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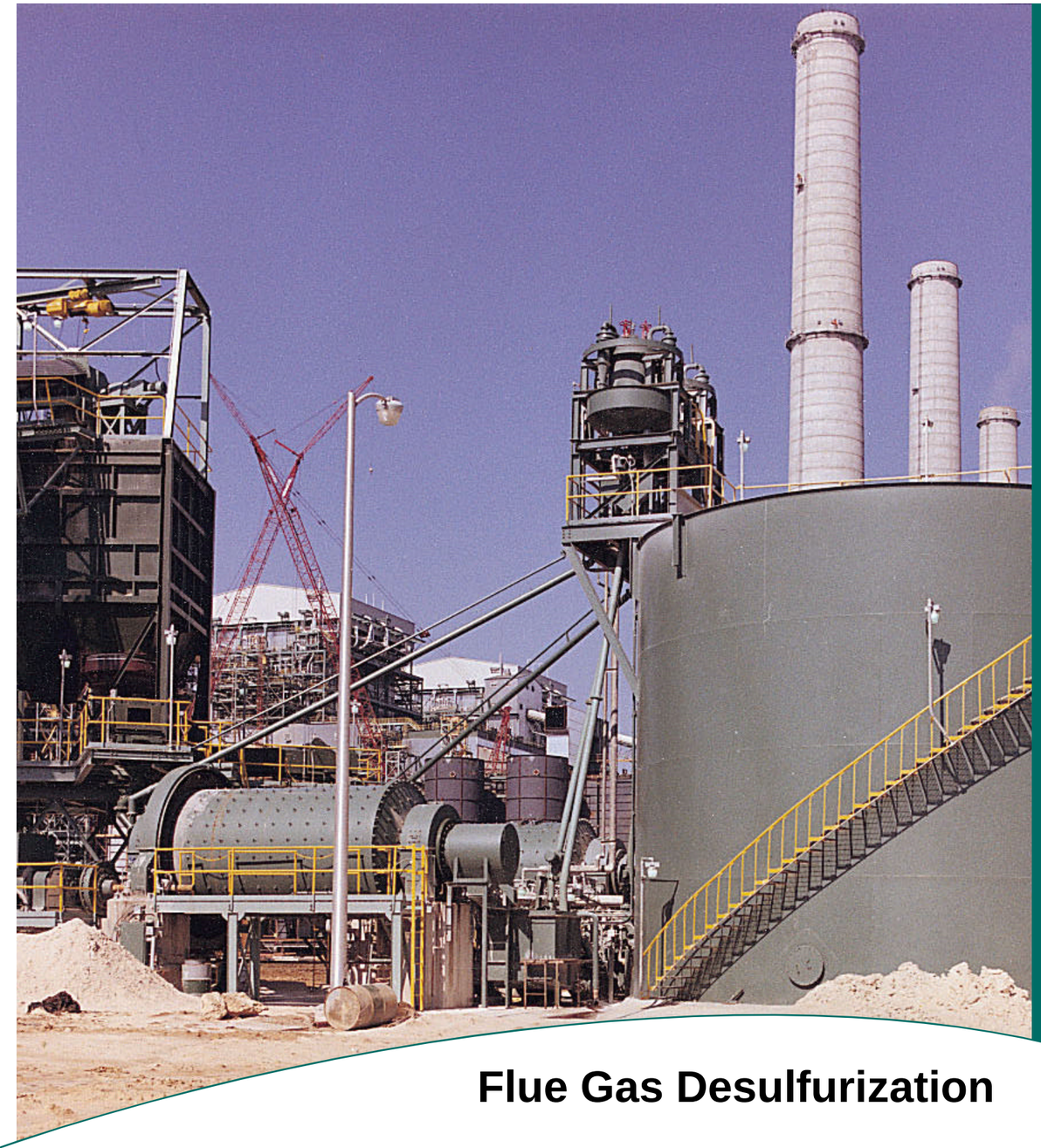

