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Batteries from Widex

Summary

As initiator of an up-to-date IEC standard for hearing aid batteries Widex has decided to market a *full performance* Widex battery. This battery meets the coming standards for effective battery life in standard as well as high power tests, eliminating the need to choose between standard batteries and high power batteries. To ensure optimum performance and avoid premature activation of battery alarms, modern digital hearing aids require a constant high working voltage of well above 1.1 V, even at peak loads. Only few batteries are able to meet this requirement under all conditions. Another requirement is optimum performance as soon as the label is removed. Traditionally the focus has been on theoretic battery life. Widex focuses on effective battery life, which also takes into consideration usage and climate. Some batteries have proven to become unstable when exposed to the more realistic and demanding loading necessary to measure effective lifetime. Reliable and leak-free batteries are required to avoid unnecessary troubleshooting and mechanical damage. A Widex *full performance* battery is characterised by effective capacity utilisation in all conditions. This gives optimum battery life for high power instruments as well as for less powerful instruments which are maybe worn for just a couple of hours a day. Widex will continue to influence the development of batteries so that they are continuously adapted to meet the demands of modern and audiologically sophisticated hearing aids.

Background

With the appearance of digital hearing aids, it has become increasingly clear that a battery is not just any battery. Digital technology places new and still heavier demands on battery performance. Confronted with this situation, Widex and the other Danish hearing aid manufacturers initiated a project in 1997 aimed at redefining battery performance specifications[1]. At that time, the entire hearing aid industry agreed that the existing IEC standard does not reflect modern hearing aids' demands on batteries.

The co-operation has resulted in a joint Danish proposal for a new standard for hearing aid batteries[2]. The proposed standard differs from the existing standard in several respects. A major difference is that the end point has been changed to 1.1 volts. The present voltage of 0.9 volt is too low to ensure proper operation for the majority of hearing aids. Regarding digital hearing aids a voltage of between 1.05 and 1.10 volts will activate the "reset"- or "power down" function and consequently the battery alarm. This means that the lifetime of the batteries will in practice be limited to the point on the curves (fig. 1 and 2) where the voltage during a realistic pulse load drops below approx. 1.10 volts.

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[1] *Toft, Ole: New standard proposal for battery testing procedures – Background. (1999).*
[2] *Toft, Ole: The final Danish test load proposal – Background (from Oticon, GN ReSound and Widex). (2001).*

Also the different test currents have been drastically changed, and separate test profiles have been established for standard and high power (HP) batteries of the different types. Load currents are now composed of *background and pulse current*[3] . The pulse load is applied regularly during the entire discharging sequence. The constant average current used as background load ensures a test sequence that corresponds exactly to the lower limit of an acceptable battery lifetime. This limit is fixed at 100 hours for standard cells and 50 hours for HP cells. The pulse currents that test the battery performance during peak loads have been established as an acceptable compromise between the demands of the hearing aids and the limitations of battery technology[4] . There is a long way from a proposal to an adopted IEC standard, but the Danish proposal is gaining foothold as a market standard (de facto standard). Most battery manufacturers have started using the proposal when carrying out tests. In connection with the project, Widex developed a measuring system[5] for testing batteries according to the proposal. The system is now being used by our colleagues in the industry, at test laboratories and by several leading battery manufacturers.

Widex' initiative has undoubtedly contributed in a positive way to development in the hearing aid battery business, but a new measuring standard alone does not mean that all batteries will be perfect in future. Actually, the quality level is perceived as more fluctuating than before. A reason for this could be that the manufacturers now experiment more with the construction and chemistry of the batteries than before. Another likely reason is that the number of batteries that fail in tests is higher due to the more stringent requirements.

"Full Performance" – Widex batteries

Based on this, Widex has decided to market batteries in its own name. The decision allows us to choose the battery on the market that meets as many of the demands of modern hearing aids as possible. The Widex batteries will be subjected to our thorough quality control to ensure a consistently high quality level.

To avoid any confusion around standard and HP batteries, we have chosen a full performance battery representing the best compromise between maximum *reliability*, *leak-free operation*, *high working voltage* and a *long effective life (capacity)*.

A "full performance" battery is characterised by having an acceptable capacity combined with good HP properties. This combination is very important as it is often extremely difficult to determine whether a hearing aid user can use a standard battery or should use an HP battery type. Standard cells have the highest capacity but their working voltage often dips so violently at peak loads that distortion or premature activation of the low battery alarm occurs. Real HP type batteries normally have such a low capacity that users with a more moderate hearing loss find the battery lifetime unacceptably short.

Another advantage of a "full performance" battery is that the users avoid problems if their hearing aids are later supplemented with an accessory such as a Micro-Link FM receiver, which is also powered by the hearing aid battery.

Reliability

A battery of "maximum reliability" must, according to our terminology, be a battery you can rely upon. Far too often we have received complaints about hearing aids where the problem turned out to be insufficient battery voltage / capacity. There have also been instances where batteries showed periodic failure. In most cases, the batteries have been of well-known brands and with an expiry date that was still well in the future.

