Table 18.3 Continuation of Table 18.2. Different product groups of lead acid batteries are classified with respect to the different classes as defined in Section 18.3.2 (● optimum, ○ acceptable) table from Reference [9]

Type of battery	Class 1	Class 2	Class 3	Class 4
SLI	–	–	–	–
Stationary	●	●	○	–
Traction	–	○	●	●
Electric vehicle	–	○	●	●
"Solar battery" (from SLI)	●	○	–	–
VRLA	●	●	●	○
Flooded	●	●	●	●

The differences in the operating conditions and the requirements listed in Table 18.2 show clearly that one "solar battery" cannot exist. The range of operating conditions in autonomous power supply systems is very large and requires appropriate individual solutions.

An additional parameter for differentiating the operating conditions of batteries is the amount of capacity throughput caused by an AC ripple. Loads and generators are connected to the battery at the same time. This results, in many cases, in so-called microcycles in which the battery current changes from charging to discharging and vice versa with a frequency between 1 and 300 Hz. Measurements and calculation have shown that this can cause an additional capacity throughput of up to 30%. This in fact shortens the lifetime of the batteries. Taking into account the optimum operating strategies, battery ageing is related strongly to the capacity throughput. The amount of this additional capacity throughput depends very much on the system's sizing and the electrical properties of the loads, the inverters, the converters and the generators [10].

18.4 SECONDARY ELECTROCHEMICAL ACCUMULATORS WITH INTERNAL STORAGE

18.4.1 Overview

There are several secondary electrochemical accumulators available on the market. They differ in parameters concerning the materials of the electrodes and the electrolyte. This results in different electrical properties like energy and power density, efficiency, lifetime, cycle life, operation temperature, inner resistance and self-discharge and last but not the least economic properties like battery costs and maintenance requirements.

Products like lead acid batteries, $ZnBr_2$, NiCd, NiFe, NiZn, nickel-metal hydride (NiMH), Zn-air, Li-ion, Li-polymer, Li-metal and rechargeable alkali mangan (RAM) are available. They operate at room temperature, but also high-temperature batteries like NaS and $NaNiCl_2$ ("ZEBRA") operating at 300 to 350°C are possible. In addition, there are capacitors storing the energy in an electrostatic field instead of chemical bonds out of which the double-layer capacitors are the most interesting for autonomous power supply systems.