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DEVELOPMENTS IN PASTE MIXING FOR LEAD/ACID BATTERIES

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Introduction

This paper discusses the OxMaster paste-mixing plant which is now operating successfully at lead/acid battery factories in many parts of the world including England, France, Iraq, Japan, Malaysia, Morocco, People's Republic of China, South Korea, U.S.A and Wales

The plant is a totally self-contained unit with the major components closely fitted together for environmental sealing and ease of access. A structural network holds the paste feeder at a proper height above the pasting machine. The mixer is placed on a platform so that maintenance and inspection can be carried out conveniently The weighing and dispensing equipment for oxide, acid, and water are mounted directly over the mixer in a single package. OxMaster systems are completely pre-assembled to include piping, wiring, and controls for quick installation on the battery manufacturer's site.

Paste mixer design and operating principles

Dispensing equipment

The dispensing tower in the OxMaster system is a packaged assembly that contains the oxide storage hopper, the acid weighing tank, the water meter, and the entire assembled circuit of valves, piping, hosing, load cells, and electrical wiring. The hopper is lined with Teflon® and has a thumper that operates only as the oxide hopper nears empty

Mixer

The mixer shell has a high-quality machined finish on its inner surface. The carbon steel version has a 316 stainless-steel liner bolted to the bottom. The mixer is designed to have a large diameter and a low shell height in order to facilitate cleaning access and cooling The units are fitted with two, as opposed to one, discharge doors in case it is required to feed two pasting lines The rotating parts of the mixer consist of a very heavy centre block mounted on the main shaft with arms extended to support the mixing blades. The latter take the form of an adjustable inside-wall scraper to remove paste continually from the centre-well wall, a second scraper that

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cleans the outer wall of the shell, and main mixing blades that look like flags. All of these blades enter into the mixing process. The centre block is encapsulated in Carpenter 20Cb3 stainless steel and has a tapered bushing for easy removal

When the mixer blades are rotating, a force is applied to the ingredients in the mixer The combination of blades completely scours the floor and walls of the mixer with every revolution The angle of the blades is also responsible for the rapid discharge of paste from the mixer (in about 45 s). Acid is introduced through two pipes that rotate with the mixer blades The face of the main mixing blades consists of a 25 mm thick piece of Ultra High Molecular Weight (UHMW) polyethylene that provides excellent wear and cleaning characteristics The outside-wall scraper likewise cleans much of the paste from the outer wall with each revolution. It has a UHMW polyethylene insert and is adjustable.

The large vertical center shaft is made from high-yield stainless steel The mixer is designed so that the main shaft is rigidly supported on roller bearings that are located outside the mixer and the paste environment The upper bearing is mounted on the Teflon®-coated bridge of the mixer, whilst the lower bearing is located on the bottom plate of the mixer and is protected by the dry well The latter rises from the centre of the shell and provides a seal which is well above the wet mixing action

Acid is introduced into the mixer by passing through the bridge The flow is controlled by a fixed orifice plate, and the acid is dispersed through a ring made from a machined piece of UHMW polyethylene Water entry is also via the bridge, and it is dispensed as quickly as possible in order to clean the rotating-blade assembly

Paste feeder

The paste feeder is a rotating-funnel/stationary-blade device that provides a controllable flow of paste from the mixer door to the paste machine The unit is completely enclosed to prevent escape of environmental contaminants, and to keep the bearing and gear mechanisms clean It should be noted that the paste feeder has been designed as a harmonious part of the mixer itself. The upper housing completely encloses the door mechanism of the mixer and snugly nestles against the mixer shell

The secret of the excellent self-cleaning characteristics of the feeder lies in the stainless-steel funnel, which is spun to a very accurate, very hard surface on a Meanite mandrel. It is then an easy task for the stationary blade which pivots on "Align-a-ball" bearings, top and bottom, to wipe the funnel clean

Controls

The OxMaster control system is based on the latest technology in micro-processor logic systems, incorporating most of the popular international brands such as Modicon, Allen Bradley, Texas Instruments, GE, Omron, and others A full manual back-up is provided for those rare occasions of automatic failure

