Tech Brief: Negative Pulse Charging Myths and Facts

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Negative pulse charging schemes have been proposed since the late 1960s and numerous patents have been filed and granted covering variations of the basic principles. Over the years, these schemes have made numerous claims including improving the charging efficiency of batteries, reducing recharge times, lowering battery temperature rise, achieving full recharge in very short times, as well as requiring shorter equalization cycles. Although these schemes have been with us for more than 30 years, there has been **no scientific conclusive evidence** to any of their claimed benefits as compared to standard constant current charging schemes.

The following table lists some of the common myths associated with negative pulse charging schemes and discusses the facts.

MYTH	FACT
Negative pulse charging results in **faster recharge rates compared to constant current charging**	**There has been no substantiated scientific evidence to prove that.** In fact, **many studies found conclusive evidence that the recharge rate is a function of the charging current and nothing else**.
Negative pulse charging results in **lower temperature rise compared to constant current charging**	Temperature rise is a function of many variables including: ▪ The charging rate (% of capacity) ▪ Gassing voltage ▪ Temperature compensation ▪ Run cycle characteristics A controlled charging process with temperature compensation **can achieve very low temperature rise**. Add to that, **there has been no established evidence that negative pulse charging have lower temperature rise compared to constant current charging.**
Negative pulse charging can recharge a battery up to 100%. No need to stop at 80%	**All charging schemes can bring a battery to 100%.** The only difference is that **above 80% - 85% the charging process needs to be controlled to allow the battery to accept proper charge**. Note that oxygen gas appears at the positive electrode at about 85% SOC and Hydrogen gas appears at the negative electrode at about 90%-95% SOC. The reason why **80%-85% was chosen is primarily to limit gas evolution**. This is critical due to the fact that with fast charging, there **are no battery rooms and no ventilation** (chargers are distributed throughout the plant). **Recharging the battery to 100% every fast charge cycle will result in unnecessary hydrogen generation and can pose a hazard.**
Negative pulse charging can achieve 100% recharge in 2 hours or less	Well, the math doesn't even add up. These are the facts: ▪ The **high charging rate can be sustained up to the gassing voltage**, which is normally reached at **50%-60% state of charge**. As such, this will take approximately 50 minutes at 0.5·C ▪ While in constant voltage, the charging rate drops as the battery dictates the charging rate. A such, it may take another 20-30 minutes to reach 80-85% SOC. Totally time is 1-1.3 hours. ▪ **Above 80%-85%, the gassing reactions start**. The charging rate is greatly reduced to ensure proper acceptance of charge. Typical finish rates start at 5% to 10%. As such, it will take 1.5-3 hours to finish charge the battery. **Total time: 3+ hours.**

Negative pulse charging can **fully return the battery specific gravity within 2 hours.**	Many seem to underestimate the specific gravity of the battery at the end of a charge cycle. Industrial flooded motive power batteries that are fully charged will have typical specific gravities of about **1.280 to 1.285** for a **flat plate** design and **1.300 to 1.310** for a **tubular plate** design. The **main goal of charging a battery is the restoration of the battery's name plate specific gravity**. Even small variations in specific gravity translate into large changes in state of charge. **A 1.260 specific gravity is simply not 100% but rather 85% to 90%**.
Fast charging schemes employing pulse charging techniques **can equalize the battery during a fast charge cycle. No need for a fully blown equalization cycle**	The reality is that an equalization cycle is needed with and without fast charging. Fast charging doesn't change the basics of battery chemistry. An equalization **cycle is an extended overcharge cycle** that is necessary to: ▪ Break and prevent battery sulfation ▪ Mix the electrolyte to prevent stratification ▪ Balance the voltage between the cells of the battery Normally equalization is performed over a 3-6 hour time interval (or even longer) using a low charge rate of 3-5 A / 100Ahrs. Although many schemes claim that pulse charging help break battery sulfation, and extended equalization cycle is still needed to prevent stratification and **more importantly balance the cells**.
Fast charging schemes employing pulse charging techniques **require only a single cable, single connector, and single battery post**	There is **no connection between the type of the fast charger and the need for single or dual connectors, cables, and intercell posts**. All of that is a **function of the charging current**, namely: ▪ For charging currents < 350 A, you can use single connector, single cable, and single intercell connectors. ▪ For charging currents > 350 A, you need dual connectors, dual cable, and double intercell connectors since Note that the maximum size connector available on the market is a 350A connector, which places a limit to the maximum charging current. Also note that the charging current inadvertently heats the cables, the connector, and the battery posts. **Doubling the connectors, cables, and posts is an attempt to reduce I^2R heating on top of the battery**.

References:

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