FUTURE OUTLOOK FOR LEAD/ACID BATTERIES IN JAPAN

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Introduction

Pollution problems, coupled with the oil crisis which erupted in the 1970s, have highlighted a need for the development of technologies for creating, saving, and storing energies throughout the world. Various efforts have been, and are being, made to meet this need. Among these efforts is the worldwide work devoted to the development of advanced batteries primarily for use in electric vehicles and utility load levelling. Despite this intense work, it will still be years before some of these advanced batteries become commercially available. Thus, lead/acid batteries, which have been ranked at the top in every yearly battery production since their invention by Gaston Planté in 1860, are likely to maintain this position for years to come. This is primarily due to the fact that the lead/acid battery (a) is a reliable power source which supplies power of good quality, (b) is normally operated at room temperature ensuring easy handling and safe operation, and (c) is chiefly made from lead which can easily be recycled for repetitive use. This article reviews the present status of lead/acid batteries in Japan, and presents a future outlook for them.

Automotive lead/acid batteries

In 1982, automotive batteries accounted for 83% of the lead used in the total manufacture of lead/acid batteries (~ 213 000 tons) in Japan.

The major problems presently associated with automotive batteries are two-fold. The first is how to optimize the battery design to meet the two substantially different requirements, namely, cold cranking performance and reserve capacity. The second problem is the selection of Ca alloy, low Sb alloy, or their hybrid, to make the batteries maintenance-free. Regarding the first problem, it is becoming increasingly difficult to design an automotive battery compatible with the above two different requirements within the limits of ever-decreasing volume and weight. In the selection of the alloys, Ca alloy is widely used in the United States, but low Sb alloy is dominant in Europe. In Japan, both alloys are used almost equally. As is well known, Ca alloy is advantageous for low self-discharge and low water loss, but low Sb alloy is beneficial for deep discharge life. Therefore, one suggestion could be to provide and install two different batteries in an

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automobile; one would use Ca alloy and be designed exclusively for cranking, and the other would use low Sb alloy and be designed solely to meet reserve capacity requirements. In this case, the battery for cranking should, of course, be installed near the engine for less voltage loss, but the battery for the reserve capacity could be installed anywhere in the automobile where the space is best utilized.

Lead/acid traction batteries

Production of fork-lift trucks in Japan showed a maximum annual production of 102 000 vehicles in 1980, but in 1982 this declined to 75 000 vehicles [1]. In plants and warehouses which have been the best market for fork-lift trucks, so-called rationalization is going on, whereby longer conveyor lines are more often applied in plants, and automatic transportation systems using robots are increasingly employed in warehouses. These developments will reduce market opportunities for fork-lift trucks as a whole. Nevertheless, the proportion of battery-powered fork-lift trucks has been increasing steadily, *i.e.*, 8% in 1965, 16% in 1975 and 21% in 1982 [1]. Trends indicate that the figure will eventually reach as high as 40 - 50%, which is comparable with that in Europe at present.

The well-appreciated advantages of a battery-powered fork-lift truck, such as low breakdown rate, low noise, no emission gases and easy operation, will further increase their share of the market. Thus, an increase in battery demand for fork-lift trucks can only be achieved by replacing engine-powered fork-lift trucks with battery powered trucks. An increase in the volume efficiency (W h l^{-1}) of the battery, coupled with maintenance-free operation, is believed to be the key to realizing the above replacement. At present, reduction in maintenance has already been achieved by the use of the so-called one-shot watering device, which tops up a set of batteries in a fork-lift truck within a few minutes [2]. There are also devices available that display both the specific gravity and the level of the battery electrolyte

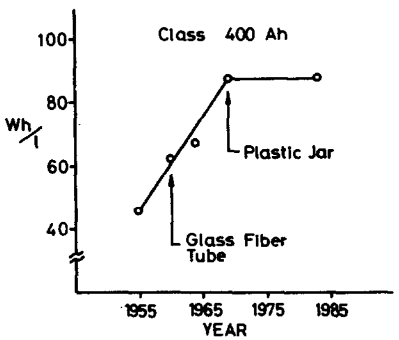

Fig. 1. Development of volume efficiency (W h l^{-1}) of traction batteries in Japan (data based on Yuasa Battery Catalogues).

on the instrument panel in front of the truck operator [3]. Therefore, most effort will be concentrated on the improvement of the volume efficiency. The improvements gained in the volume efficiency of traction batteries in Japan is shown in Fig. 1. In this respect, technical innovations such as glass-fiber tubes and plastic jars have made major contributions, but further gains in the last ten years have been almost nil. Use of an unusually dense electrolyte coupled with a new alloy grid to minimize the inevitable decrease in battery life, as well as further development of the active material, may raise the present 90 W h l^{-1} to a higher value in the future. With such a high energy battery, a method to prevent over-heating during charging must also be considered.

Lead/acid stand-by batteries

The recent trend for electronic devices to become more sophisticated and smaller inevitably reduces their power requirements and thus allows the use of smaller batteries. For this reason, the so-called "sealed" lead/acid batteries have found a wider market and as a consequence larger versions have been introduced. In 1983, such batteries ranged from 0.6 to 150 A h, compared with 1.2 - 36 A h in 1980. Even larger versions will appear in the near future. The present sealed lead/acid battery uses Ca alloy grids and either a mat-like retainer to absorb electrolyte or a gelled electrolyte. The maximum size of battery which can use this type of construction has still to be determined.

In Japan, conventional lead/acid stand-by batteries mostly use pasted plates or tubular plates with antimonial alloy grids or spines. Sealed systems using Ca alloy grids have been recently manufactured in small quantity, and there are very few batteries manufactured with Planté plates. For conventional batteries up to 2400 A h, catalyst plugs are available for gas recombination to make them virtually maintenance-free, and about 80% of the batteries are shipped with these plugs. Batteries with these plugs can generally be used for around five years without the need for water addition. Conventional batteries are also available up to 8010 A h as so-called tank cells, and are mainly used as a back-up or emergency power supply in telecommunication installations or as a stand-by supply in power stations. However, there are no catalyst plugs available for these batteries and the development of such devices is urgently needed. Success here will depend primarily on the safety measure to be incorporated in the big catalyst plug.

To ease the maintenance required by these stand-by batteries, there is also a set of measurement devices [4] that remotely monitor the specific gravity, level, and temperature of the cell electrolyte using optical, multi-electrode and silicon temperature sensors, respectively. With such aids, stand-by batteries can practically be made maintenance-free.

Conclusion

The present status of lead/acid batteries in Japan has been described together with comments on the future prospects for their technologies. With appropriate technological developments, coupled with relevant product improvements, the lead/acid battery is expected to continue to grow in demand.

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