DARAMIC®

Technical Bulletin

Topic: DARAK Separator for Gel Batteries

1. Introduction

Valve regulated lead acid batteries (VRLA) are commonly used for stationary applications, such as telecom, computer backup and solar batteries and for traction applications, such as floor sweepers, advanced guided vehicles, and wheel chairs.

The electrolyte in VRLA batteries is immobilized in order to create gas channels for the migration of oxygen from the positive to negative plate. The electrolyte can be immobilized by means of two different technologies: a highly porous absorptive glass mat (AGM battery) or by adding fumed silica to the acid and thereby forming a gelled electrolyte (gel battery).

Comparing both systems, gel batteries have advantages over AGM batteries in applications which require deep/frequent cycling and long service life, and when exposed to high temperatures.

This technical bulletin covers separators for gel batteries, which must meet special requirements due to the specific battery technology.

2. Separator Requirements

Reliability and long life are required for traction and stationary batteries. Accordingly, battery separators for these applications must meet strict requirements. The separator must also fit into an environment characterized by the immobilized electrolyte.

2.1 Acid Displacement

Gel batteries experience an initial, small amount a water loss which forms cracks in the gel. These cracks allows oxygen transfer to the negative electrode. The addition of silica and the formation of cracks reduces available acid. Therefore, separators with low acid displacement are desirable to avoid further limitation of the available acid. Acid displacement of separators is determined by porosity and geometry (i.e. backweb thickness, overall thickness and profile design).

2.2 Electrical Resistance

Compared to flooded and AGM batteries, electrolyte immobilization increases the internal electrical resistance of gel batteries. Therefore the electrical resistance of a separator should be as small as possible and is determined by porosity, wettability and geometry.

2.3 Porosity

High porosity in a separator is a key factor to achieve low electrical resistance and reduced acid displacement.

2.4 Pore Size

The pores of battery separators should be small enough to prevent lead particles from penetrating through the separator and causing short circuits. Preferably, the average pore size and the largest pores should be below 1 micron.

2.5 Acid and Oxidation Stability

Separators in industrial VRLA batteries are exposed to an aggressive environment for a long time. Some stationary cells have a service life of up to 20 years. Therefore, the separator must be stable against acid and oxidation.

2.6 Contamination

Separators must not release substances which are harmful to the battery, i.e. cause corrosion or undesirable effects on the electrode reactions. For example, chlorine can be converted into perchlorate which causes pole and grid corrosion. Of course, such harmful contaminations are most critical for batteries with long service life and/or operated under harsh conditions.

2.7 Handling/Processing

It goes without saying that separators must be easy to handle and thereby contribute to an effective battery production process. A critical parameter in gel batteries is the homogeneous distribution of the gel without voids or bubbles. This remains a challenge, as the mixture of silica and acid is thixotropic, i.e. its viscosity increases when not agitated. Therefore separators with ribs on both sides are preferred for gel batteries.

2.8 Environmental

With environmental considerations becoming increasingly important, separators should not pose issues for battery recycling.

3. DARAK Separators for Gel Batteries

DARAK separators have been the preferred separator for gel batteries for more than 30 years, which proves their reliability and performance and the confidence of the industry.

3.1 DARAK Key Properties

Table 1 shows the key parameters of DARAK separators. DARAK is available in four different backweb thicknesses, as designated by a four-digit code.

Attributes	DARAK 2003	DARAK 2000	DARAK 5005	DARAK 5000
Overall Thickness (mm)	2.0	2.0	2.0	2.0
Backweb	0.35	0.4	0.5	0.6
Porosity (%)	70	70	70	70
Average Pore Size (µm)	0.5	0.5	0.5	0.5
Maximum Pore Size (µm)	< 1	< 1	< 1	< 1
Acid Displacement (ml/m^2)	180	190	220	240
Electrical Resistance* (Ωcm^2)	0.08	0.09	0.10	0.12

*Measured after 2 h soaking in acid at 25 °C

Table 1: Key Properties of DARAK Separators

DARAK separators are manufactured by using an aqueous solution of a modified phenolic resin, carried by a fleece and is polymerized by means of heat. With progressive curing, the water solubility of the phenolic resin decreases and a phase separation occurs. Finally, the resin crosslinks in a three-dimensional microporous structure and the water is dried off.

This results in a highly porous battery separator with excellent mechanical and chemical stability. It is worth mentioning that DARAK – opposite to other separators - is also stable against the addition of phosphoric acid, which may be added to the electrolyte for longer battery cycle life. This outstanding stability allows for the use of thin backwebs, which translates again into a very favorable electrical resistance and acid displacement.

Not only is the average pore diameter of DARAK below 1 micron, it has also an unrivaled narrow pore size distribution as illustrated in fig. 1. Ninety percent of all pores are within the range of 0.3 and 0.8 micron, and virtually no pores exceed 1 micron. Therefore, DARAK separators minimize the risk of shorts by the penetration of lead and lead dioxide particles through the separator.

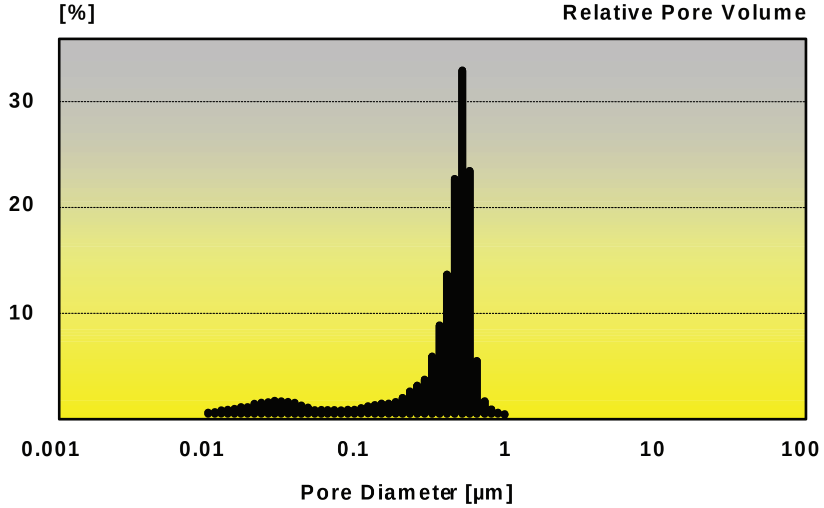

Figure 1: Pore Diameter Distribution of DARAK Separators

In addition, DARAK separators do not contain additives or substances which are harmful to the battery or pose issues for battery recycling.

3.2 Dimensions

DARAK separators are available with and without glass mat and can be supplied in various sizes as noted in table 2. Other sizes may be available upon request.

	DARAK 2003	DARAK 2000	DARAK 5005	DARAK 5000
Backweb Thickness (mm)	0.35	0.40	0.50	0.60
Height (mm)	87-1250	87-1250	87-1250	87-1250
Width (mm)	65-800	65-800	65-800	65-800
Overall Thickness (mm)	0.65-3.10	0.70-3.15	0.80-3.25	0.90-4.15
Thickness with Glass Mat 04 (mm)	1.20-3.35	1.25-3.40	1.35-3.50	1.45-4.40
Thickness with Glass Mat 06 (mm)	1.40-3.55	1.45-3.60	1.55-3.70	1.65-4.60
Thickness with Glass Mat 08 (mm)	1.60-3.75	1.65-3.80	1.75-3.90	1.85-4.80

Table 2: DARAK Separator Size Range