AP1030:
ATMOSPHERIC HAZARDS ASSOCIATED WITH LEAD ACID BATTERY CHARGING STATIONS

Atmospheric Hazards

Lead acid batteries are used to power forklifts, carts and many other types of machinery in many industrial settings. Many facilities have charging areas where multiple heavy duty lead acid batteries are recharged at the same time. In some cases facilities maintain large banks of lead acid batteries that are used to provide backup power to critical systems during an emergency. Fire engines, HAZMAT and emergency response vehicles frequently include banks of lead acid batteries for the same purpose. Gases produced or released by the batteries while they are being charged can be a significant safety concern, especially when the batteries are located or charged in an enclosed or poorly ventilated area, or on the truck.

Flammable Gases

In an area where lead acid batteries are being charged, the first gas to measure is H_2.

Hydrogen is not toxic, but at high concentrations is a highly explosive gas. The 100% LEL concentration for hydrogen is 4.0% by volume. At this concentration, all it takes is a source of ignition to cause an explosion. Sparking from a battery terminal as it is connected or disconnected from the charging system is more than adequate as a source of ignition energy. That's why lead acid batteries should only be charged in well ventilated areas.

Toxic H_2S

Sulfuric acid contains sulfur, and hydrogen sulfide (H_2S) is a possible by-product of over-charging and battery decomposition. If you smell the rotten egg odor of H_2S in the charging area, you should assume that this very dangerous gas is a possibility. You should leave the area, and use a gas detecting instrument with an H_2S sensor to confirm whether the gas is present before returning.

However, H_2S is not the most common gas associated with charging or discharging lead acid batteries that contain sulfuric acid. Given the over-heating and other problems you mentioned, you may not find H_2S, but you probably will find the presence of other atmospheric hazards when you test the atmosphere in the area with your gas detector.

The most common reaction byproducts associated with sulfuric acid (H_2SO_4) are hydrogen and sulfur dioxide. Overcharging, or lead acid battery malfunctions can produce hydrogen. In fact, if you look, there is almost always at least a little H_2 around in areas where lead batteries are being charged.

Overcharging, especially if the battery is old, heavily corroded or damaged can produce H_2S. Deteriorated, old or damaged lead acid batteries should be removed from service, as damaged batteries are much more likely to be associated with production of H_2S.

Sulfuric acid reacts with a number of metals and substances to produce SO_2 as well as other "sulfur oxides" (SOx) such as SO_3, SO_4, S_2O, etc. Many sulfur oxides have a pungent odor, but they are NOT H_2S. H_2S is a reduced sulfide, not an oxide. When you have a spill, SO_2 is generally the most common gaseous sulfur reaction by-product.

CC 22 H_2 Gas Measurement Transmitter

- *H_2 transmitter*
- *Connect via MODBUS (RS 485) or 4-20mA*
- *Backlit graphic LCD changes color to indicate alarm*
- *Built-in push-button interface*
- *Non-intrusive calibration*

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GMA 200-MW4 Controller

- *Advanced controller for LEL, O_2, CO_2 and toxic gas*
- *IP-65 wall housing with built-in horn and strobe*
- *Up to four points of gas measurement in any combination*
- *Backlit graphic LCD changes color to indicate alarm*
- Connect via MODBUS (RS-485) or 4-20mA

Chemical Reaction Resulting in Hydrogen

During discharge of a lead acid battery you have the following two half-cell reactions. Neither SO_2 or H_2S are normally produced, even by catastrophic discharge!

Negative plate reaction:
Pb (solid) + HSO_4 – (aqueous) → $PbSO_4$ (solid) + H+ (aqueous) + 2 e−

Positive plate reaction:
PbO_2 (solid) + HSO_4 – (aqueous) + 3 H+ (aqueous) + 2 e− → $PbSO_4$ (solid) + 2 H_2O

The total reaction can be written as:
Pb (solid) + PbO_2 (solid) + 2 H_2SO_4 (aqueous) → 2 $PbSO_4$ (solid) + 2 H_2O

During charging, (especially in the event of overcharging), lead acid batteries produce oxygen and hydrogen. These gases are produced by the electrolysis of water from the aqueous solution of sulfuric acid. Since the water is lost, the electrolyte can be depleted. This is why you need to add water to “wet” (flooded type) non-sealed lead acid batteries. When a lead acid battery cell “blows” or becomes incapable of being charged properly, the amount of hydrogen produced can increase catastrophically:

Water is oxidized at the negative anode: 2 H_2O (liquid) → O_2 (gas) + 4 H+ (aqueous) + 4 e−

The protons (H+) produced at the anode are reduced at the positive cathode: 2 H+ (aqueous) + 2 e− → H_2

CC 33 Combustible Gas Measurement Transmitter

- *Configurable for wide range of flammable gases*
- *Explosion proof stainless steel or cast aluminum housing*
- *ATEX and IECEx Certified for Zone 1 hazardous locations*
- *Backlit graphic LCD changes color to indicate alarm*
- *Non-intrusive calibration*

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Hydrogen Measurement

Iin an area where lead acid batteries are being charged, the first gas to measure is H_2. The best way to measure hydrogen in an area where you are charging batteries is with a permanently installed monitoring system. You can use a standard catalytic LEL sensor, or you can measure the hydrogen by means of a substance specific electrochemical sensor. The sensor and housing need to be designed and certified for installation and use in hazardous locations characterized by the potential presence of combustible gas. Since hydrogen is lighter than air, H_2 sensors are usually mounted to the wall or ceiling at a height at least slightly above the source of gas.

Readings from the H_2 sensors can displayed right where the sensor is located, or on a remotely located controller or monitor. Readings from the sensors can be used to activate relays, fans or alarms, or the information can be transmitted and integrated into the facility's overall environmental health and safety and fire detection systems.

For LEL range measurement, using a standard catalytic combustible gas (CC) sensor with a range of 0 – 100% LEL is a good approach. For situations where you need to take action at a lower concentration, using an electrochemical (EC) toxic gas sensor to measure the hydrogen may be a better approach. The typical range for an EC hydrogen sensor is 0 – 2,000 ppm. (This is equivalent to a range of 0 – 5.0% LEL.)
In the event of a sulfuric acid spill, or where the sulfuric acid is coming into contact with metals and / or other materials, you may need to measure SO_2 as well. Although this is normally not necessary in charging areas where the acid is fully contained in the batteries.

If you are concerned with aerosol droplets of sulfuric acid, you can directly measure H_2SO_4 as well. Once again, this is not normally a concern in battery charging areas.

Deteriorated, old or damaged lead acid batteries should be removed from service, as damaged batteries are much more likely to be associated with leakage leading to the production of SO_2, or charging malfunction which could lead to the production of H_2S.

GfG Solutions for Battery Storage Areas

A GfG CC 22 or CC 28 gas measurement transmitters with a display for the detection of hydrogen with the GMA 200-MW4 controller is the ideal solution for lead acid battery storage areas. GfG transmitters can be connected to a single or multi-point controller which is located outside the hazardous area. Gas detection and monitoring systems are not only required, but critical to the safety of people and assets. Explosions and fires as well as exposure to toxic gases are clear and present dangers.

GfG Fixed Systems - A Leader in Gas Safety

GfG systems are flexible, scalable, and support the widest range of sensor technologies in the industry. GfG fixed systems offer substantially lower cost of ownership through intrinsically safe and increased safety designs that do not require the cabling to be run in explosion proof conduit.

GfG Instrumentation has been a world leader in the gas detection industry for almost 60 years. We have the complete gas detection solution for environments where lead acid batteries are present.

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