type. An investigation of short-circuits was carried out; the current decay at short-circuit is shown in Fig. 4. A current of more than 400 A was generated at the start of the test on the new YT4B battery. The battery did not fail, however, and this confirms a good level of safety.

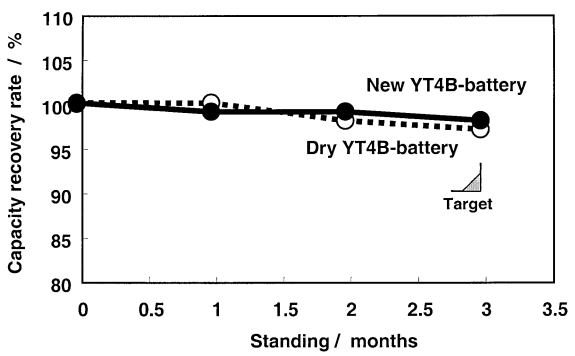

Fig. 3. Rechargeability of dry and new YT4B batteries after deep discharge at 40°C.

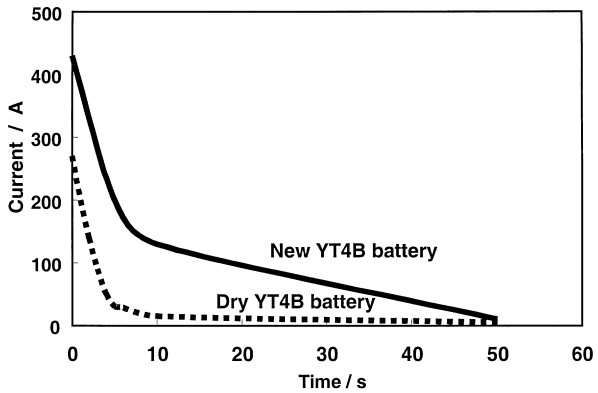

Fig. 4. Current decay of dry and new YT4B batteries at short-circuit.

4. Conclusions

There is an increasing requirement for motorcycle batteries of higher performance, smaller size, and lighter weight. The new YT4B design has realized higher performance with lighter weight by employing thinner expanded grids. The battery is also of a wet design, which provides an improvement in handling. By virtue of these features, the new YT4B battery should achieve strong market acceptance.