



DATA SHEET SERIES M-8 BALL MILL OXIDE SYSTEM

PROCESS DESCRIPTION

BALL MILL FOR BATTERY OXIDE

THE EAGLE **SERIES M-8 BALL MILL OXIDE SYSTEM** has been developed to produce a high quality **Battery Oxide** to demanding specifications for use in lead acid batteries.

Battery Oxide is a type of *Leady Oxide* that has portions of its material as non-reacted free metal lead (Pb) and lead oxide (PbO). The free metal lead portion is a fine powder and is in the range of 20 to 35% of the mix; the lead oxide portion is the remaining percentage and consists of small particles that have a predominate tetragonal crystal structure (α PbO).

SERIES M-8 has mechanical features and a PLC based control system that automatically maintain operating conditions in the ball mill that directly affect important **Battery Oxide** characteristics, such as; Pb/PbO ratio, PbO crystal structure, particle size, and surface texture.

SYSTEM OPERATION

Lead ingots are melted in a melting pot. Molten lead is pumped to a water-cooled casting machine that casts 50 gram cylinders of lead. The cylinders are transported to a 40-ton surge tank where an appropriate inventory is maintained.

Cylinders are weighed and metered into the rotating drum of the ball mill at a rate that matches the production rate of oxidation process.

As the lead cylinders are tumbled inside of the ball mill, they oxidize on their surface to lead oxide. The oxide particles abrade off the cylinders and are milled by the tumbling action of the mass.

Friction between the cylinders creates heat that initiates the oxidation process, then, after the oxidation process is established, a large amount of heat is generated by the exothermic reaction of lead converting to lead oxide. Exothermic heat raises the temperature of the mass of material in the mill, which accelerates the oxidation process.

A draft of air through the mill carries the **Battery Oxide** out of the mill and into the collection system. Heavier particles remain in the mill until they are small enough and light enough to be carried by the air.

The collection system baghouse is fitted with high temperature, membrane coated, filter bags that hang vertically and are cleaned with a pulse of compressed air. Oxide is deposited in an oversized baghouse hopper and continuously discharged through an oversized auger screw conveyor and rotary air lock. From here, the **Battery Oxide** can be transported to a storage tank using any of several conveying methods.

Air exhausting from the baghouse passes thru a HEPA filter before exhausting the system, assuring that the system meets strict environmental regulations.

PLC MONITORING / CONTROL

SERIES M-8 control systems allow the operator to independently monitor and control the oxidation process. Sensors located at several locations in the equipment measure critical operating conditions. Data is analyzed by a central PLC that automatically maintains optimum conditions for a steady reaction.

The three most important PID loop functions automatically react to and control:

- 1) **Temperature** of the reacting oxide mass.
- 2) **Weight** of the oxidizing mass in the mill.
- 3) **Draft** of air through the ball mill.

Alarms, an automatic cool down procedure, and an emergency shut down sequence allow the system to operate with a high level of security. Operating data and alarms are logged and downloaded to electronic files. *Real Time* and *Historical* trending charts graphically display essential data that help the operators and process engineers adjust the system for optimum performance.

PRODUCTION RATE

280 to 333 Kilograms per hour

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620 to 725 Pounds per hour

CONTROLS DESCRIPTION

TEMPERATURE SENSING / CONTROL

The system temperature profile is monitored using multiple thermocouples and sensors;

- The lead melting and cylinder casting equipment uses thermocouples to monitor and control the casting process.
- The ambient air temperature and humidity are measured and the data is stored in the PLC.
- An IR sensor measures the temperature of the mill drum near the discharge end. A small pressure fan blows cooling air onto the external surface of the ball mill.
- Two thermocouples mounted in the discharge tube independently measure the oxide/air mix as it exits the mill and enters the riser pipe to the collection system. A high temperature alarm on either sensor will cause the PLC to initiate a water-cooling system on the external surface of the mill drum and slow the drum rotation speed with VFD option). A differential alarm between the two sensors warns the operator that the thermocouples need cleaning.
- Additional thermocouples are located in the ▪ baghouse hopper, ▪ between the baghouse and HEPA.
- Thermocouples mounted in the two mill bearings and on the drive gearbox output bearing, monitor those components for heat related conditions.

LOAD AND LEVEL SENSING / CONTROL

Load cells monitor material load in several key components and provide this information to the PLC for process control and inventory evaluation:

- The cylinder storage tank uses load or level sensors for inventory control of cylinders to feed the ball mill. **(Recommended Option)**
- Cylinders are weighed and metered into the ball mill in 2 to 5 kg increments. Each

increment is weighed as a *mini-batch*; the PLC accumulates the data and reports the information as accumulative weight per unit of time, average feed rate per minute and per hour.

