ARTICLE IN PRESS

Available online at www.sciencedirect.com

SCIENCE DIRECT®

ELSEVIER

Journal of Power Sources xxx (2003) xxx–xxx

JOURNAL OF POWER SOURCES

www.elsevier.com/locate/jpowsour

Small scale lead battery refining plants 'turning a waste hazard into a commodity'

John Simpson*

Dross Engineering, 'Broden' Pentrich Road Swanwick, Alfreton, Derbyshire DE65 1BN, UK

Abstract

Using the case study of the lead-acid battery recycling plant on the Reunion Island in the Indian Ocean, Dross Engineering will show that small scale refining plants are a viable option for island economies and small nation states and can act as feeder plants for larger processors or as manufacturer based recycling stations. Based on the premise that shipping 1 t of lead bullion has less impact on the environment than shipping the same quantity of used lead-acid batteries. Dross Engineering has developed a plant that is economical to operate, simple in design and environmentally friendly. The presentation will show details of the equipment and certain aspects of the process and will demonstrate that such plants have a valuable role to play in safeguarding our environment and providing a viable income generator for local economies.

Keywords: Lead-acid batteries; Waste hazard; Commodity

1. Introduction

Dross Engineering provides economical, well thought out furnaces and equipment for non-ferrous metals processors. We have been involved for over a quarter of a century in providing solutions to the problems of recycling such commodities. We believe that our small scale lead-acid battery recycling plants provide a viable alternative to current options available for meeting present and future legislation and trends in line with the OECD declaration, Basle convention, end of life (EoL) vehicles and batteries/WEEE directives, etc. ... thus providing the industry with another option for turning waste hazards into valuable commodities.

2. The way we live now

- *Cleaner and greener*: Programs and initiatives to educate and raise public awareness have done much to cause us to clean up our act. Our global thinking and local action also seeks to promote responsible business practices and minimum standards on human rights, employment, the environment and public health throughout the world. But the process is a 'long and winding road' and we do not quite know what is behind the 'door' at the end.
- *Rising environmental costs*: Based on economics alone the cost effectiveness of lead recovery remains fragile. Essential environmental and occupational health legislation has added to the burden making it even more difficult to reconcile the cost of collection and treatment against the market price of lead.
- *Rafts of new measures*: Particularly in the developed world new measures such as EoL vehicles, integrated pollution and prevention controls, etc. ... cost (or will cost) considerable sums of money to comply with and to meet targets of reduced emissions and energy usage year on year.
- *Big is best in the west*: Historically the tendency in the developed world has been to centralise collection and recycling to a small number of high capacity, high technology plants. But with a down side of creating a high concentration of pollutants.

3. Is this the only answer?

- *Perhaps our world view is incomplete*.

  Of course, we recognise the differing needs, priorities and conditions globally. But can the solution market forces have formed in the developing world continue to be the solution for the future? And what about:

  ○ island economies,
  ○ micro-states,

* Tel.: +44-1773-528902; fax: +44-1773-528902.
E-mail address: jsimpson@dross-engineering.com (J. Simpson).

0378-7753/03/$ – see front matter © 2003 Elsevier B.V. All rights reserved.
doi:10.1016/S0378-7753(03)00563-9

  ○ emerging nations or simply those countries where geography or other conditions make logistics difficult.

- *We only have one planet and all share one environment*.
  Present options in those cases are limited: there is always the city 'dump' or better still a quiet local beauty spot when no one is looking. What recovery there is, is all too often left in the hands of the 'informal' sector of unregulated 'backyard' recyclers and reconditioners notorious for their lack of respect for sound environmental and occupational health measures.
  Should this always be so?

Our received wisdom is that small plants are not viable. But the times they are a changing:

- In Europe, new 'producer responsibility' legislation (including EOL vehicles and the forthcoming directive on: waste electrical and electronic equipment (WEEE)) with 'cradle to grave' requirements for traceability and recovery will be implemented under the watchful eye of our fellow 'worldcitizens'. But such initiatives are changing and will continue to change our approach to recycling (perhaps it will finally be seen as a true public utility). Maybe one approach to meet the new 'producer responsibility' legislation would be for manufacturer based recycling plants.
- Technology is now available on both the smelting and fume abatement fronts that is both cost effective and offers high performance and improved efficiency in small scale units.
- Initiatives to raise public awareness and to educate new attitudes are legion if not always successful. The implementation of mandatory schemes for recovery and action programmes to reach recycling targets is on the increase. And the growing acceptance of the idea of charges, refundable deposits and eco-taxes continues to encourage the recycling of batteries.

4. Case study: the Reunion Island plant

One example of such small scale plants that we at Dross Engineering have been involved in can be found on the Indian Ocean paradise of the Reunion Island. The Reunion is a French overseas department (DOM 974) with the same institutional structure and responsibilities as any department in metropolitan France. It has a population of 700,000; 250,000 vehicles and a replacement battery market of 120,000 units PY. Before September 2001 less than 5% of the used batteries where recycled (returned to French mainland). The vast majority were simply dumped in the countryside.