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Flue Gas Desulfurization

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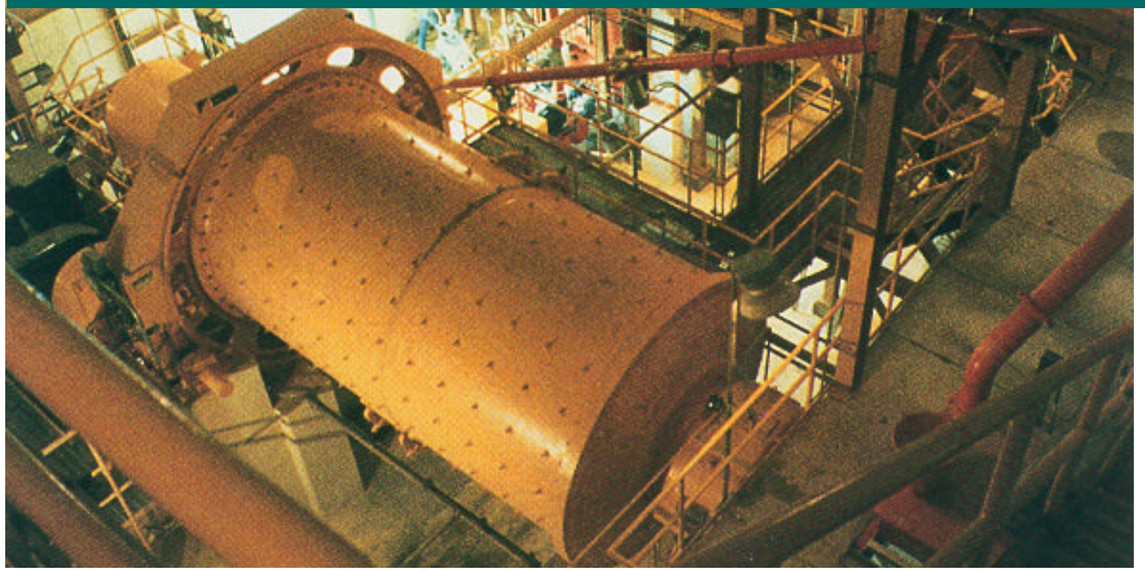


Worldwide awareness of environmental issues mandates regulatory measures which establish strict ambient air quality standards to control emission levels. For decades, many countries have been devastated by uncontrolled emissions of pollutants. The ecological balance has been damaged to the point that stringent steps must be taken to control pollutant emissions. As a result, various national and regional agreements have reduced acceptable pollutant emission levels. Highly industrialized countries with densely populated regions suffering from high levels of pollution have established the most rigid emission standards.

While the ambient air quality standards apply to all types of industries, power utilities that utilize high sulfur coals face the most stringent controls and greatest impact. Specific standards for power plants vary. New power plants are subject to more stringent standards than power plants that are currently in operation.

Various methods for compliance have been considered and utilized. Flue Gas Desulfurization (FGD) utilizing wet scrubbing is the most highly developed and proven system. Alternative forms of emission control include dry process scrubbers utilizing hydrated lime slurry to neutralize the SO_2 produced during combustion, clean coal technologies, and switching to low sulfur fuels. Undoubtedly, additional technologies will develop as research in this field continues. However, wet scrubbing will remain the mainstay for the industry for the foreseeable future.

FGD Systems are termed regenerable and nonregenerable. In regenerable systems, the SO_2 is absorbed by a chemical medium and then thermally regenerated. The regenerated SO_2 is treated to produce either sulfuric acid or sulfur, and the desulfurized medium is recycled.

The majority of FGD systems currently in operation are the nonregenerable type based on technology using lime or limestone as the SO_2 removal medium. In each case, a slurry is prepared which interacts with the flue gases forming compounds of calcium sulfate/sulfite. The scrubbing medium is a calcium carbonate slurry for limestone and a calcium hydroxide slurry, commonly known as milk-of-lime, for lime. The product slurry consisting of water, fly-ash and calcium sulfate/sulfite is filtered and released into storage ponds.

