DEVELOPMENTS TO THE CHLORIDE TYPE 8 OXIDE MILL INCLUDING COMPUTERISED PRODUCTION CONTROL

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Introduction

Some 25 years or so ago, the company now known as Chloride Technical and Trading (CTT) developed and manufactured a wide range of machinery and process plant. This equipment was initially for use in Chloride's own factories, and later, as Chloride's requirements became filled, the supply was extended to associates and third parties. With the growth in Europe and North America of specialist battery equipment manufacturers, however, other suppliers were compelled by market forces to continually improve their products and thus the competitiveness — both technically and commercially — of many items of plant produced by CTT was reduced. Nevertheless, in many markets (*e.g.*, Eastern Europe) some items of CTT plant had achieved a very high reputation for quality and longevity so that the demand for these items continued. Foremost among these was the range of ball mills for battery oxide production.

Historically, Chloride was a company with a strong preference for ball-mill oxides typically containing about 60 - 65 wt.% PbO. The range of oxide plants was, therefore, of this type and the company's factory processing technology was organised to match this PbO level. Ball mills were produced with outputs ranging from about 15 t/week (90 kg h^{-1}) to 200 t/week (1190 kg h^{-1}). As time passed, the range of mills was reduced, in effect, to one type only — the Chloride Type 4 with a 100 t/week output (Fig. 1).

As the Chloride Group expanded and modernised its factories up through the 1970s there was a particular need to replace those mills that had small outputs. During this time, there was also considerable discussion within the industry about the relative characteristics of reaction (Barton)-pot oxide and Hardinge (ball-mill) oxide, especially in relation to the amount of free lead in the oxide and its subsequent effect on battery performance and initial capacity. The response of CTT was to design and build the Chloride M40 ball mill. This was a new approach for CTT but one that used a well-known principle — the air swept, or venturi, classification system — such as that found on the Shimadzu mill. The product from this type of classification is typically 70 to 75 wt.% PbO and can be even higher at an output of above 40 t/week (Fig. 2). There were several attractions with this plant, apart from the increased PbO levels, especially the ability to stop and start easily without scrap and the fact that special (and substantial) foundations were

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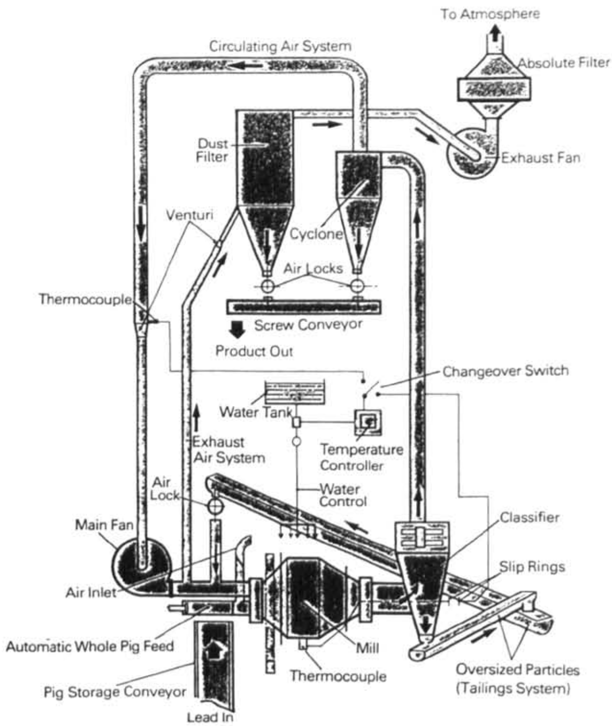


Fig. 1. Chloride Type 4 leady oxide mill.

