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MODERN TECHNOLOGY FOR LEADY OXIDE PRODUCTION

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Introduction

As a consequence of the progress in the automation of the manufacture of batteries, increasing demands are being made on the quality of the lead oxides to be used. The chief quality criteria are:

- maximum uniformity in particle-size distribution
- minimum deviations from the specification for the oxidation degree and the residual metal content
- uniform specific surface area
- minimum variation in acid absorption value.

These four product parameters are decisive for ensuring good productivity in a modern, largely automated, battery factory. If these criteria are not met, then the benefits of installing most modern automated types of mixing/pasting equipment are not fully capitalized. Moreover, automated plate-curing units cannot be used optimally.

As the manufacture of leady oxide constitutes 50% of the total production costs of a battery, manufacturers must clearly make every effort to produce leady oxide as cheaply as possible. The following cost factors must be taken into account:

- investment cost and depreciation expense
- energy consumption costs per tonne of oxide produced
- wage and salary costs incurred per tonne of oxide
- annual maintenance costs
- downtime due to problems with the machinery or the process itself.

A cost analysis for the production of lead oxides with Heubach installations will be given at the end of this paper.

Heubach–Barton system

The Barton-pot process (which is named after its inventor, G. Barton) is a so-called thermal process in which liquid lead is introduced into a furnace where an agitator atomizes the lead so that fine droplets are formed. Air, drawn or sucked in, causes the lead droplets to oxidize. The air current transports the oxide particles into a filter system where the particles are collected, transmitted through a de-dusting unit into a conveyor system, and then passed to the battery production line.

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In the Heubach version of the Barton-pot process, a level switch in the melting bath controls an automatically operating pig feeder that has a design that allows 20, 40 or 60 pigs, each of 50 kg in weight, to be received (*i.e.*, 1, 2 or 3 tonnes of lead pigs). The load depends on the space available. A doser, that has been developed and patented by Heubach, supplies as much liquid lead into the furnace as the latter can process according to the preselected specification. A variable air flow, controlled with respect to temperature, influences both the particle-size distribution and the degree of oxidation of the leady oxide produced. The ability to add warm air to the intake connection of the furnace allows the temperature of the supplied air to be adjusted independently of the ambient value. A calming shaft is fitted to the air exhaust system of the furnace. This shaft avoids the necessity of having to separate the coarse from the fine particles — a process that has to be carried out in conventional Barton pots. The air volume control is backed by so-called 'false air flaps' that cool the oxide exiting from the furnace down to a temperature of ~ 370 °C.

The physicochemical characteristics of leady oxide produced by the Heubach–Barton process are listed in Table 1. The values are on the conservative side and therefore can be guaranteed. The experimentation and experience underlying the design and manufacture of Heubach–Barton furnaces have been amassed over many years of operation. As a result, special care is taken in the fabrication of the furnace. For example, the furnace bottom is made from heat-resistant cast steel with a machined inner surface. Integrally-cast webs reliably prevent the bottom from sagging or buckling. The very compact agitator and the super-dimensioned agitator shaft are also made from heat-resistant steel. When the agitating speed and the operating temperature are changed, the same furnace can be used to produce litharge with

TABLE 1

Comparison of the properties of leady oxide produced by the Heubach–Barton and Heubach-mill processes

Property	Oxide	
	Heubach–Barton	Heubach-mill
Acid absorption (mg H_2SO_4/g oxide)	200 - 230	260 - 280
Mean particle size (μm)	8	5
Mean BET surface area (m^2 g^{-1})	1.2 - 1.4	2.4 - 2.8
Mean Scott density (g cm^{-3})	1.4 - 1.6	1.2 - 1.4
Mean tamped density (g cm^{-3})	3.6	2.9
Reactivity	good	excellent
Oxidation degree (% PbO)	60 - 85	60 - 80
Deviations from specified degree of oxidation (%)	±2	±1
Guaranteed capacity at 70% PbO (kg h^{-1})	650 - 1000	250; 500; 1000 (according to mill used)

an oxidation degree of 99.7%. The operating temperature will then reach 630 to 650 °C. The use of a super-dimensioned drive causes oxide that has deposited on the furnace wall to be removed and returned to the agitator level. Cleaning at regular intervals is not necessary and the agitators have to be examined for wear only once a year. Should wear phenomena be detected, the agitator can be removed through a manhole in the furnace shell and the worn surfaces can be reconstituted by build-up welding.