Many countries suffering from high levels of pollution require that the products from FGD plants must be commercially usable. This policy eliminates waste product disposal, generates a source of revenue that offsets operating costs and reduces possible future liability from waste disposal. The latest scrubber technology is capable of producing a wallboard grade of gypsum with complete oxidation to form $CaSO_4$. Often this process includes “forced oxidation” which introduces air into the slurry to complete the reaction. Precise performance of the limestone grinding system is essential, because maintaining consistent limestone particle size in the reagent is necessary to insure the formation of high quality $CaSO_4$.

LIMESTONE CHARACTERISTICS

Ball Mill sizing is based upon tonnage, feed size, product size, operating or test plant data or the Bond Work Index Method. The Bond Work Index indicates a relative grindability of the limestone. The Work Index number (WI) is developed by grinding a small sample of the material in a laboratory unit using a defined procedure.

The power requirement for grinding, based on the Bond WI (typically 9-13 for limestone), is defined as follows (where P=80% passing product size and where F=80% passing feed size):

$$\frac{HP - HRS}{T} = 1.341 \times \frac{10\ W.I.}{\sqrt{P}} - \frac{10W.I.}{\sqrt{F}} \times \text{Correction Factor}$$

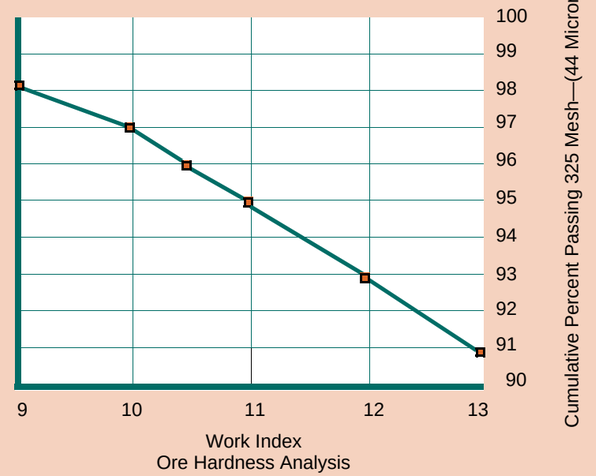
Correction factors add power for oversized feed, scalped feed, fine grinding P<74 micron, and open circuit or dry grinding when applicable. Fine grinding factor used when P80<74 micron is:

$$\frac{P80 + 10.3}{1.145\ (P80)}$$

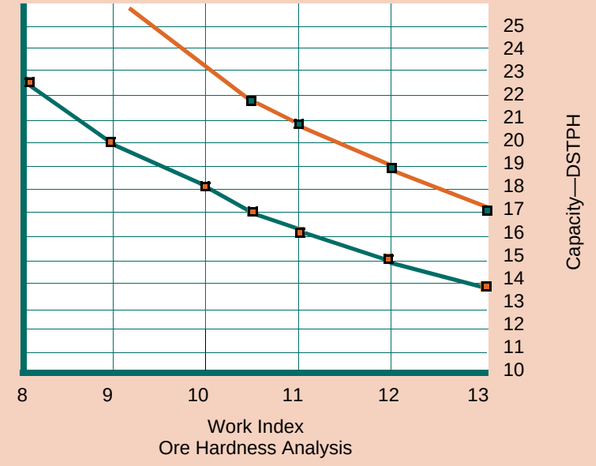
Typically, ball mill systems are sized to receive 3/4” x 0” and VERTIMILL™ systems require 1/4” x 0” feed. The feed for many systems is specified without fines for handling of 2 to 12% moisture during the winter months. This increases power requirements. For grinding a scalped feed, Metso developed scalped feed factors which are based on our vast experience at numerous operating plants. The scalped feed factor ranges from 1.03 to 1.5, depending on the feed characteristics. Therefore, the specified feed size may require up to 50% more power to insure efficient grinding system performance at the specified capacity and product size requirements.

