Management of Spent Lead-Acid Batteries in South Africa

What are lead-acid batteries?

Lead-acid batteries (LABs) are secondary batteries (meaning that they are rechargeable) in which lead and lead oxide reacts with the sulphuric acid electrolyte to produce a voltage. The most common use for LABs is to start an engine where the battery delivers a short burst of high amplitude current to energize the starter motor that turns the crankshaft on an internal combustion engine. These batteries are called SLI (Starting, Lighting and Ignition).

SLI battery

LABs are also used as a backup power source. When a LAB supplies its power as backup it may discharge completely or only very slightly. It is recharged when the power comes back where-on after it sits idle for long periods of time.

Reserve batteries or battery bank

Thirdly LABs can deliver the majority of its capacity repeatedly, possibly on a daily basis in what is called a deep-cycle application. Examples of this type are electric and hybrid vehicles including golf carts and scooters; industrial applications including forklifts and marine applications like running trolling motors.

Deep cycle batteries

Why are lead-acid batteries of concern?

A typical automobile battery contains 8 - 9 kg of lead (plates) and 5 kg of sulphuric acid, and if handled improperly, poses hazards to human health and the environment. SLABs are safe but can become hazardous when touching damaged cells, trying to smelt lead plates on an open fire and when handling the acids. Some lead compounds are extremely toxic to human health, long-term exposure to even tiny amounts of these compounds can cause deplorable health effects such as learning irregularities and behavioural problems in children, anaemia, nerve disorders, kidney damage, muscle and joint pain, loss of memory, seizures, birth defects and ultimately death. In addition lead is also known to cause high blood pressure, memory loss and lower the ability to concentrate. Lead can enter the body by inhalation of lead dust or ingestion when touching the mouth with lead-contaminated hands.

Sulphuric acid in its inherent characteristics is extremely corrosive and is potentially more harmful than any other electrolytes used in other battery systems and can cause severe bodily injury upon contact, swallowing damages internal organs and can lead to death. Furthermore, sulphuric acid is a good carrier for dissolved and suspended lead and in these states, lead can easily finds its pathway to enter and contaminate soil and water (both surface and groundwater). After leaking on the ground, the acid and lead particulates dry-up and become airborne. This makes lead particulates to be in a form that can enter human body through inhalation. LABs also present a fire and explosion hazard.

When does a lead-acid battery become a spent lead-acid battery?

When a LAB can no longer be able to be recharged and retain the charge applied its lifetime reaches its end and becomes "spent" as it is no longer useful for the application for which it was designed. This is mainly caused by a process known as sulphation and this begins when lead sulphate ($PbSO_4$) precipitates over the battery plates eventually reaching a point where the ions can no longer migrate from or to the plates or electrolyte due to lead sulphate coating, and the reactions which produce the electric energy cease.

How are spent lead-acid batteries regulated?

Domestically, SLABs are regulated as waste in terms of the **National Environmental Management: Waste Act, 2008 (Act 59 of 2008) (NEM:WA) as amended.** NEM:WA is the central piece of legislation that is core to the management of waste in South Africa. It regulates the management of waste in order to protect human health and the environment by providing reasonable waste management measures. Some measures which are identified in the Act and which may be relevant to the management of SLABs are: the declaration of priority waste, extended producer responsibility, listed waste management activities, industry waste management plans, contaminated land, and other measures.

The **National Waste Classification and Management Regulations, 2013 (GN No. 634 of 23 August 2013)** which aim to achieve the objects of NEM:WA regulate the classification and management of waste; prescribe requirements for the disposal of waste to landfill; prescribe requirements and timeframes for the management of certain wastes; and prescribe general duties for waste generators, transporters and managers. In this respect, the Regulations require the generators of waste to classify the waste they generate and to prepare a safety data sheet for the hazardous waste generated in accordance with SANS 10234. This implies that, the waste residues that are generated during SLABs recycling process shall be classified and should the classification comes out to be hazardous, then a safety data sheet shall be prepared.

The Regulations were promulgated with two sets of National Norms and Standards, viz.: **National Norms and Standards for the Assessment of Waste for Landfill Disposal (GN No. R. 635 of 23 August 2013) and the National Norms and Standards for the Disposal of Waste to Landfill (GN No. R. 626 of 23 August 2013)**. The former gives a procedure for the assessment of waste for landfill disposal, meaning that should the possible management option for the waste residue generated during the SLABs recycling process be disposal, that waste shall be assessed in accordance with this procedure in order to determine the type of landfill in which the waste shall be disposed of. The latter imposes an immediate restriction to the disposal of lead-acid batteries in landfills.

NEM:WA also gives powers to the Minister to publish a **list of waste management activities which have or are likely to have a detrimental effect on the environment** and specify the requirements for conducting such activities. The published list established three categories of waste management activities **(GN No. 921 of 29 November 2013).** Categories A and B list waste management activities which require a waste management licence whilst Category C lists activities which are controlled in terms of the developed Norms and Standards.

