The Importance of Water Levelling for Aircraft Nickel-Cadmium Batteries

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Introduction:

- Nickel Cadmium Cells in Aircraft batteries consume water as a normal part of their activity.
- The amount of water consumed is a measure of the in-flight continuous charging of the battery[1].
- Bench tests have to be performed to determine if the water consumption is abnormal[2].
- The life of the battery is directly related to the maintenance that it receives.
- Testing intervals must be kept short to insure proper performance of the battery.

Water Consumption:

- When water is consumed beyond the levels given by the manufacturer of the battery, it is an indication that the battery must be serviced more frequently, there could be a problem with one or more cells or that there is a possible electrical problem in the aircraft (overcharging).
- If the battery is allowed to function with water levels below the minimum specified electrolyte level, then, in-flight battery overheating will be experienced. This in turn will contribute to an accelerated deterioration of the cell separator material and eventual cell failure.
- When cells are operated with less than the minimum required electrolyte level, the active area of the plates is reduced hence forcing current over a smaller area (higher current density) resulting in an overheating of individual cells or the entire battery.
- In extreme cases, this may result in a catastrophic in-flight failure (thermal runaway), a condition that requires that the battery be disconnected from the bus. Note that when a battery experiences an in-flight thermal runaway it will normally need to be replaced (new cells/new battery)[3].

Ground Service:

- When batteries are bench tested, distilled water is added at the end of the charge and the amount of water delivered is recorded for each of the cells.
- In the electrochemical process in the cells, water is absorbed by the plates during discharge and water is released during charge. It is for this reason that the only time when the electrolyte level can be tested and adjusted is at the end of the charge process (topping charge). Typically, when cells reach 1.6V or higher.
- If water is added at other than at full charge, there is the danger that spilling of electrolyte will take place when the battery does reach full charge. When the water evaporates, there will be a conductive white residue of Potassium Carbonate deposited over the cell top, links and posts giving a clear indication of overfilling.
- An exception to the when-to-add-water-rule is if a high cell voltage develops during charge (usually over 2V). This is an indication that the cell is “dry”. At this time, an injection of 5cc to 10cc will bring the cell voltages to normal levels and allow for testing to continue.
- It is also advised to initially dispense 5cc to 10cc on each cell for a battery that has a known history of high water consumption or if the battery has remained on the shelf for a prolonged period of time.
- Uneven water consumption can be an indication of cell imbalance, cell age and cell damage.
- Battery overheating during bench charging can be the result of low initial electrolyte levels.
- The CMM for each battery/cell provides the basic information of consumable water level as a guide to determine if the electrolyte loss is excessive.

[1] Water is decomposed when cells reach the gassing voltage (1.4V)
[2] Water level cannot be determined while the battery is in the aircraft. It must be removed and subjected to prescribed bench tests.
[3] Cells that have separator failure must be replaced. They cannot be repaired.

- It is for all of these reasons that measurement and recording of water levels during bench charging must be performed to obtain a more complete picture of the condition of the battery.

Summary:

- The life of the battery is directly related to the maintenance performed.
- Under normal use conditions, a properly maintained battery will last five years or better (with a few cell replacements).
- In contrast, an improperly maintained battery can easily fail in less than six months.
- Cost savings achieved by stretching battery testing are quickly surpassed by the cost of cell/battery replacements.
- Start with a test interval much shorter than recommended. If tests indicate that the battery is performing properly, then increase the testing interval until performance degrades (cell imbalance, water consumption, etc.). Shorten the interval somewhat and establish this as the test interval. Verify in subsequent cycles and adjust as needed.