Additional consideration must be given to the amount of the circulating load (recycle) and its effect on grinding system performance and power requirements. Typically, circulating load will range between 300% and 500% depending on feed size, limestone hardness, mill characteristics, ball size, etc.

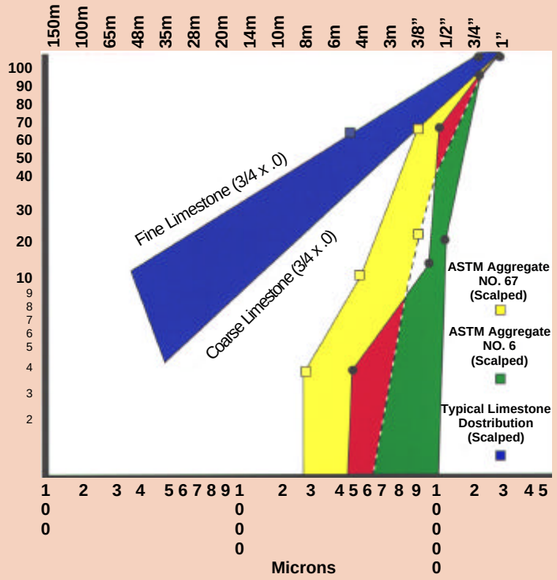
Typical Generating Station
Work Index Versus Product Fineness



Typical Generating Station
Work Index Versus Capacity



Typical Feed Distribution



Typical Densities in Circuit

Mill Discharge:	65 to 70%
Cyclone Feed:	50 to 54% Solids for 95% minus 74 Microns (325 mesh) 54 to 57% Solids for 90% minus 74 Microns (325 mesh) 58 to 62% Solids for 80% minus 44 Microns (200 mesh)
Product:	27 to 30% Solids for 95% minus 74 Microns (325 mesh) 30 to 35% Solids for 90% minus 74 Microns (325 mesh) 35 to 40% Solids for 80% minus 44 Microns (200 mesh)
Cyclone Recycle:	TYP 68 to 72%*

* Often, make-up water for the new feed is added at the hydrocyclone underflow (oversize) to improve recycle flow back to the mill.

Typical 80% Passing Feed and Product Size in Microns

Feed Size			Product Size			
Millimeters	(Inches)	F80	% Passing	Microns	(Mesh)	P80
25.4 x 3.2	(1 x 1/8)	19,000	80	74	(200)	74
19.0 x 12.72	(3/4 x 1/2)	15,000	80	44	(325)	44
19.0 x 0	(3/4 x 0)	14,000	85	44	(325)	37
12.7 x 0	(1/2 x 0)	9,400	90	44	(325)	31
9.5 x 0	(3/8 x 0)	6,400	95	44	(325)	23

As the need for flue gas desulfurization increases, Metso stands ready to provide the equipment necessary for dependable, cost efficient operation. We can provide your complete reagent preparation system from the feed bin to the product storage tank. Let our engineers review your process specifications and recommend a mill designed to optimize your FGD system