Currently, there are three sets of developed National Norms and Standards which may be relevant to the management of SLABs:

- **Standards for Scrapping or Recovery of Motor Vehicles (GN No. 925 of 29 November 2013);**
- **Norms and Standards for the Storage of Waste (GN No. 926 of 29 November 2013); and**
- **Norms and Standards for the Remediation of Contaminated Land and Soil Quality (GN No. 331 of 02 May 2014).**

In the supply chain of SLABs, the above mentioned licensing requirements may, depending on the thresholds specified in these Notices, apply on the recyclers of SLABs (i.e. secondary lead smelters), those that are temporarily storing SLABs and those that are allegedly draining the acid on the ground.

Lastly, the **National Waste Information Regulations (GN No. R. 625 of 13 August 2012)** which are also meant to advance the objects of NEM:WA regulate the collection of data and information to fulfil the objectives of the national waste information system (the System) as set out in section 61 of NEM:WA. In relation to the management of SLABs, the Regulations require a person who generates, recycles, recovers, treats, disposes and/or exports hazardous waste to register such an activity in the System and to report on quarterly basis, the quantities of hazardous waste managed. The reporting requirement, however does not apply to the generators of hazardous waste.

Internationally, the **Basel Convention on the Control of Trans-boundary Movements of Hazardous Wastes and their Disposal of 1989** controls SLABs as hazardous waste and requires them to be handled accordingly in order to prevent damage to human health and the environment. The Convention sets out the rules

for controlling transboundary movements and disposal of hazardous and other wastes. The main goal of the Convention is to protect human health and the environment from adverse effect which may result from the handling, transportation and disposal of hazardous and other wastes. To achieve this, the Convention pursues three objectives:

- To reduce transboundary movements of hazardous and other waste to a minimum consisted with environmentally sound management;
- To treat and dispose wastes as close as possible to their source of generation; and
- To minimise both their quantity and hazardousness which is defined in the Convention as taking all practicable steps to ensure that hazardous wastes or other waste are managed in a manner which will protect human health and the environment against adverse effects which may result from such wastes.

How are spent lead-acid batteries managed?

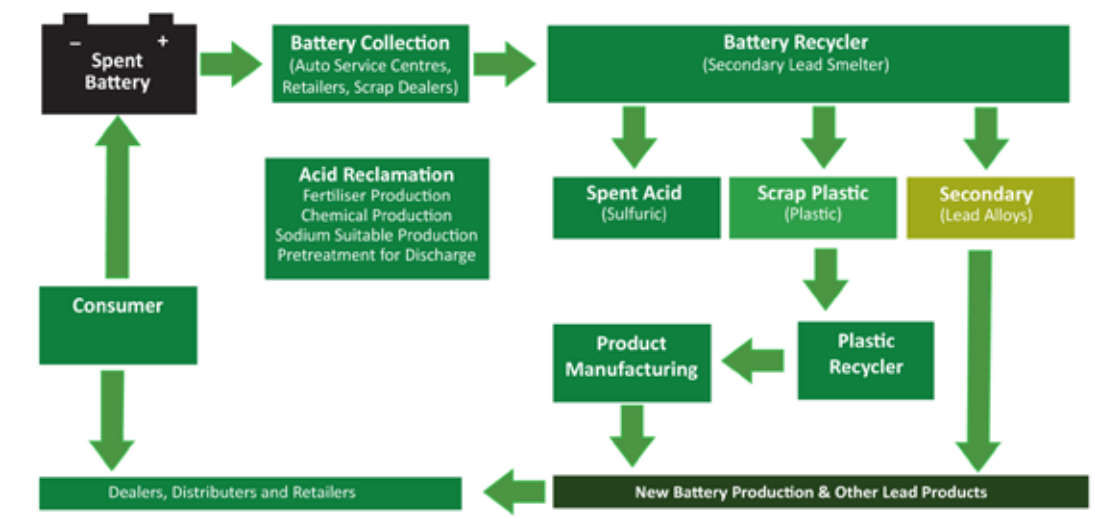
SLABs are mainly managed through recycling and this has proven to be a general trend worldwide. The recycling of SLABs is heavily driven by the economic value associated with the lead content in them. In South Africa, recycling of SLABs is said to have began during the Second World War when lead was considered a strategic metal due to its use in the manufacturing of ammunition. In 1942, it then became a legal requirement for the battery industry to introduce a battery collection system known to the industry as a "scrap deposit", but formally known as a "one-for-one returns system". The system was introduced to collect and recover as much lead plates as possible for secondary processing of lead. The South African battery manufacturers have, since then continued with a system of collecting SLABs.

Collection: The one-for-one returns system is implemented by manufacturers, distributors, retailers, wholesalers, service stations and any other retailing points where a new LAB is sold to users whilst a service of retaining an old one is also rendered. The retained SLABs are then collected by distributors when they are distributing new LABs. The collected SLABs are transported to secondary lead smelters for recycling. All SLABs that miss the net of one-for-one returns system are traded on an open market where individuals, especially waste pickers, collect and sell them to scrap metal merchants. The scrap metal merchants either trade them to secondary lead smelters in the country or export them to other countries for recycling. Secondary lead smelters also accepts SLABs from individuals.