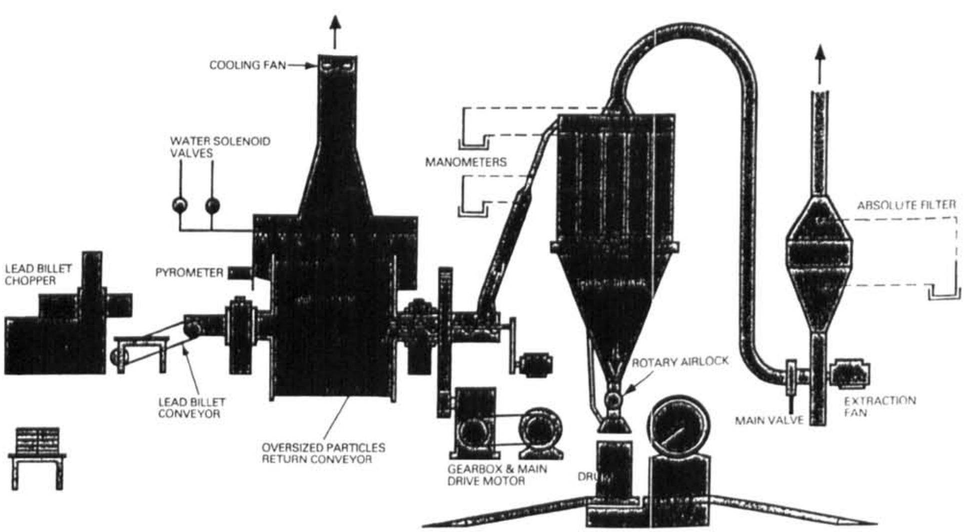


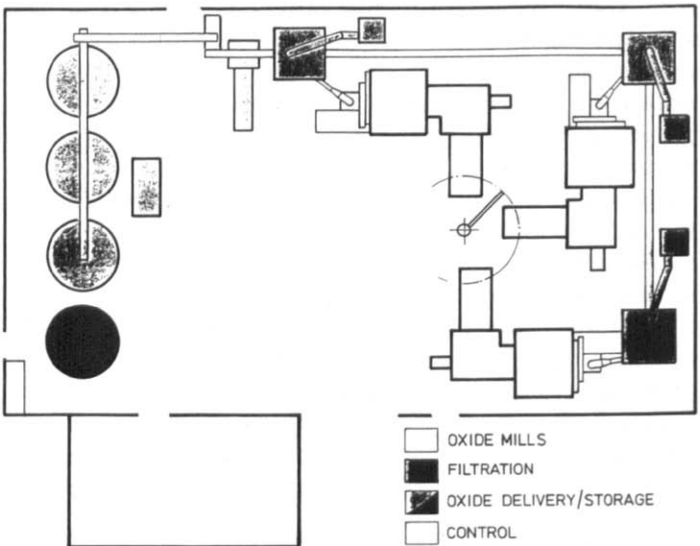
Fig. 2. Chloride Type 8 leady oxide mill.

not required. Also, of course, the fact that the plant could be operated at 60 - 65 wt.% PbO levels meant that existing processing specifications could be maintained if the user required.

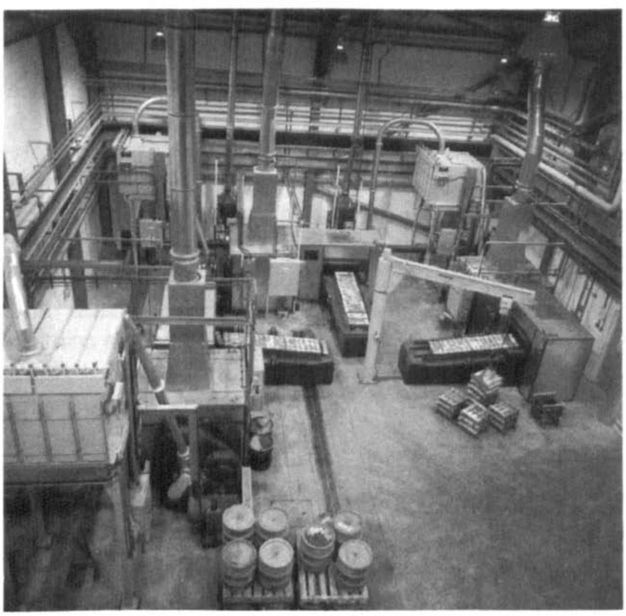
Development of the M40 mill began in the early 1970s and from the beginning it was decided that the mill feed should be in the form of whole lead billets rather than pre-cast cylinders or balls. A new system had to be developed whereby the lead pigs were chopped into pieces of about 12.5 kg prior to feeding through the mill trunnion. The size of these pieces obviously affected the throughput of the mill and a later development uprated the mill to a more acceptable 50 t/week; this model was called the Chloride Type 8 mill. Other design features included ease of installation — all major components being floor mounted and without the need for structural steelwork or special foundation — a high level of control and instrumentation, and inbuilt safety and environment features. Naturally, all these improvements added to the manufacturing cost and in the business climate at the time the perceived benefits were often not enough to justify the extra price to many customers, especially those in the developing countries where such a plant would be most desirable. Furthermore, since CTT had rationalised its own machinery development and building programme to a small range of equipment and had begun to market a much wider range of plant from specialist suppliers, the facilities and finance to develop the mill into a more acceptable machine were no longer available.

