# Closed loop recycling of lead/acid batteries

B. Bied-Charreton
*Metaleurop, 58 rue Roger Salengro, 94126 Fontenay-sous-Bois (France)*

**Abstract**

The traditional lead/acid battery is a recycleable product, irrespective whether it is of an automotive, traction or standby design. The product benefits from the traditional lead metallurgy that has been developed for both primary (mines) and secondary (recycling) smelting. Secondary smelting accounts for 60% of total lead production in Europe, and this makes lead the most effectively recycled metal. In secondary smelters, scrapped batteries are crushed and smelted. The polypropylene from the boxes is recycled to produce secondary plastic for battery, automotive, or other miscellaneous uses. The lead metal is refined to be re-used in the battery industry. The acid is retreated. Recycling requires a collection network. The lead/acid battery benefits from the traditional collection network that has been established for scrap-iron and non-ferrous metal scrap. In Western Europe, the recycling rate for scrapped batteries is estimated to be 80 to 90%. All participants in the battery recycling loop agree that the process must be a clean cycle for it to be credible. The collection organization is improving the quality of storage and transportation, especially with regard to the acid that can only be neutralized in correctly-controlled facilities, generally located at the smelters. The smelters themselves tend, through local regulations, to run at the optimum level of protection of the environment.

## Collection rate of lead/acid batteries

The recycling loop for lead/acid batteries is operating very well in Western Europe. This is especially true when lead/acid batteries are compared with other recycleable products. In Western Europe, the collection rate of lead/acid batteries is well ahead of the rates for glass, paper or metallic cans (see Fig. 1). Furthermore, the latter materials are themselves at the forefront of recycleable products.

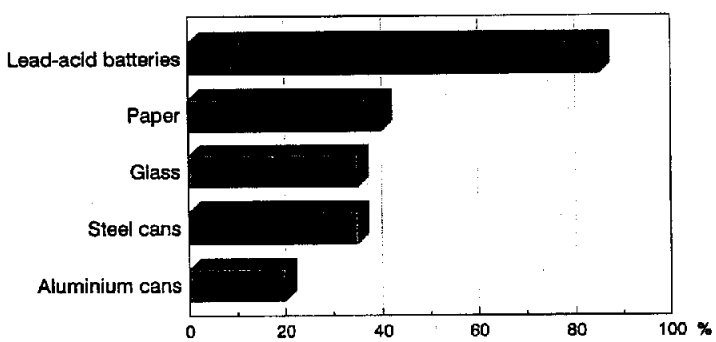


Fig. 1. Estimated collection rates of various recycleable products in Western Europe.

0378-7753/93/$6.00 

The average collection rate of 85% for lead/acid batteries (Fig. 1) is obtained as follows (Fig. 2). The first step is to calculate the theoretical resource of battery scrap (i.e., the amount before any battery is lost). For industrial and small batteries, it is usual to base this calculation on the average service-life of each battery type and its past consumption levels. For automotive (SLI) batteries, it is possible to escape from the uncertain value of the average service-life, by assuming that scrapped batteries equal the sales of replacement batteries plus those collected from broken vehicles (i.e., in number, but not in weight, of batteries). Finally, the process scrap from battery plants and the imports/exports of batteries, must be included to obtain the theoretical resource of battery scrap.

A comparison of the theoretical value with the quantity of battery scrap delivered at lead smelters yields the apparent recycling rate. Why apparent? This is because