- The entire ball mill and drive assembly, including the oxidizing material in the mill, are weighed with very accurate load cells. When the load cells sense that oxide exits the ball mill to the collection equipment, the PLC activates the cylinder feed system to add cylinders to the ball mill.
- The collection equipment support structure is weighed. **(Recommended Option)** If material accumulates in the baghouse, posing a threat of an oxide fire, an alarm will warn the operator. If the build up continues, a second alarm will shut down the ball mill and flood the baghouse with nitrogen.

AIRFLOW AND PRESSURE SENSING / CONTROL

Airflow through the ball mill is the most critical component of producing high quality **Battery Oxide**. Airflow volume and static air pressure readings are monitored with various sensors throughout the system.

- The air volume entering the ball mill is measured. The PLC reacts to changing conditions by varying the speed of the exhaust fan to maintain a steady flow of air through the ball mill.
- Static air pressure in the riser pipe to monitor for material build up in the discharge tube.
- The differential air pressure across the baghouse filter bags is measured and will show an alarm if the pressure is too high.
- The differential air pressure across the HEPA filter cartridges is measured and will show an alarm if the pressure is too high. High pressure indicates a dust leak in the primary baghouse.
- The total air flow through the system is measured.

OXIDE SPECIFICATIONS

OXIDE SPECIFICATION	UNIT	RANGE
PbO	percent	80 to 65
Pb	percent	20 to 35
Apparent Density	grams / cm ³	1.1 to 1.6
Acid Absorption	milligrams / gram	240 to 280
PbO Tetragon Crystal	percent	99
Particle Size	median micron	2.0 to 3.0

DELIVERABLES

LEAD MELTING POT

- Capacity, 3 ton (Optional 5 & 10 ton)
- Gas Burner (Optional electric immersion)
- Fume hood (Ducts to customers baghouse)
- Lead pump and heated lead line

CYLINDER CASTER

- Variable casting rate
- 450 to 1,800 kg/hr
- Water cooled
- Replaceable cavities (3 per section)

CYLINDER STORAGE

- Elevator
- Storage tank
- Caged ladder
- Load cells (Option)

CYLINDER FEED

- Feed gate
- Weigh assembly
- Feed conveyor

BALL MILL ASSEMBLY

- Mill and drive frame assembly
- Mill drum, reversible end to end
- Inspection door
- Self aligning, double spherical bearings
- Replaceable trunion and bearing mounts
- Motor, gearbox, double roller chain drive
- Adjustable chain tensioning
- Variable speed (Recommended option)
- Re-circulating bearing and chain lubrication
- Shell cooling, air and water
- Water injection
- Load cells
- Shell housing
- Discharge tubing to collection system

COLLECTION SYSTEM

- Baghouse, vertical bags, pulse cleaning
- Inlet plenum
- Enlarged hopper
- Oversized discharge screw
- Rotary airlock
- Automatic sampler
- HEPA filter assembly
- Interconnecting duct
- Exhaust fan, variable speed
- Support frame

MOTOR CONTROL CENTER

- Main disconnect and circuit protectors
- Motor starters and overload
- Control voltage transformer
- Factory wired

CONTROL PANEL

- Free standing control panel
- PLC and panel view
- Sensors and signal conditioners
- Factory wired

DATA ACQUISITION

- Real time
- Historical
- Data storage

MANUALS AND INSTRUCTIONS

- Installation manual
- Assembly blue prints [AutoCAD]
- Operator training manual
- Operating procedures
- Material testing procedures
- Preventive maintenance procedures
- Repair and maintenance procedures
- Supplier and manufacturer warranties



CONNECTED ENERGY VALUES

<u>EQUIPMENT</u>	<u>CONNECTED CAPACITY</u>
Lead Melt Pot Heat	Natural Gas 200,000 kilocalories
Lead Line Heat	4 kilowatts
Electric Motors	Hp / kW 80 / 60
Combustion Blower	
Lead Pump *	
Cylinder Caster *	
Cylinder Elevator	
Feed Conveyor	
Ball Mill *	
Shell cooling fan*	
Exhaust Fan *	
Baghouse Conveyor	
Rotary Air lock	
* VFD Speed Control	
Potable Water	25 gal/min / 95 L/min
Cooling Water	35 gal/min / 130L/min

COST SUMMARY

Prices will be quoted in **US DOLLARS**

Prices are **EX WORKS**, Indiana, USA

MODULAR PRICING: Meltpot and casting

Ball mill assembly

Collection equipment

STARTUP and **TRAINING** are quoted separately

Standard **TERMS AND CONDITIONS** apply

Standard **DELIVERY** is 20 weeks

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