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The Effect of Sulfation on Battery Operation

By: Bruce Zeier, President of Bravo Zulu International Ltd.

Having designed the Batt-Recon system of sulfation elimination, I am often asked how a battery operates and what effect sulfation has on the operation of a lead-acid battery. A battery is simply a chemical storage device that converts chemical energy into electrical energy. The process of sulfation is critical to this conversion, without sulfation there is no electrical energy release from the battery. The re-charging process is inefficient and during each charge/discharge cycle, there is an increasing accumulation of sulfates that remain on the battery plates. This accumulation retards the process of chemical to electrical conversion, causing premature battery replacement and increasing electricity costs used to re-charge the battery.

We have identified three levels of battery sulfation referred to as Level 1, Level 2 and Level 3, which can be measured electronically using an impedance meter. Level 1 sulfation by definition, is the normal movement of the sulfate radical SO4, from the sulfuric acid electrolyte H2SO4, to the battery plates during the discharge and re-charging cycle. Without Level 1 sulfation, a battery would not provide electrical power. Level 1 sulfation could then be referred to as the "Good Sulfation."

Level 2 sulfation by definition, is the failure of the charging process to re-introduce the sulfate radical from the lead plates back into the electrolyte solution. Level 3 sulfation results from Level 2 sulfation progressing into a crystalline form and aggressively attaching itself to the lead plates or falling to the bottom of the cell as sediment. Simply stated, the effects of Level 2 and 3 sulfation are a reduction of electrical efficiency and reduced battery longevity. Therefore, Level 2 and 3 are viewed as the "Bad Sulfation."

How does a battery work?

A battery consists of two opposing materials, a positive and negative plate, that are immersed in sulfuric acid, H2SO4. The positive plate consists of lead dioxide (PbO2) and the negative plates consist of sponge lead (Pb). As a load is applied to the battery, a chemical reaction occurs between the two plates and electrons travel outside the battery.

As the battery discharges, the positive plate consisting of PbO2 sheds the oxygen molecules into the electrolyte solution while attracting the sulfate radical, SO4 to the plate. The result is the positive plate converts to lead sulfate, PbSO4, while the oxygen shed from the positive plate combines with the remaining hydrogen molecules in solution to form water. The negative plate consisting of PB, or sponge lead, also combines with the sulfate radical SO4 to create PbSO4. During discharge, both plates convert to the same material, PbSO4, while the electrolyte becomes less acidic being diluted by the addition of the newly formed water molecules. This reduces the specific gravity of the solution, which is the chemical "state of charge" of the battery. As a consequence, the voltage drops in each cell because the voltage is dependent on the differential between the plate materials and the strength of the acid.

Recharging the battery reverses the process, both plates shed SO4 into solution and the excess water molecule is broken apart into free oxygen and hydrogen. The oxygen forms with the positive plate to re-create the original PbO2, lead dioxide molecule, the negative plate returns to the original Pb, sponge lead condition. The free hydrogen combines with SO4 released from both the positive and negative plates to form H2SO4 electrolyte, thus completing the cycle.

Normally the electrolyte specific gravity is increased during charging because the acid being re-created is replacing the water concentrations in solution. In circumstances were the battery is shorted internally, positive plate grid corrosion is excessive, a loss of active material has occurred, or there is an excess of Level 3 crystalline sulfates lying in sediment; then the specific gravity will reach a point were it will no longer increase regardless of the applied charge.

As the battery charges, oxygen is given off at the positive plate while hydrogen is given off at the negative plate. The oxygen traveling upwards along the positive plate corrodes (oxidizes) the grid to lead dioxide contact area, reducing the cross section area of the grid and reducing the battery's capacity. The positive plate also tends to develop "positive post growth," which is the expansion of the corrosion caused by aging and oxygenation of the positive plate.

As the plates become more sulfated, regardless of whether the sulfates are Level 1, 2, or 3, the resistance of the cell is increased. This can be measured using an impedance-testing device such as the Batt-Recon Model 1200, motive battery impedance tester. The Model 1200 applies a known electrical alternating current into the battery and measures the reduction of the current as it exits the battery. As sulfates accumulate, impedance (battery resistance) increases and performance decreases. As sulfates increase, it is more difficult to restore amp-hours into the battery, causing the charger to run longer wasting electricity.

The Batt-Recon system is designed to safely and quickly remove Level 2 and 3 sulfates from the plates. Once the plates are clean and the sulfation is at the minimum possible level, the resistance due to potential sulfation is also at its minimum. Operating the battery with the minimum amount of Level 1 and 2 sulfation, optimizes the battery's performance. Optimized batteries re-charge faster using less charging electricity, typically 10 to 40% less. Optimized batteries provide longer run times and have longer life expectancy, than non-optimized batteries.

Successful battery operation requires Level 1 sulfation, but the accumulation of Level 2 and 3 sulfation reduces the battery's capacity and performance. Therefore, we as maintenance technicians are required

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to maintain the balance between the "Good Sulfation," Level 1, and the prevention and/or elimination of "Bad Sulfation," Level 2 and 3. The frequency of this balancing act will depend upon environmental factors and battery design characteristics. Bravo Zulu International is developing a new Battery Optimization Scanning System, (BOSS) to simplify the technician's ability to maintain batteries in their optimum state of efficiency. The BOSS system will work in conjunction with the Batt-Recon Model 4800 Sulfation Elimination System, providing automatic Battery Optimization for fleet or individual battery operations.

For more information on Battery Optimization, call us at 951/928-0595, or email to: sales@battrecon.com.

BATT-RECON: The Emerging Technology!

The Model 4800 F System:

Creates New Service Clients
Generates Cash Flow
Saves Electricity Costs
Extends Battery Life

As lead-acid batteries cycle between charge and discharge, sulfates accumulate on the internal lead plates of the battery preventing the efficient flow of electricity. This results in longer charging times, fewer operating hours of use, 10-40% wasted charging electricity and premature replacement of the battery. The Batt-Recon Patent Pending Process of Sulfation Elimination restores most batteries to a serviceable condition saving you time and money!

Tired of changing batteries on your lease returns?

In 45 minutes you can Restore instead of Replace!

"We use the Model 4800 as a marketing and revenue generating tool. Clients are impressed with a technology that saves them money by quickly testing and restoring motive batteries in their facility. I like this system because it is portable, fast and based on science, not some "Snake Oil" remedy or additive!"

Roy Stone, President
Stone Equipment Company
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Bravo Zulu International Ltd

28610 Watson Road, Sun City, California 92585
Phone: 951-928-0595 Email: sales@battrecon.com

www.battrecon.com