Did you know?

- When purchasing a new LAB whilst returning an old one (SLAB) to the retailer, you get what is known as a "scrap discount" of about R171 (as of 2015) on the original price of a new LAB.
- You can also trade your SLAB without necessarily purchasing a new LAB. The payments for a SLAB in these cases vary depending on the price of lead scrap as determined by Scrap Index.com and sometimes the London Metal Exchange, but are typically about R50 per SLAB (as of 2015).
- When you purchase a new LAB without returning a SLAB, a R50 incentive is charged on you as a levy. However, the levy does not apply to LABs sold to vehicle assembly plants for use in new vehicles or where LABs are purchased as original equipment, e.g., LAB purchase for a new burglar alarm. The levy does also not apply when LABs are exported.

The SLAB recycling process consists of the following:



SLABs Receiving Bay: The receiving bay is an area designed to receive SLABs collected through the one-for-one returns system or from various industries within the country whilst some are imported from other countries. On receipt, SLABs are stockpiled on site on an impermeable floor to prevent the ingress of leaking acid to the soil thereby preventing potential groundwater pollution. SLABs are usually loaded by forklifts on the conveyor system which transports them to the SLABs processing facility.

SLABs Processing Component: The main module of the SLABs processing component is a battery breaker which breaks and pulverises the battery into small coin shaped pieces. These pieces are placed into settling tanks and using differences in their density, they are separated – heavier pieces, such as lead, sink and settle at the bottom of the sump, while lighter pieces, like rubber (ebonite) and plastic float. In a LAB, there are two types of plastics, viz: Polypropylene and Polyethylene. Polypropylene plastics are sent to a plastic recycling facility for reprocessing whilst polyethylene plastics are burnt in a furnace as energy recovery and also assists in removing the carbon from the process. Lead is sent to a smelting facility for separating metallic lead from a mixture of various substances whilst the acid is drained to effluent management plant for neutralisation.

Lead Smelting Component: This component consists of furnaces which are used to melt scrap lead under extreme heat to separate metallic lead from a mixture of other substances. The mixture of scrap from the breaking process consists of several substances mainly: metallic lead, lead oxide (PbO), lead sulphate (PbSO4), and other metals such as calcium (Ca), copper (Cu), antimony (Sb), arsenic (As), tin (Sn), and sometimes silver (Ag). The metallic lead produced from this process is also known as hard or antimonial lead and is packaged in a form of lead ingots. The furnaces are attached to a series of scrubbers which operate as part of a pollution abatement system to control air emissions.

Lead Refining Component: In this component, the antimonial lead produced in the lead smelting facility is refined further in order to produce what is known as soft lead. The main objective of the refining process is to remove almost all Cu, Sb, As, and Sn, since the soft lead standard does not allow more than 10g per ton of these metals.

Blending Component: The main component of a blending facility is a blending kettle which is used to produce specialised lead alloys. In this section, highly specialised engineering equipment is used to cast pure lead into various alloys that are required in the manufacturing of various types of LABs. The produced alloys include refined soft lead, D-alloy, 6% Sb alloy, positive calcium alloy, negative calcium alloy and the W-alloy. These alloys are produced in strict compliance with the relevant SANS. SABS officials visit the facility on regular basis to monitor adherence to these standards. The produced alloys are packaged in a form of lead bullions and are colour coded in order to differentiate between the produced alloys.

Plastic Recycling Facility: Plastic recycling facility basically reprocesses the shredded plastics (polypropylene) into palletised briquettes. The produced briquettes are reused in the battery manufacturing process for producing new battery casings.

Acid Effluent Plant: The acid effluent plant is basically a wastewater treatment facility where acidic effluent is neutralised before discharged into a municipal sewerage system. The water from the plant is laboratory tested to determine if it meets the effluent discharge standards prescribed by the municipality before it is released. The municipality verifies the quality of tested water on monthly basis to ensure adherence to the prescribed effluent standards. During site visits conducted at SLABs recycling facilities, it was indicated that although it is possible to regenerate battery acid, it is generally not economically viable because it needs to be topped up with concentrated acids in order for it to be reused and this requires a lot of energy inputs.

Furthermore, the battery acid is generally too low for regenerating and it is therefore only managed through neutralisation onsite. Even if it could be regenerated, its application would only be limited to the battery manufacturing industry and could therefore not be used for any other industrial applications as the acid is already contaminated with lead sulphates. However, there are technologies available which can provide means to produce lead-free acid of which if it can be processed further and converted into sodium sulphate (Na_2SO_4) and sold to laundry detergent, glass and textile manufacturing sector.

Further Information

Details of facilities that recycle SLABs maybe found on the South African Waste Information Centre at **sawic.environment .gov.za**