With the advent and development at Chloride Industrial Batteries of the recombination 'Powersafe' battery, a new opportunity arose. The outstanding success of Powersafe in world markets led to the complete modernisation of the Clifton Junction site in Manchester — a process that is still continuing. As part of this development, CTT were engaged to supply much of the machinery and plant for the new manufacturing unit. Although output requirements required some 150 t of oxide per week, the factory engineers decided to install three Type 8 mills, rather than the 100 or 200 t Hardinge mills normally used in Chloride's U.K. factories (Fig. 3). This decision presented an ideal opportunity to modernise the Type 8 mill and provide it with a wider appeal to world markets requiring up-to-date control and monitoring technology.

Apart from the control and monitoring system, there was one other area of major change with the advanced Type 8 mill — the mill feed system. The basic idea of not melting lead to cast cylinders to feed the mill was retained, but a new approach was required that would produce large numbers of chopped lead pieces and make them available to any one of three individual mills. The eventual design incorporated a centrally located billet chopper and feed table. The basic principle is that the operator uses a swing jib crane to load each storage conveyor with lead billets. From this point on, the feed system operates automatically; the progress of the billets is controlled and monitored by a series of photoelectric proximity and reed switches. Billet alignment and position are controlled automatically and the weight of the lead billet is recorded on the central panel computer for production control and costing purposes. When the load in the mill falls below a fixed level, the sensors signal to the chopping system that more lead is required. The chopped pieces fall down a feed chute and their passage is registered on the



(a)



(b)

Fig. 3. Chloride Type 8 oxide milling installation: (a) schematic of layout; (b) actual operation.

control panel. This sensor also indicates if there is a blockage in the system; the chopping system is stopped automatically in the absence of a signal that a full billet has been cut and fed into the chute.

Once into the system the lead is controlled and monitored by the electrical panel that incorporates programmable logic control (PLC), Fig. 4. The PLC used in the Chloride system is an IBM compatible computer, the hardware consisting of:

PLC Auxiliary panel
IBM Computer
IBM Keyboard
500 mm Colour graphic screen
355 mm Mono text monitor
Epsom printer

Extra wiring and cabling for inter-connections and communications between the plant and the panel is also necessary. The advantage of computer-based operation lies in the capability to vary the amount of control and the information collected from the system. The following options are available.

(i) Full sequential control for plant start-up/shut down, automatic cooling around a set point, alarm indication, early prediction and detection of the mill product going out of specification (Fig. 5(a)).

(ii) By using pressure transmitters and flow monitors, the operating conditions of the air and water lines can be continually monitored and the amounts used tabulated.

(iii) For maintenance scheduling and breakdown/failure prediction, thermocouples can be added to key items such as bearings, motors and gearboxes and the temperatures monitored and displayed.

(iv) The normal manometer system for indicating the air pressure within the bag filter can be replaced by calibrated airflow transmitters. Failure of

