(charge factors of approximately 1.2), frequent overcharging and frequent full discharges are necessary to achieve long lifetimes.

A number of factors are responsible for the high reliability and the very long lifetime of NiCd batteries: the design is mechanically very robust, the cells are not easily damaged by incorrect technical handling, such as inverse charging, overcharging and long idling periods at medium or low states of charge and the reactants involved are not very corrosive with regard to the electrodes and other components in the cell.

One drawback is the so-called memory effect, which occurs under some operating conditions. This term is used to describe the tendency of the battery to adapt its electrical properties to the cycling conditions in which it has been operated over a long period of time. This means that a battery that is cycled over prolonged periods up to a certain DOD, tends to limit discharging to this DOD even if a higher discharge at high discharge current is planned. This effect can be resolved by discharging the battery several times with a low current. In modern NiCd batteries, this effect is not very pronounced any more.

Despite the good electrical properties, the market share of NiCd batteries in autonomous power supply systems is not very high due to the high costs. Investment costs for NiCd batteries are round about a factor of 3 higher than lead acid batteries.

18.4.3 Nickel-metal Hydride (NiMH) Batteries

The active material of the positive electrodes of a nickel-metal hydride (NiMeH or NiMH) battery in its charged state is NiOOH, the same material as in a NiCd battery. The negative active material in the charged state is hydrogen, a component of a metal hydride. The metal alloy is subjected to a reversible absorption/desorption process during charge and discharge of the cell. The reaction for the reversible charge/discharge process is indicated below [11].

$$NiOOH + MH \rightleftarrows Ni(OH)_2 + M \tag{18.2}$$

An aqueous solution of potassium hydroxide is the main component of the electrolyte. Only a small amount of electrolyte is used in sealed nickel-metal hydride cells, most of which is absorbed in the separator and the electrodes. In the cell, oxygen can be transported from the positive to the negative electrode and can recombine there with hydrogen to form water. Thus, the cells can be used like dry cells and can also be installed in any desired position.

The discharge characteristics of sealed nickel-metal hydride cells are very similar to those of sealed NiCd cells. The open-circuit voltage is between 1.25 and 1.35 V/cell, and the nominal voltage is also 1.2 V.

The electrical characteristics are quite similar to NiCd batteries even though their energy efficiency is about 80 to 90% and the maximum power available is less than that in NiCd batteries. The latter is of little relevance in autonomous power supply systems. Memory effects are less pronounced than in NiCd batteries. Self-discharge at 25°C is also in the range of 20%/month, but at 45°C it is as high as 60%/month.

Nickel-metal hydride batteries are not as robust against polarity reversal as NiCd batteries. If the positive electrode gains a negative potential, hydrogen is generated at