4.1. A local solution

Dumped spent lead-acid batteries represented a considerable hazard to the island's ecology as well as being a waste of resources. A 'local solution' to the problem was initiated by the VERDI company who, working in co-operation with government bodies (including the Direction Regionale de l'Industrie, de la Recherche et de l'Environnement (DRIRE)) and battery importers on the island decided that they needed a plant that was compatible with the size of the island yet meeting all applicable environmental standards. The lead-acid battery recycling plant was commissioned in September 2001 at La Possession close to the island capital: St. Denis. The Equipment was supplied and installed by Dross Engineering.

4.2. How does it work?

The institutional structure includes an association formed by the island's battery importers who subscribe to the association on the basis of the number of batteries they import. The association pays a fee (in effect a subsidy) to the local licensed recycler (VERDI). VERDI receives pallets of spent batteries FOC and they also get to keep the lead (!). In return VERDI assumes the responsibility of meeting environmental legislation under the supervision of the DRIRE.

4.3. The plant itself

In practice, spent lead-acid batteries are stored prior to separation of components using a saw and other simple separation equipment. Lead plates and paste are reduced together using the normal chemical additions in an oil fired tilting rotary furnace (3000 kg capacity). Raw lead is then transferred to a refining kettle where it is re-melted and receives minimal cleaning before being cast into 25 kg ingot moulds and sold to export. Off-gas from the furnaces passes through a cyclone and a filter and slag is disposed of in landfill. Plastics are crushed and washed before being sold to export. Pure acid is added to regenerate recovered electrolyte which is again sold locally. The plant has a capacity of some 145/150,000 batteries per year with a production of approximately 1000 t of lead.

4.4. Assembly and installation

The plant was assembled and commissioned last year. The total covered area including storage and charge preparation and the reducing and refining shop measures $38\,m \times 9\,m$. The off-gas and hygiene air from the reduction furnace and the refining kettle is captured and ducted to the cyclone and filter located outside the main building.

4.5. Filter and cyclone

The filter was supplied by American Air Filter from their 'optiflow' range and was chosen for its performance and ease of use. A small cyclone is fitted to the system for improved efficiency.

Fig. 1. The Reunion Island.

4.6. Operation

As explained previously, on receipt, batteries are stored prior to component separation, electrolyte recovery and charge preparation. Tilting skips operated by fork lift are used to charge the reduction furnace.

4.7. Production

Molten metal and slag is poured into bulk lead moulds from the tilting rotary furnace after reduction. Once solidified the slag 'crust' is removed and the raw lead transferred to the refining furnace for re-melting and cleaning prior to

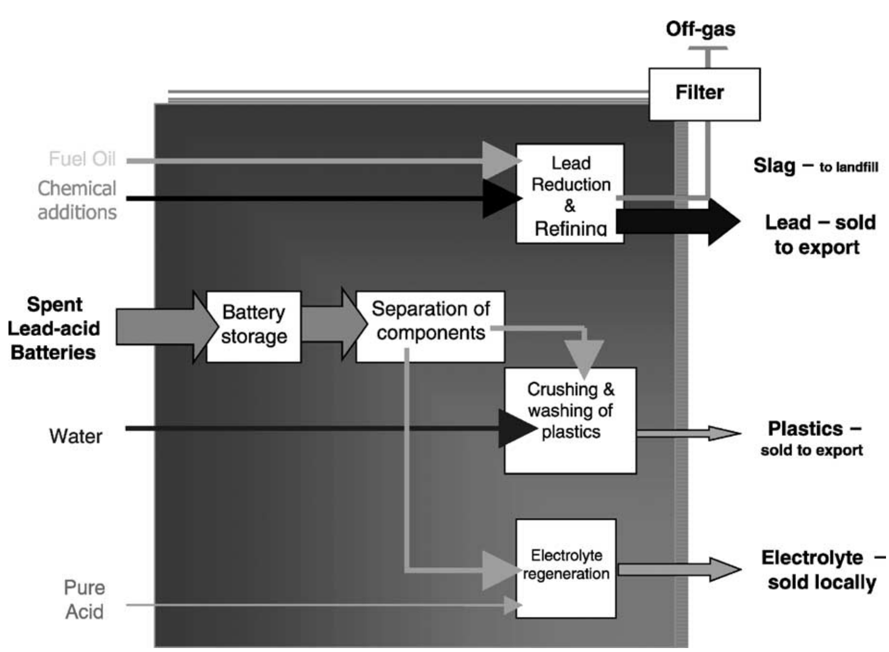

Fig. 2. Material flow chart.

Fig. 3. Overview of plant during construction.