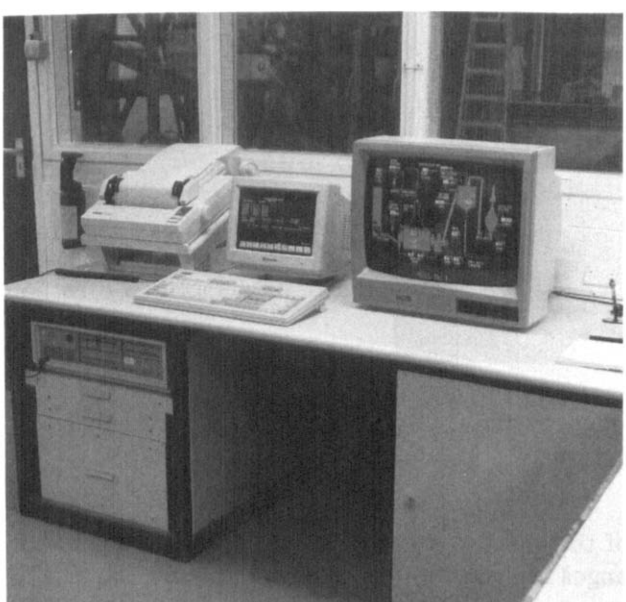
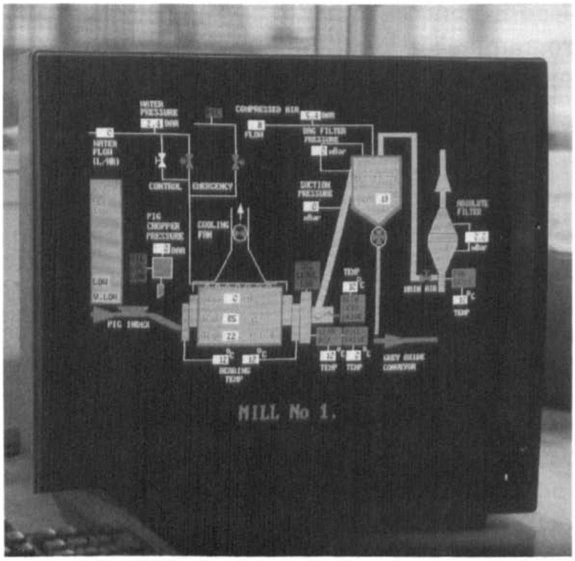
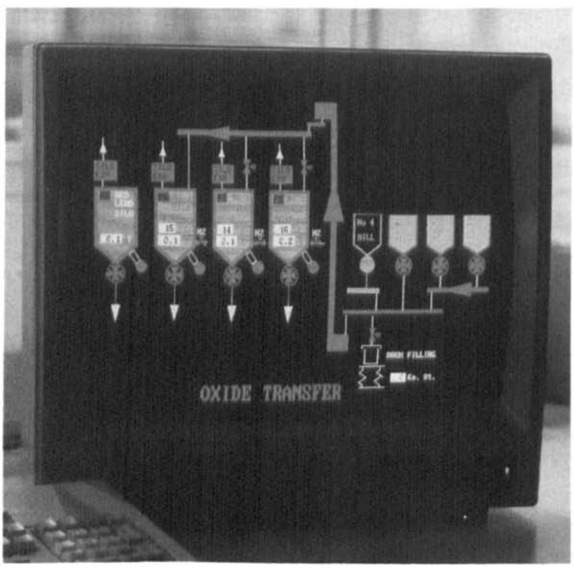


Fig. 4. Programmable logic control system of Chloride Type 8 leady oxide mill.



(a)



(b)

Fig. 5. Graphic representation of operations of Chloride Type 8 leady oxide mill on PLC system.

any filter bag, or blinding of the absolute filter is instantly detected. In addition, by monitoring the changes in pressure over a period of time, bag changing and maintenance requirements can be scheduled well in advance (Fig. 5(b)).

(v) The standard Type 8 mill has multipoint detection of temperatures within the system; these are recorded on chart paper. With the PLC, the temperatures can be sent to the printer and produced as coloured graphics at the end of each shift. This information is stored in the computer memory for typically 28 days, after which it is transferred to floppy discs from where it can be retrieved for screen display at any future time. The same procedure can be used for other information, *e.g.*, the silo storage level probes, load cells, temperature monitoring, etc.

(iv) From the management-information/cost-control aspects, the computer system can be set up to compile: the amount of lead put into the mill; the quantity of oxide produced; the amounts of oxide put into the silo/storage system and into drums; the amounts of electricity, water and compressed air used. The information can be printed separately or, if the facilities exist, linked into a factory computer network.

With the advanced Type 8 oxide mill, the versatility and scope for monotoring and gathering control and management/cost information is considerable. Not all manufacturers will require all the options, others may need different options. There are negative factors, of course, not least among these are the cost of the system and the problems that may occur in some countries in servicing the equipment. With careful specification of requirements and the undoubted reliability of solid-state componentry, however, the disadvantages are easily outweighed by the ability to predict failures and to gain a good knowledge of the operations taking place within the system.

The extensive range of equipment available for producing batteries is, as can be seen from the literature and information given out by machinery manufacturers, continually being expanded and made more sophisticated. CTT's experience, even in the less industrialised countries of the world, shows that it is difficult to direct buyers' attention away from what is perceived to be the 'state-of-the-art' towards simpler basic equipment which, in many cases, would be more appropriate. The use of PLC equipment to supplement basic control systems seems to be a fairly sensible middle course between highly sophisticated, fully automatic machinery and the old, standard mechanised equipment no longer acceptable to most purchasers. PLC control has the aura of modernity and can be incorporated at reasonable cost and with confidence in its inherent reliability.