Our trust in the chosen battery is based on many years of regular performance tests. We also make sure that the manufacturer does not change the product without prior warning and a new evaluation. Furthermore, the parties have agreed that Widex can return the batches that do not meet the agreed specifications.

Leakage

Battery leakage is a serious matter, as potassium hydroxide is highly aggressive. A leaking battery will usually stop working after just a short while and even minor leaks can ruin vital parts of a hearing aid. The most common cause of battery leakage is a very humid environment combined with a cell type with an inadequate safety margin. Leakage can also occur if a standard cell has to supply high current. A very high capacity will generally imply a smaller safety margin. This is due to the fact that the capacity of a zinc-air cell is exclusively determined by the amount of zinc in the cell. The safety margin, however, is related to the residual cell volume, i.e. the free space required by the zinc powder to expand during the oxidation process. An HP cell needs a higher residual volume for expansion as the higher load current gives increased oxidation. This also explains why an HP cell has a smaller capacity.

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[3] *Toft, Ole: Test load profile. (2001).*

[4] *Kristensen, Allan G. & Daugaard, Carsten: Delta Acoustics & Vibration, Technical note: In-Situ measurements on hearing aid current consumption.(1999)*

[5] *Toft, Ole: User's manual for Widex battery test system (5th Edition). (2000)*

Working voltage

A high and stable working voltage helps ensure that sophisticated hearing aids are used optimally. In a digital hearing aid, the gain (amplification) and max. output depend directly on the battery voltage. A gain variation of max. 1.5 dB can therefore occur depending on the existing battery voltage. As regards powerful and especially analog hearing aids, a lower working voltage will also result in reduced dynamics and increased distortion. The greatest drawback of a low battery voltage, however, is that it increases the risk of failure (i.e. the aid becomes silent) and/or activated battery alarms in critical situations.

Capacity

Traditionally, the primary competitive parameter among battery manufacturers has been to achieve the highest capacity on the market. This is understandable as a high capacity means a long battery life. Unfortunately, the method for measuring battery capacity is still based on the existing IEC standard, which all batteries can comply with. The relatively small load currents mean that the capacity data obtained are very optimistic. The capacity that is effectively available to the hearing aid users is generally only a fraction of the nominal capacity. The utilisation rate is usually somewhere between 75% and 90%, but even lower values are seen with very powerful instruments.

The difference between determining battery capacity according to the existing IEC standard and the Danish proposal for a revised IEC standard is best illustrated by a couple of test results. In both cases, a comparison is made between the average discharge curves for Widex type 13 cells and that for one of the corresponding cell types on the market that has the highest nominal capacity. The curves shown represent the 50% quartile for 8 cells and the daily test time was 16 hours.

The first figure (fig. 1) shows the discharge curves when only background current is used. This corresponds to measuring the capacity according to the existing IEC standard, except that we use a higher load (3 mA). It can be seen that the Widex cells have a significantly higher voltage level but a slightly lower capacity. The capacity is found where the curves cross the 1.1 volt line. The result is 228 mAh for the Widex batteries and 264 mAh for the competing battery. According to this measuring method, the Widex cells only have a 86% capacity compared to the competing battery.

The next figure (fig. 2) shows similar curves, where the more realistic pulse current is used. The load is now in accordance with the Danish proposal for an IEC standard for type 13 HP cells. It will appear that both curves cross the 1.1 volt line at approx. 220 mAh. However, it should be pointed out that the competing battery temporarily dips to below 1.1 volts after discharge of approx. 8mAh. This means that the user will experience failure and/or battery alarm after just 2 – 3 hours of use and probably replace the battery. Imagine the following situation: A hearing aid user changes battery/batteries to be well prepared before going to the theater or the like. In the middle of the performance the battery stops working, and then where are the spare batteries?

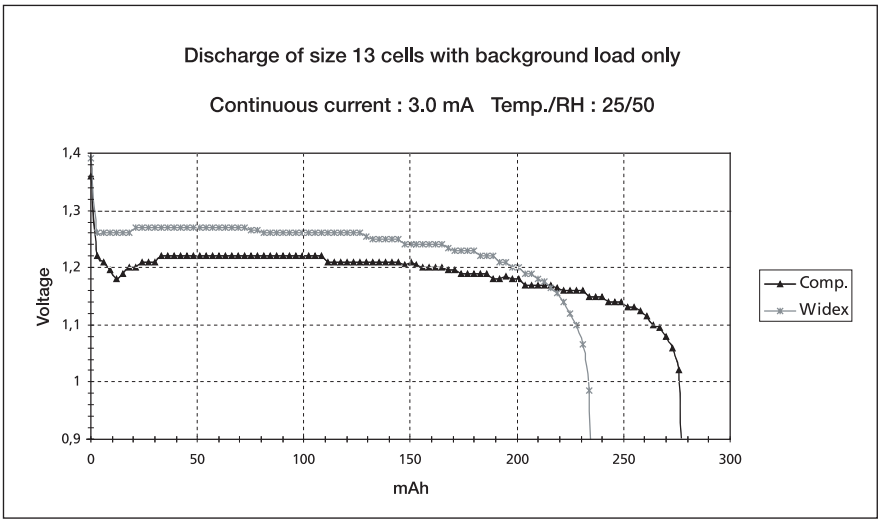

Figure 1. Temp / RH: Temperature in degrees Centigrade. RH = Relative Humidity in %