Heubach-mill system

The Heubach lead oxide mills excel through their sturdy design, high reliability during operation, high productivity, and the extremely good quality of the oxide produced. By the use of a float switch in the melting bath, a bar feeder that is designed to receive between 1 and 3 tonne of lead bars automatically regulates the supply of bars. Specially designed dosers feed the liquid lead to casting machines where cylinders of ~100 g in weight are formed. The capacity of the casters is 1.5 tonne h^{-1}. The cylinders are transported by an elevator to a storage bin from where they are automatically fed via a vibrating chute to the mill. The delivery of the cylinders to the mill is not continuous, but is controlled by pressure cells that allow 100 kg of cylinders to be fed at a time. A minimum-maximum limitation prevents the mill from being discharged or overloaded when operating without supervision. The capacity of the cylinder bin provides 48 h of mill operation. The cylinders required for 24 h of operation can be cast in an 8-h shift. This means that the mill can operate for 16 h per day without supervision. Heubach mills with capacities of 250, 500 and 1000 kg of leady oxide per hour are available.

The most important process parameters, *i.e.*, air volume, temperature and mill weight, are controlled and monitored within very narrow limits. The temperature control is assisted by a lance that injects the amounts of water required. This design criterion allows the temperature deviations during production to be kept to a minimum. This, in turn, results in a very uniform particle-size distribution and also allows the degree of oxidation to be maintained within ±1% of the specified value.

The physicochemical characteristics that can be attained for leady oxide produced by the Heubach-mill method are given in Table 1.

Control equipment

For both types of leady oxide plant, in addition to the conventional contactor control, Heubach offers a freely programmable Siemens Simatik or Télémécanique control system. Via a centrally arranged operating unit, all product parameters can be adjusted and automatically controlled. A six-colour dot printer continuously updates the actual values during operation.

TABLE 2

Comparison of the cost of producing 1 tonne of leady oxide by the Heubach–Barton and Heubach-mill processes

Item	Heubach–Barton	Heubach-mill
Energy	58 kW h (13 m^2gas) = DM 15.26/t	155 kW h = DM 24.80/t
Wages	0.40 h × 40 DM/h = DM 16.00/t	0.24 h × 40 DM/h = DM 9.60/t
Maintenance (DM/annum)		
filters	5000	5000
lubricants	1000	5000
melting bath	8000	8000
agitators	500	—
V-belts	600	—
toothed wheels	—	5000
store	—	2000
wages	9900	10000
	25000 DM/annum = DM 3.57/t	35000 DM/annum = DM 5.00/t
Total cost	DM 34.83/t	DM 39.40/t

A trouble-signalling table allows faults to be immediately localized and cleared. On request, a printer can be supplied that prints out the actual values of the product parameters at specified intervals and records the time at which troubles occur. This printer provides, therefore, a valuable tool for management of the system. An interface in the system allows the product parameters to be entered into a computer that can evaluate these data within the scope of a statistical process control. Interlocks in the system ensure that in the case of malfunction, the plant is automatically switched off in logical order without causing damage to the environment or danger to the operating staff.

Filter systems

The filter systems are equipped with flat bag filters. The latter are made from polyester-coated needle felts. In an off-line system, the bags are cleaned by means of a vibropulse technique. The surface is dimensioned so that a load of 100 g m^{-2} is not exceeded and the filter cloths can resist a permanent temperature of 130 °C. Through the inclusion of a secondary filter, designed as a pocket filter and incorporated in the filter casing, a maximum pollutant emission of 0.1 mg m^{-3} can be guaranteed. The regulations of the 'Technical Instruction — Air' at present in force in the F.R.G. specify a maximum emission of 0.5 mg m^{-3} — a value that is considerably less sensitive than that achievable with Heubach leady oxide equipment. Indeed, emissions even lower than 0.1 mg m^{-3} can be obtained if the filter systems are operated and maintained in accordance with the recommended procedure.

Production costs

Table 2 gives a typical analysis of the costs of producing leady oxide by either of the two processes. It can be seen that the Barton method affords the more economic route.