# Development of lead/acid batteries for photovoltaic power systems*

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## Abstract

In order to increase charging efficiency and reduce maintenance such as topping up, lead/acid batteries should not be overcharged However, when they are used for long periods without overcharging, stratification of the electrolyte can result because the electrolyte is not agitated by the gas evolved during overcharging, thus reducing battery life In consequence, we have developed two types of lead/acid batteries vented (Model SLB), and sealed (Model SRE), for photovoltaic power applications

## Introduction

Lead/acid batteries used in solar photovoltaic systems must be able to operate under severe conditions involving repeated overcharging, overdischarging, and insufficient charging As a consequence, the batteries are subject to numerous problems including loss of electrolyte, lowering of the charge/discharge energy efficiency, and rapid deterioration of capacity Therefore, the design of such batteries differs from that of conventional types In general, batteries used for solar photovoltaic applications must have the following performance characteristics: (i) capability to withstand irregular charge and discharge, (ii) excellent charge/discharge energy efficiency, (iii) simple maintenance requirements

The Japan Storage Battery Company (JSB) has developed a vented type and a sealed type of lead/acid battery for photovoltaic power applications The characteristics and performance of these batteries are described in this paper

## Model SLB lead/acid batteries (vented type)

Figure 1 shows an external view of the cells The design features a hybrid construction with tubular positive plates (lead–antimony alloy grid)

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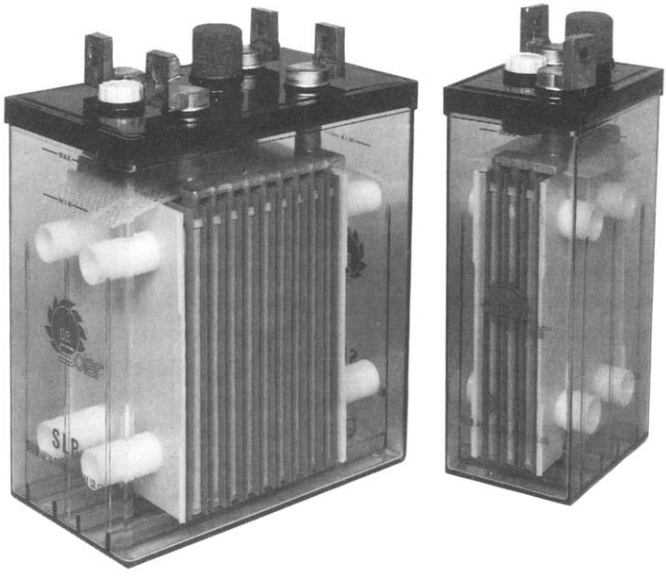

Fig 1 SLB model lead/acid batteries (left SLB-600, right SLB-200)

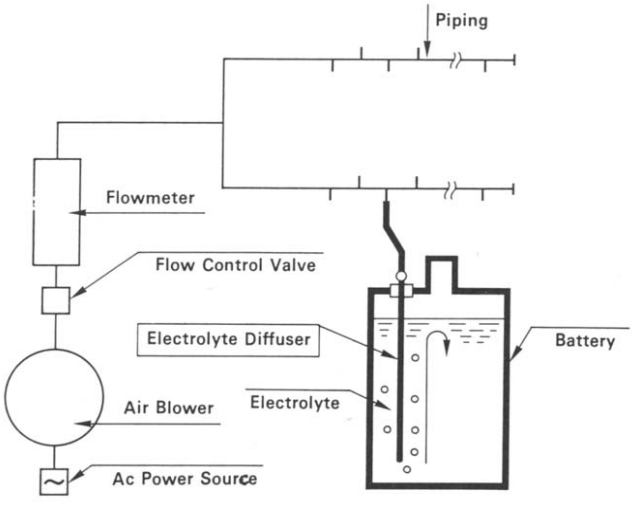


Fig 2 Schematic diagram of electrolyte diffuser

and flat negative plates (lead–calcium alloy grid) The container is moulded from transparent synthetic plastics to allow inspection of the cell interior.

Eleven versions of the SLB battery are available; they range in capacity from 50 to 2500 A h An electrolyte diffuser can be installed as an option (Fig 2). This device improves charge/discharge energy efficiency and tends to lengthen the battery's service life (Fig. 3)

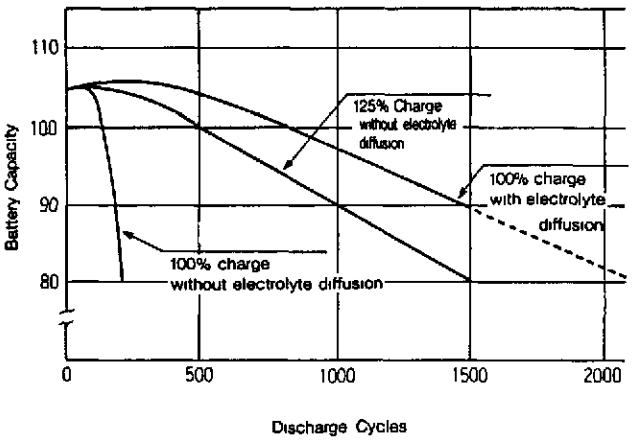


Fig 3 Effect of electrolyte circulation

TABLE 1

Specifications of SRE500 sealed lead/acid battery

| | |
|---|---|
| Dimensions (mm) | 171(W)×236(L)×356(H) |
| Weight (kg) | 39 |
| Nominal voltage (V) | 2 |
| Nominal capacity (A h/10 h) | 500 |
| Cycle life (cycles/65% DOD) | 1500 |
| Self discharge (%/month) | 3 |
| Cost* (¥/W h) | 15 |

*Estimation for production of 200 MW h/year

The SLB battery has the following distinctive features

- service life of over 1500 cycles at 75% depth-of-discharge (DOD)
- charge/discharge energy efficiency > 85%
- low maintenance (water replenishment required only once a year)
- self-discharge rate of about 3%/month at 25 °C

## Model SRE500 lead/acid battery (sealed type)

Sealed lead/acid battery technology, employing an immobilized- or starved-electrolyte system with internal recombination of oxygen, is especially attractive for photovoltaic power systems because of the maintenance-free and position-free characteristics In general, however, sealed lead/acid batteries with lead–calcium alloy grids exhibit poor cycle life under deep-discharge service. Furthermore, sealed batteries are more expensive than flooded types.

JSB has been developing a maintenance-free, long-life, low-cost, sealed lead/acid battery (Model SRE500), based on the internal recombination of oxygen, as part of the 'Sunshine Project' under contract from the New Energy

TABLE 2

Specifications and targets

| | |
|---|---|
| Nominal capacity (A h) | 100 |
| Cycle life (cycles, 40% DOD*) | 2000 |
| Self discharge (% per day) | 0 1 |
| Cost (¥/W h)** | 12 |
| Period of development (years) | 4 |

*Charge and discharge current 1 0 C A
**Estimation for production of 200 MW h/year

and Industrial Technology Development Organization (NEDO), period F Y 1985–F Y 1988 The specifications of the battery are given in Table 1 The design features a gelled electrolyte with improved positive and negative plates The positive plates are of a thick, tubular type that can withstand deep-discharge and severe overcharging operations. The flat-type negative plates have a newly developed active material and exhibit a high charging efficiency that permits operation under a partial state-of-charge From charge/discharge cycling tests, the durability of this battery was found to be over 1500 cycles at 65% DOD

## Status of research and development

JSB has been advancing the development of the sealed lead/acid battery under contract from NEDO since November 1989 The specifications and targets are listed in Table 2