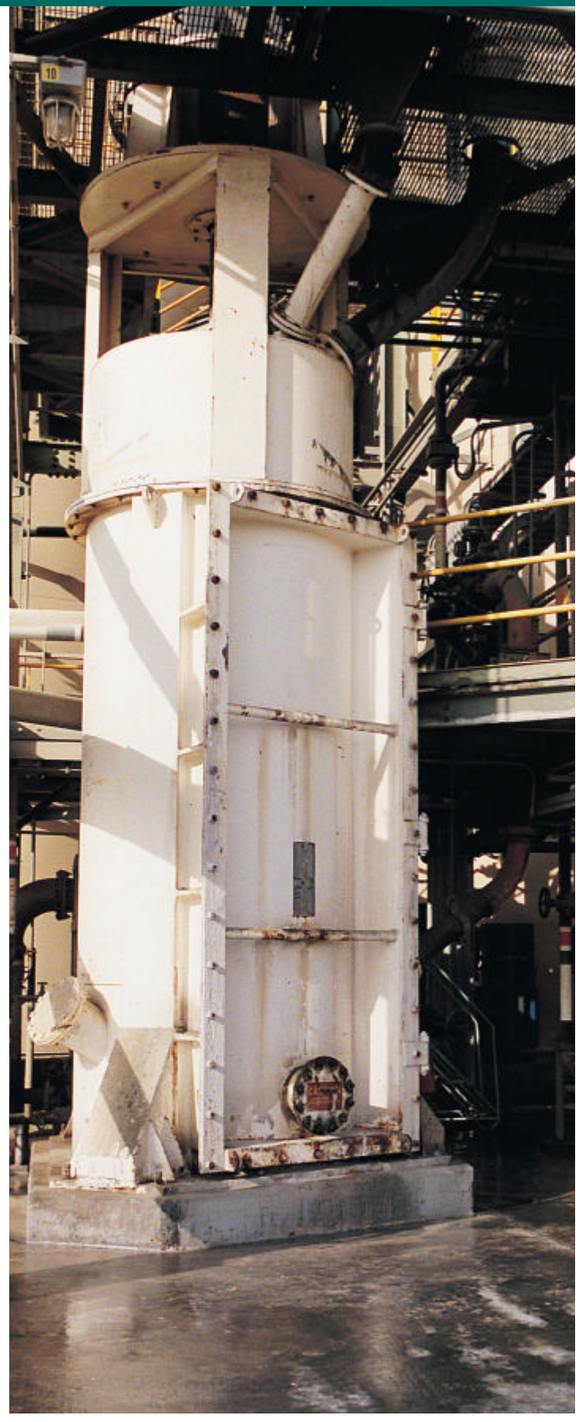
EXPERIENCE

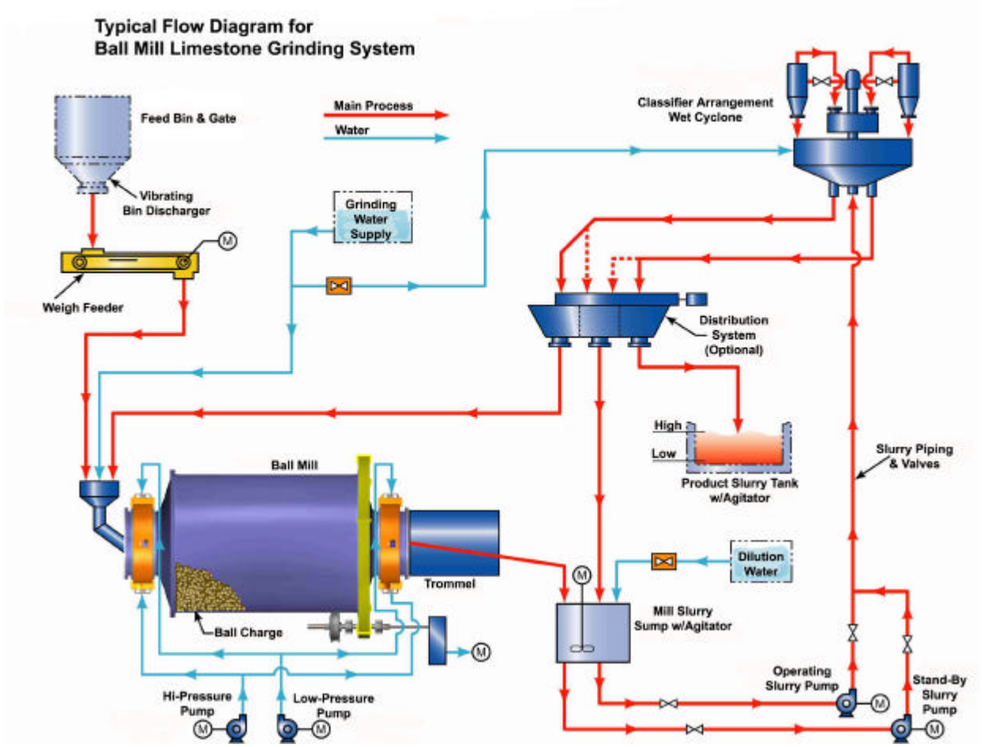
Metso Minerals combines the experience and expertise of Kennedy Van Saun (KVS) and MPSI to become the world's leading supplier of grinding systems for FGD applications. Our experience record is unrivaled with over 230 of these systems installed worldwide.