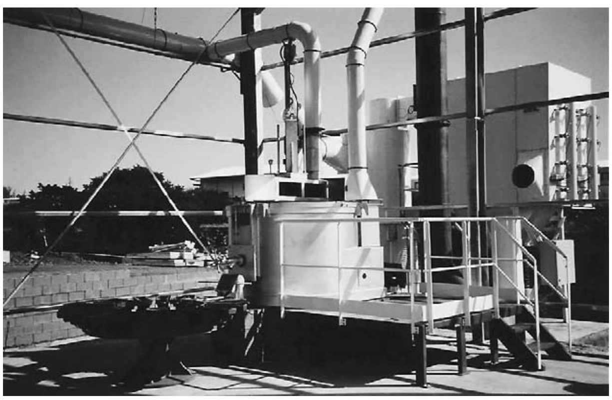

Fig. 4. Refining kettle and filter during installation.

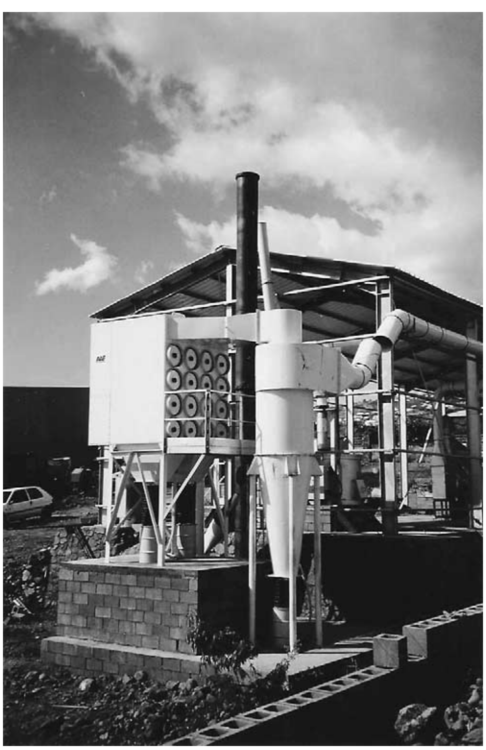

Fig. 5. Filter and cyclone.

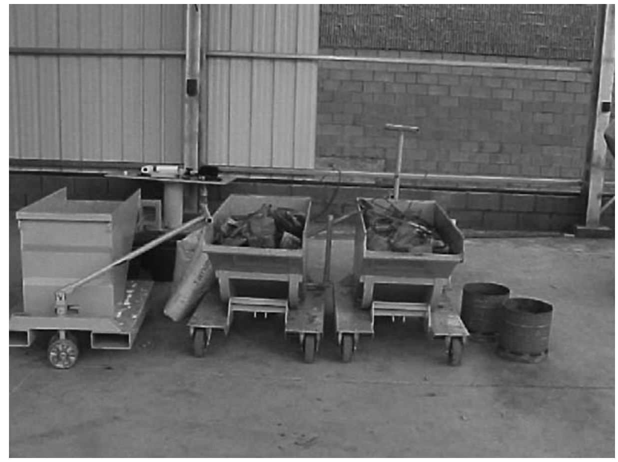

Fig. 6. Charge preparation in tilting skips.

Fig. 7. Electrolyte removal.

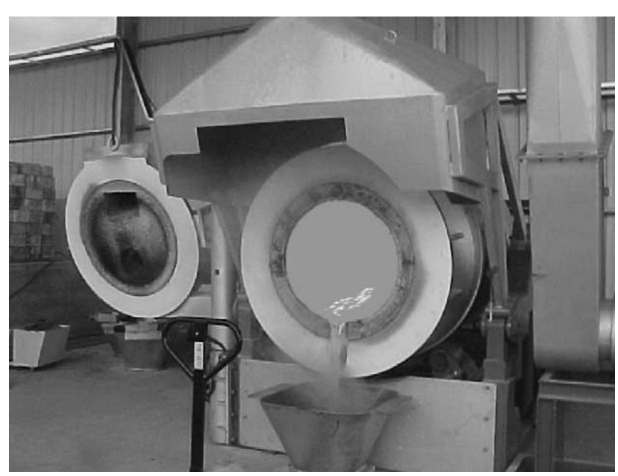

Fig. 8. Tap out of raw lead from tilting rotary reduction furnace.

Fig. 9. Ingot casting from refining kettle.

Fig. 10. Stock of ingots.

casting into ingots which are then stored on pallets prior to shipment.

The Reunion Island is now on course to turn what was a waste hazard into a valuable commodity.

4.8. Equipment

The equipment we have developed at Dross Engineering is economical, simple in design, built to withstand the rigors of foundry environment and tailored to help turn waste hazards into commodities.

It is our belief that small-scale recycling plants are a viable option for:

- island economies and micro-states,
- emerging nations,
- feeder plants to larger processors,
- manufacturer based recycling stations.

After all, shipping 1 t of lead bullion has less impact on the environment than shipping the same quantity of used lead-acid batteries (Figs. 1–10).