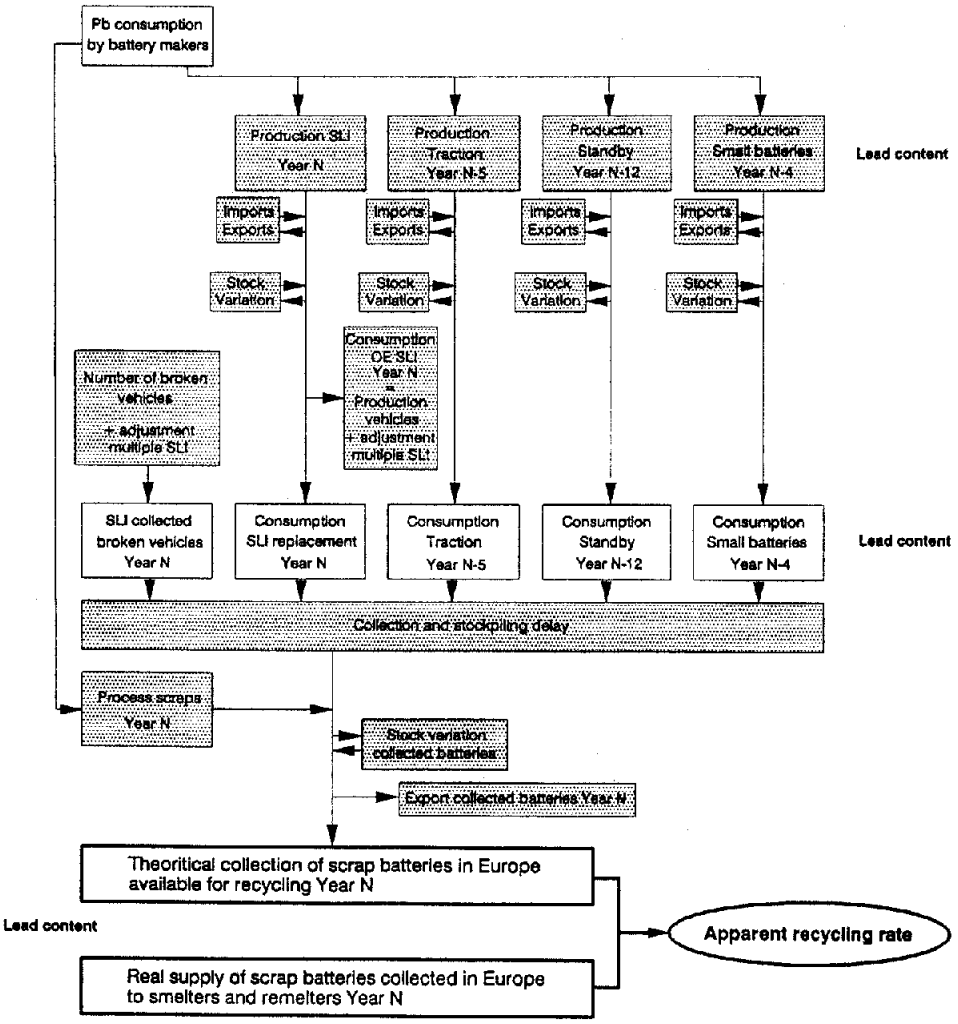


Fig. 2. Apparent recycling rate of lead/acid batteries — year N.

stock variations are very poorly documented (it is well known that they are linked to the frequent fluctuations in the lead price), and because no consideration has been given to the delay for collection and stockpiling (this delay is estimated to be the order of a year).

Despite the fact that the recycling rate is only an apparent figure (it lies between 80 and 90% of the real value), the rate should be normalized for Western Europe in order to check its evolution over several years. This is necessary at a time when the EEC Directive on battery recycling is becoming effective, and when various countries are implementing collection schemes for lead/acid batteries that are aimed at increasing recycleability.

The collection rate of industrial batteries is already very good; it is close to 100% (this should also be the case in future for batteries employed in electric vehicles). Thus, most of the improvements should focus on the collection of automotive and small batteries. These products are consumer goods and, consequently, require the active participation of the consumer to achieve a very good recycleability.

## Recycling rate of lead/acid batteries

The recycling loop of lead/acid batteries is not yet perfect. In addition to the above-mentioned collection rate, the recycling rate of the battery itself can be improved (see Fig. 3).

The free acid of a battery is often lost before the scrapped battery arrives at the smelter (this represents about 15% of the total battery weight). The collection and transportation network is currently attempting to implement the recycling of full batteries. At smelters, the free acid that is not lost is collected and completely neutralized.

At secondary-lead smelters, batteries are crushed, and their various components separated. The lead from grids, connections and paste (about 55% of battery weight),

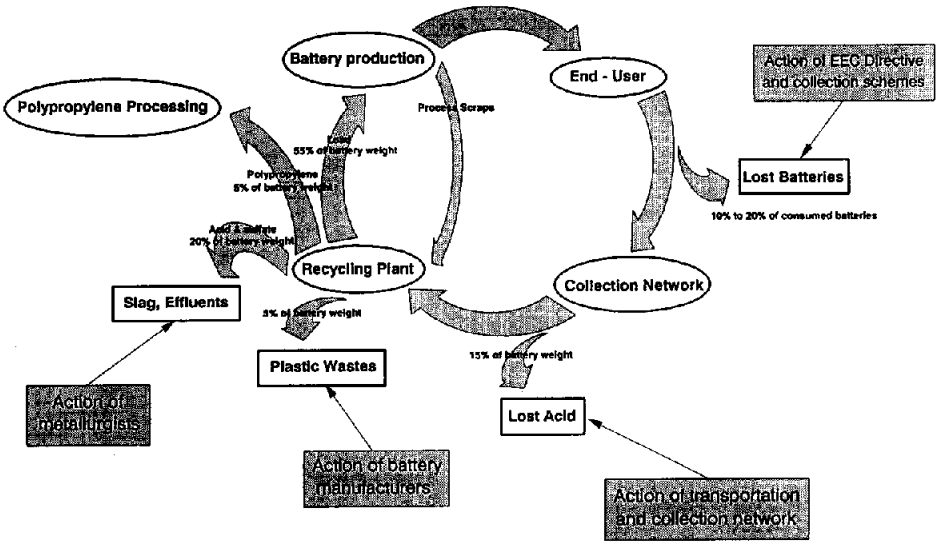


Fig. 3. The recycling loop of lead/acid batteries.

is smelted and refined to meet the high-quality standards of the automotive industry, and then recycled in the battery industry itself or in other industries.

The remaining acid and sulfate (about 20% of battery weight) are recovered in the soda slag that is produced by the smelter. Metallurgists are working towards further reducing the volume of slag that is produced.

The polypropylene from battery cases is also separated (about 5% of battery weight) and recycled in the form of polypropylene granules to make components for the automotive industry, containers for horticulture, etc. There are also various plastics that are not polypropylene (e.g., polyvinylchloride, polyethylene, acrylonitrile/butadiene/styrene). These originate from separators, envelopes or cases, and cannot be effectively separated and recycled. Such plastics are therefore dumped (about 5% of battery weight). Battery manufacturers must promote the use of materials that are easy to recycle at the end of battery life.

Finally, an active partnership between all the participants of the recycling loop is encouraged, in order to reduce breakages in the loop. This is likely to increase further the recycleability of the lead/acid battery, a product that has already set the standard in the field of product recycleability.