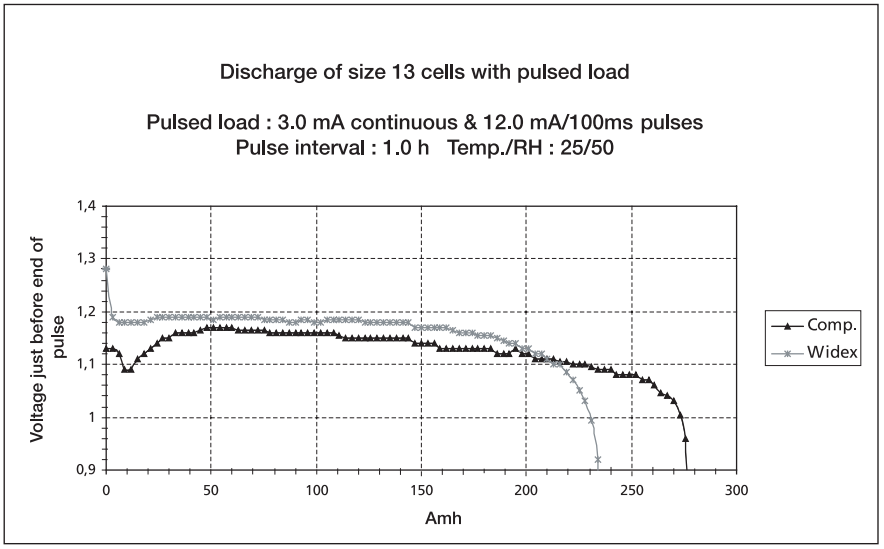

Figure 2.

Usage and environment

It is the *effective capacity*, and thus the practical service life in the current sound environments, that counts. However, the effective capacity also depends on usage and the climatic conditions you are in. A battery life of approx. 14 days usually means that 90% of the original capacity is utilised. If the hearing aid is only used for a couple of hours a day, extending the battery life to approx. 4 weeks, the effective capacity typically falls to approx. 40%. The figures from a corresponding test of the Widex batteries were 98% (2 weeks) and 85% (4 weeks), respectively.

One of the reasons for capacity loss is that the cells during passive oxidation build up an unintended passivating layer (zinc-oxide) which increases the inner resistance resulting in voltage loss. Another reason is that if the battery life is extended due to reduced daily use, the environmental impact on the cells increases. This can result in drying up or absorption of moisture depending on the climatic conditions surrounding the cells. In both cases, the cells will gradually stop working, but accumulation of moisture in the cells moreover increases the risk of leakage. The Widex batteries show no signs of leakage problems when tested in an extreme test climate (30° C and 90% RH). This test climate corresponds to the conditions found, for example, in the Far East, where a high temperature is often combined with an extremely high relative humidity (RH).

The other extreme, i.e. a very dry climate, is found in, for example, Finland. There, the relative humidity can sometimes be as low as 10 – 30%, which makes most batteries dry out and shortens their lifetime. The actual climatic conditions to which the batteries are exposed are not, however, always easy to predict nor are they always directly dependent on the geographic conditions[6]. In cold climates one would typically use some kind of headgear to keep warm, in which case both the temperature and humidity around the ears and hearing aids would be affected. In very warm climates, air-conditioning is used, effectively lowering temperature and relative humidity.

Activating time

Finally, it is important to observe the battery characteristics immediately after activation, i.e. removal of the battery sealing label. A long activating time results in increased distortion, failure or battery alarm signal immediately after a change of batteries. This will confuse the user, who may consider it necessary to discard one battery after another. If the next batteries are not better, the user will probably complain about the hearing aid. Widex finds it very important that our batteries have a *short activating time*.

Widex – the complete solution

Widex batteries are a result of many years of research and development by the manufacturer. To this can be added the long co-operation between Widex and the manufacturer to specify battery requirements and relevant test procedures. This has resulted in a battery that meets as many of the different demands of modern, digital hearing aids as possible - without compromising qualities such as reliability and safety. These key requirements will still be essential in the ongoing inspection process ensuring a constant high quality level for the *full performance* batteries which are a part of the complete solution from Widex.

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[6] *Baily, Jean W. & Valente, Michael: Measurements Of Relative Humidity And Temperature In Hearing Aids. Hearing Journal (Oct. 1996).*

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