One of the most important features of the OxMaster mixer is its excellent cooling characteristic Because of the large diameter and surface area of the shell and the low shell height, most of the cooling air is directed onto the material being mixed Cooling is accomplished by air only. A slight negative pressure is present at all times When cooling of the mix is required, the inlet damper is automatically opened allowing up to 85 m^3 min^{-1} of cooling air to enter. The continuing path of cooling air carries it across the paste and out of the exhaust damper. The automatic exhaust damper can also provide matching make-up air when required to keep the system in balance Suction energy is usually provided by a wet scrubber, and in many cases the existing plant system can be used. Most current operators of OxMaster are making 1100 kg batches in from thirteen to twenty minutes with discharge temperatures of around 45 - 48 °C Two to five minutes longer can result in discharge temperatures around 40 °C Those currently using OxMaster mixing systems seem to agree that not only is the production rate high, but the quality of the paste is very good and very consistent.

Advantages of the system

The following advantages are claimed for the OxMaster system

(i) The paste plant is almost completely pre-assembled and ready to operate when it arrives at a battery factory. This eliminates the weeks of expensive installation time normally associated with a paste mixing system It can also save much expensive downtime if a replacement plant is being put in the place of an old one.

(ii) The system produces consistent high quality paste with shorter mixing cycles.

(iii) The mixer and feeder are substantially self-cleaning, with final clean-up being a much easier task than in the past.

(iv) The mixer has excellent cooling — by air only.

(v) Because of the compact and enclosed design, environmental problems are considerably reduced.

(vi) The system is constructed from acid-resistant materials for longer life

(vii) Emphasis has been placed on simple maintenance and easy access.

(viii) The system is automatically operated by sophisticated electronic controls

Retrieval of waste paste

Many attempts have been made to return waste paste from the plate pasting operation, and there are a few systems in operation worldwide similar to the OxMaster unit discussed here The reason why most attempts to retrieve waste paste have failed is due to an over-simplification of the problems involved with paste-machine alterations, materials of construction for corrosion and wash-down resistance, controls and interlocks for operator

convenience and safety, dependable mechanical components, and ease of maintenance

Two types of OxMaster paste-return system are available one with three belt-conveyors for use in automotive-type plants that have drying ovens at the end of the pasting machine, and a four-belt-conveyor system for use in plants making larger industrial plates that have a run-off conveyor instead of a drying oven The systems have been designed in modular fashion with a central support frame that provides flexibility for mounting to different sizes and types of pasting machines The support frame also houses the waterproof wireway for control wiring, interlock limit switches, and the rollers to provide movement to the final conveyor

The reclaim system is capable of handling the worst possible waste conditions

When installed on an industrial paster, a three-belt system does not interfere with the normal operation of the pasting machine The first belt comes from beneath the pasting-machine head pulley where the mud box is usually located The system actually removes the need for a mud box and, obviously, eliminates the labour required to shovel mud during pasting operations. The first belt moves paste to the intermediate belt which takes the paste to the final belt for return to the pasting-machine hopper. The final belt can be moved in or out, on command, so that room is provided for the hopper to be lifted

The controls of the retrieval system are electrically interfaced with those of the pasting machine to provide automatic, simultaneous operation of both systems, the final conveyor is automatically retracted when the paste hopper is raised Control over the system is provided by a small, programmable logic controller that is mounted on a panel along with the main disconnect, the control transformer, the motor starter switch gear, the solenoid air valves and the trouble shooting simulator switches, malfunction sensors to detect broken belts or slipping pulleys are incorporated in the system. The ease of mechanical disassembly of the system is enhanced by the ease of electrical disassembly resulting from the use of space-age, water-tight connectors that are toggle operated and come complete with seal covers attached

Most conveyor parts are made from high quality UHMW polyethylene or stainless steel, which allows easy washing and cleaning and also long life against corrosion The belting has a Nitrile COS cover which provides excellent wearability and is ideal in wash-down situations The belts have no plies to separate, providing excellent fray resistance. The belt scraper is a weighted device with a machined blade of UHMW polyethylene

Slurry return system

The purpose of the slurry return system is to catch drippings from the squeeze roll of the pasting machine The squeeze-roll slurry is collected at a

steady rate in small quantities. In some plants, the retrieved material is recycled back to the pasting machine hopper; in others, the slurry is returned to the lead recovery and de-watering system. For automotive battery plants, the squeeze-roll slurry can be stored in an agitated surge tank equipped with a slurry pump similar to the one under the pasting machine. During the mixing cycle of the negative paste, a measured quantity of stored slurry can be introduced into the mixer.