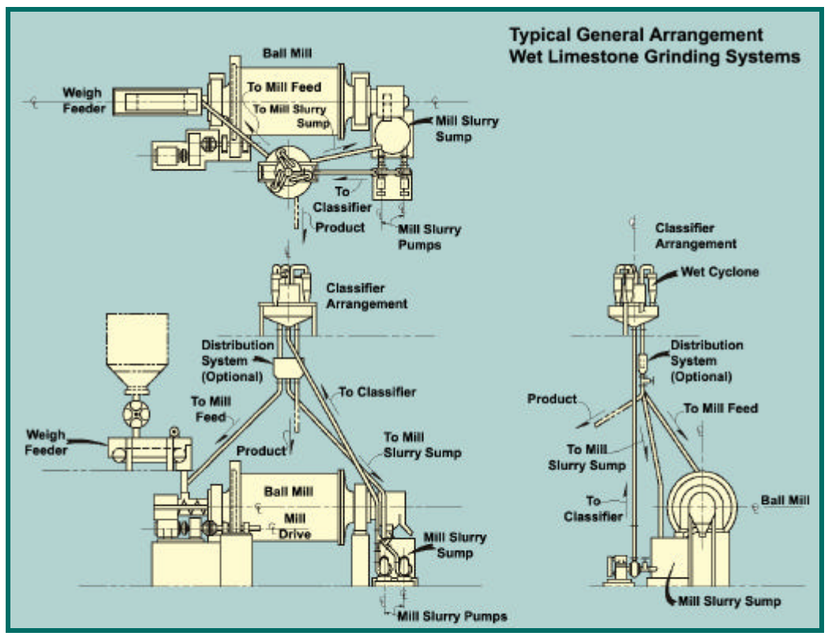
Metso offers both ball mills and the VERTIMILL™ for limestone grinding and lime slaking. Our traditional horizontal ball mill produces a consistent and highly reliable product within a closed circuit. The VERTIMILL™ presents our latest technology for FGD grinding applications. Introduced over 20 years ago, the VERTIMILL's™ proven design provides an efficient alternative for your reagent preparation. This vertical stirred grinding mill can save up to 30% on your energy costs, has lower installation and operating costs, and operates at a reduced noise level.

