DRYFIT BATTERIES

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In 1957 our Development and Research Division was given the task of making a special type of battery suited to the special needs of modern transistor techniques. These power sources were to be accumulators, retaining the numerous advantages of conventional lead storage batteries. However, at the same time certain disadvantages which had previously accompanied these advantages had to be eliminated.

A good starting point for the solution of the self imposed problem was our fairly long experience in designing, production and use of our spill-proof miniature accumulators. As a matter of fact, they have been used now for more than 15 years as reliable and robust D. C. power sources for portable equipment.

After intensive work, our Research Division displayed in the same year a sensational small dry accumulator :

Its power ratio per weight and volume had been considerably increased.

Its rate of self-discharge had been reduced to such an extent that several months of maintenance-free storage could be allowed.

The accumulator was dry, i. e. the acid was stabilized so that the battery could be used in any possible position.

No necessity to top up with water.

The battery was called dryfit, a name which truly describes its features :

dry and always fit, i. e. ready for use.

We are proud to say, who are in active collaboration with M/s. Accumulatorenfabrik Sonnenschein, since 1962 are in a position to introduce the various ranges of highly specilised Dry Charged Photo Flash and dryfit batteries in India. The main purpose of its introduction in India is to cut-down the imports of various other type of accumulators. Such as Ni-Cd, Silver, Zinc and other types of alkaline cells. Dryfit batteries are capable of replacing Ni-Cd and other type of batteries. Dryfit batteries really are which claim to combine the advantages of conventional lead accumulators with those of popular dry cells.

Dryfit batteries remain novel accumulators although millions of them provide their excellent performance every day around the world.

CONSTRUCTION :

Containers and covers are of high quality plastic material for saving weight and volume.

The one-piece cover is tightly sealed to the container.

Valves

Each single cell has a soldered-in electrolyte-proof valve which protects the interior of the battery against atmospheric influences. Its further purpose is to relieve gas pressure being possibly produced during service.

Plates

The positive and negative plates are of the grid type. On account of a very special alloy, shelf life of the battery is considerably increased.

The active negative material consists of pure porous metallic lead.

The positive active material, however, consists of lead oxide with fourfold positive charged lead atoms.

Only refined lead with a purity of 99,99% is used on the production of both active materials. The contents of sulphate are limited to less than 2% in the negative, and less than 5% in the positive material.

Separators

Special glass fibre separators avoid short circuits even from sediment. Due to their chemical and electrical stability, the dryfit battery resists perfectly high mechanical influences and allows peak currents and a low discharge rate as well.

Acid

For filling only chemically pure sulphuric acid especially diluted and prepared—to attach it to the plates — is being used.

Terminals

All exterior terminals are of silver in order to exclude corrosion and to assure good permanent contact.

FEATURES :

Dryfit batteries are ideal D. C. power sources for all portable equipment.

Independent of position

Dryfit batteries can be transported, stored charged and discharged in any desired position, without any reserve, even upside down.

This has mainly been achieved by solidifying the acid and attaching it to the plates by a special production process.

This acid never needs being topped up with water or other chemicals. There is sufficient water reserve for the full lifetime to assure a sufficiently conductive electrolyte at a permissible specific gravity of the remaining acid.

Overcharge ability

First of all some general remarks.

Recharging beyond storage ability of the battery is not only useless, but can even be detrimental. Battery capacity will not be increased.

Apart from any possible defects to the plates, an overcharge, i. e. a charge exceeding the accumulation capacity of the battery will mainly result in a loss of water. Although there is no direct danger, because the valve will automatically relieve excessively high pressure, overcharging should be avoided in the interest of the battery's service life.

The overcharge ability of the dryfit batteries has been determined as a value corresponding 9 times the nominal capacity. For example, a 7.5 Ah battery only becomes useless—due to electrolytical overstrain—after being overcharged with about 68 Ah. However, it does not matter whether the overcharge is the result of a single charge of the given value or of a corresponding number of lower rated overchargings.

Loss of water occurs through electrolytic dissociation of the water, i. e. the gassing as a result of the high charging voltage which usually is required to obtain full charge. Electrolysis occurs gradually at a charging voltage of about 2.35 Volts per cell. Above 2.5 V/cell gassing is vigorous. Since our charging systems switch off or over at 2.47 V/cell (0.03 V) the amount of released gas is negligibly small.

Gassing

The possibly released gas—hydrogen and oxygen—is not corrossive at all. Therefore the battery can be kept in the set during recharge.

Self discharge (shelf life)

Self discharge, as a chemical reaction, is largely influenced by the ambient temperature. Due to the special lead alloy, the rate of self discharge of dryfit batteries is kept so small that significant loss of capacity only occurs after several months. Dryfit Batteries are therefore very suitable for those applications where only occasional discharges or at low rates occur.

The battery should be recharged when capacity dropped to about 50% by self discharge which, becomes the case only after about 15 months at + 20°C or +68°F.

Should, however, service life under cycling be expected, recharge for freshing up capacity to be done.

Deep discharge resistance

A deep discharge is a discharge exceeding the effective capacity of the battery, and ending at a voltage below that indicated for different rates. A deep discharge generally terminates the life of a normal battery because the plates sulphate and the electrolyte becomes non-conductive. A dryfit battery will keep its charging ability for a certain time. The battery should, however, immediately be recharged after having observed that accident.

Capacity

The determination of the nominal capacity is done in accordance with DIN (Deutsche Industrie Norm = German Industrial Standard). Capacity is

measured at an ambient temperature of +20°C = 68°F. The current used for this test equals

$$\frac{\text{nominal capacity}}{20\ \text{h}} = \text{A (or MA)}$$

The abbreviation J_{20} used hereunder stands for the 20 hour current.

Voltage characteristics

Due to a very favourable internal resistance, dryfit batteries can also be discharged under extreme high current.

The stability of the voltage during discharge is remarkable and compares very favourably with that of other systems. The voltage difference between full charge and permissible final discharge voltage is about 0.25 Volts per cell or approx. 0.75 V for a 6 Volt battery at $1 \times J_{20}$.

Final discharge voltage

Permissible final voltage always depends on the intensity of the discharge current. For the 20 hour discharge ($1 \times J_{20}$) it is 1.75 V/cell and the multiple thereof.

Low temperature effect

Due to the slowed down chemical reaction some reduction in available capacity is unavoidable. But here again the lead acid battery and specially the dryfit accumulator show very good performances.

There is a further dryfit advantage:

A DRYFIT BATTERY NEVER FREEZES EVEN IF DISCHARGED

This is due to the solidified electrolyte which does not allow formation of compact ice.

Trickle or float charge

Traditional batteries require a permanent charge at low rate to equalize self discharge and to keep the battery always fully charged. On account of the negligible self discharge of dryfit battery's in most cases there is no necessity for trickling or floating. If, however, some special conditions require a continuous charge, then we recommend the float system at constant voltage of 2.2 V/cell.

SUMMARY

To recapitulate

The Dryfit battery is a truly new sort of accumulator. It requires no maintenance apart from recharging, since topping up with distilled water is necessary.

Electrolyte proof valves replace the vents usually found in conventional batteries, and allow the escape of gas caused by possible overcharging. Overchargings, however, should be avoided in the interest of battery longevity.

Normal charges have characteristics which do not completely meet our requirements. Complete charging is achieved through the use of a charging voltage which greately exceeds the battery gassing voltage. This is usual for conventional batteries and not of great importance since the water lost through electrolysis can be replaced by topping up.

It is our opinion, however, that a battery requiring no maintenance is only half the solution to the problem, as long as the user through using a conventional charger is not relieved of the need to watch charging process.

We have given a great deal of thought as to how charging can be controlled and terminated automatically at full charge.

We have found some electronic systems which do this work properly, so that recharge too corresponds fully with modern people's requirements.

The dryfit changes function automatically through a transistorized charging switch. Control devices and mechanical contacts are eliminated. It achieves an optimum charging characteristic through electronic control.

It is a variable system which can be adopted to mostly all requirements of battery operation i. e. switching off the charging process while a small trickle current of about 0.5 mA per Ah battery capacity continues to flow or switching over to a float charge with constant voltage.

CHARGING PROCEDURE

This all—transistor system works on the following principles:

It takes account of the rising charging voltages of the accumulator to control the charging current. However, two electrical criteria are taken into account to switch off the charging current or

to switch over to a constant float charge voltage. Both have to be satisfied before the system reacts. The set therefore controls itself.

—The first criterion is that a predetermined charging voltage of 2.47 volts/cell (+0.03 volts) has to be reached.

—The second is that the charging current must drop below a predetermined low value, which is just capable of producing a charging voltage of 2.47 volts per cell.

Just reaching a certain charging potential does not indicate the real state of charge since the charging potential is decisively influenced by the value of the charging current. Charging of the battery can only be complete with certainty when charging current falls to a predetermined low value, which, as a function of the nominal capacity of the battery, is just sufficient to produce the critical potential of 2.47 volts/cell.

During the initial 4 hours charging proceeds with an uncontrolled current of about 350 mA. The current decreases slowly, due to the increasing counter e. m. f. of the battery only. The battery charging voltage increases very sharply and, after about 4 hours, reaches a value of approx. 6.9 volts [2.3 volts/cell]. The capacity increases linearly and already after this time has reached about 60% of its nominal value.

Now, a remarkable decrease of the charging current occurs, since the Zener diode in the charging circuit approaches its turn-over point.

After further 5 hours the battery charging voltage has nearly reached the nominal voltage of the Zener diode. The further rise in voltage occurs slowly and the prescribed value of 2.37 volts/cell or 7.4 volts for three cell battery is already reached after a total time of approx. 9 hours charging.

During the following 2½ hours the charging current has fallen continuously. It has reached the predetermined low switch off/over value of about 13 mA at which the required charging voltage of 2.47 volts/cell can just but safely be produced. Now the second criterion is also satisfied. The charger cuts off. A trickle current continues to flow, being limited to about 0.5 mA per Ah by a high ohmic resistor.

Shortening the charging time

The charging time of about 11½ hours may be shortened by increasing the uncontrolled charging current during the initial 4 hours. This, however, is only possible within certain limits. The permissible doubling of the current at the beginning of charging shortens those 4 hours by approx. 50%, i. e. from 4 hours to 2 hours. This relatively small saving in charging time with doubled current is due to the fact that during the controlled charging phase the current falls as the battery voltage increase and the two electrical criteria have to be met. These criteria are time dependent since a complete charge requires that even the innermost parts of the plates take part in the electro-chemical process. In addition it should be noted that the time elapsing–between reaching a cell voltage of 2.47 volts and the current falling to a predetermined low value depends to a large extent on the age and general condition of the battery.