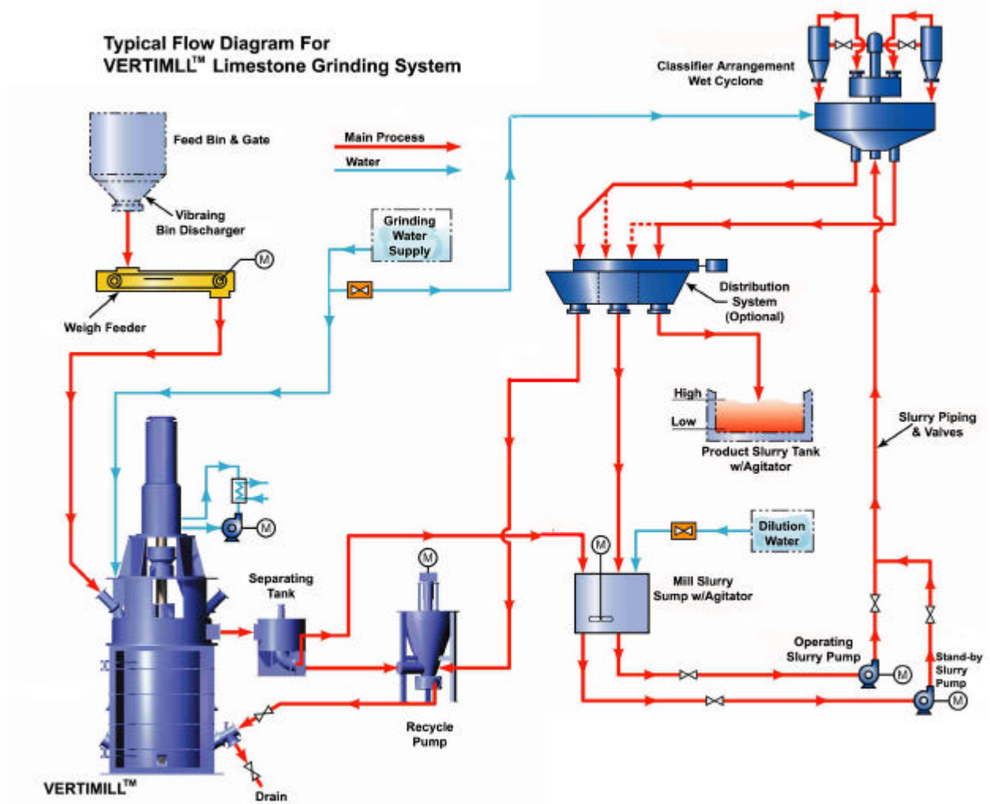
Our ECO-SYSTEMS team is a group of highly competent personnel who specifically address your FGD reagent preparation needs. They understand your need for equipment which provides dependable, round-the-clock service coal-fired power stations and industrial plants require to comply with established SO_2 emission standards.

Metso offers specialized services in the areas of design, analysis, and education for grinding systems. Our engineers design quality equipment for process optimization. Our test laboratory is available to aid in the development of your initial process circuit design. Additionally, it can be used for testing various reagent material sources to obtain reliable grindability data and to evaluate the variations in grinding performance. Our field engineers provide mechanical troubleshooting expertise and supervision for installation, operation, or maintenance assistance. Factory training for operators and maintenance staff can be scheduled on site at initial installation or at any time to upgrade the efficiency of your FGD reagent preparation system.









Control Circuit For Wet Limestone Grinding Systems

The control circuit of a wet grinding system controls the delivery of ground limestone slurry, on demand, to the product slurry tank from one or more grinding mills. Control methods range from manual to fully automatic utilizing Programmable Logic Controllers (PLC) or complete Distributive Control Systems (DCS).

In the automatic mode, the grinding system is controlled by the slurry level in the reagent product storage tank and the mill discharge sump. When the product tank reaches high level, the feeder stops; after a time delay, the clutch de-energizes; the mill stops grinding; feed water is shut-off; and the slurry valves are placed in the recycle position allowing the circulating load and product to flow through the piping into the mill sump tank. When the product storage tank reaches low level, the grinding system automatically starts and operates until the tank reaches high level. In a two-mill system, the product tank low-low level sends a signal which starts the standby mill.

The quality of the ground product is controlled automatically by monitoring and regulating the density of the slurry solids delivered to the cyclone classifiers. Particle size analysis of the cyclone overflow, typically 90-95% minus 325 mesh (44 microns), can be monitored continuously. By doing so, the operator has the necessary information to minimize reagent usage and maximize scrubber efficiency.

Metso Slaking Systems

The economics and technology of a particular FGD system may indicate that lime should be used instead of limestone. The lime is converted to milk-of-lime by slaking (i.e. by reacting the lime with an excess amount of water, above and beyond the stoichiometric requirements). The milk-of-lime is used to treat the exhaust gas stream.

Metso offers slaking systems utilizing ball mills or the VERTIMILL™. The VERTIMILL™ operates in open circuit, while the ball mills normally include a separate classification system to control particle top size