Lime Slaking :

Science of Milk of Lime Preparation

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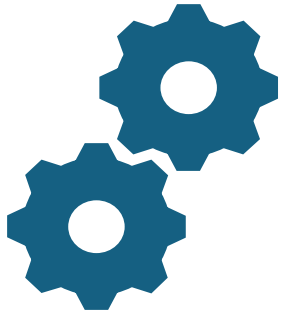
Since 2011

Lime Slaking : Process of Milk of Lime Preparation



Slaking of Lime is the process of converting Quick Lime [(CaO)] into Hydrated lime [$Ca(OH)_2$]. Although its understood as Mixing Water with Quick Lime, however the process has undergone several optimization over past few decades to improve on quality of end product milk of i.e. Lime with NIL to least of grits and controlled micro level granulation for effective use depending on application.

Team Effwa, has worked on several concepts in past over a decade and has been striving to improve design to meet customers requirement.

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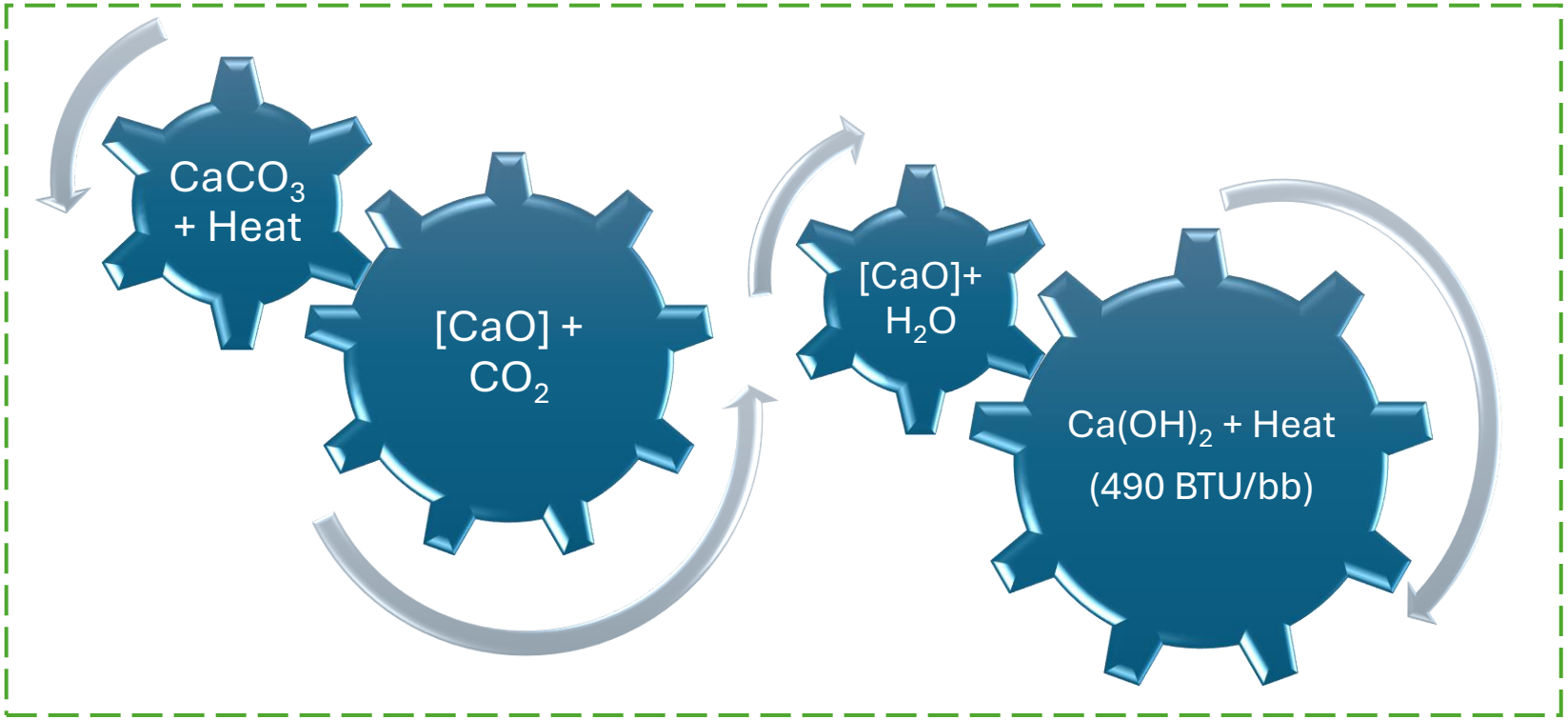
Chemistry of Lime Slaking

Limestone [$CaCO_3$] exists as a natural mineral, however, reacts very slowly, therefore, it has limited uses even in agriculture or Flue Gas Desulfurization. In most of pollution control applications lime is used in its hydrated form which involves basic chemical reactions as follows;



It means that 1 KG of reactive [CaO] requires 0.32 KG of water to produce 1.32 KG of hydrated lime [$Ca(OH)_2$] through hydration process as also called “Slaking”. When just stochiometric amount of water is added on Quick Lime it produces Dry Powder and is called as “Dry Hydration”. If excess water is used it is called “Slaking” and the product is in slurry form. The “Slaking” process is normally done with considerable excess water ranging from 2 ½ to 6 parts water to 1 part of Quick Lime.

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Types of Slakers

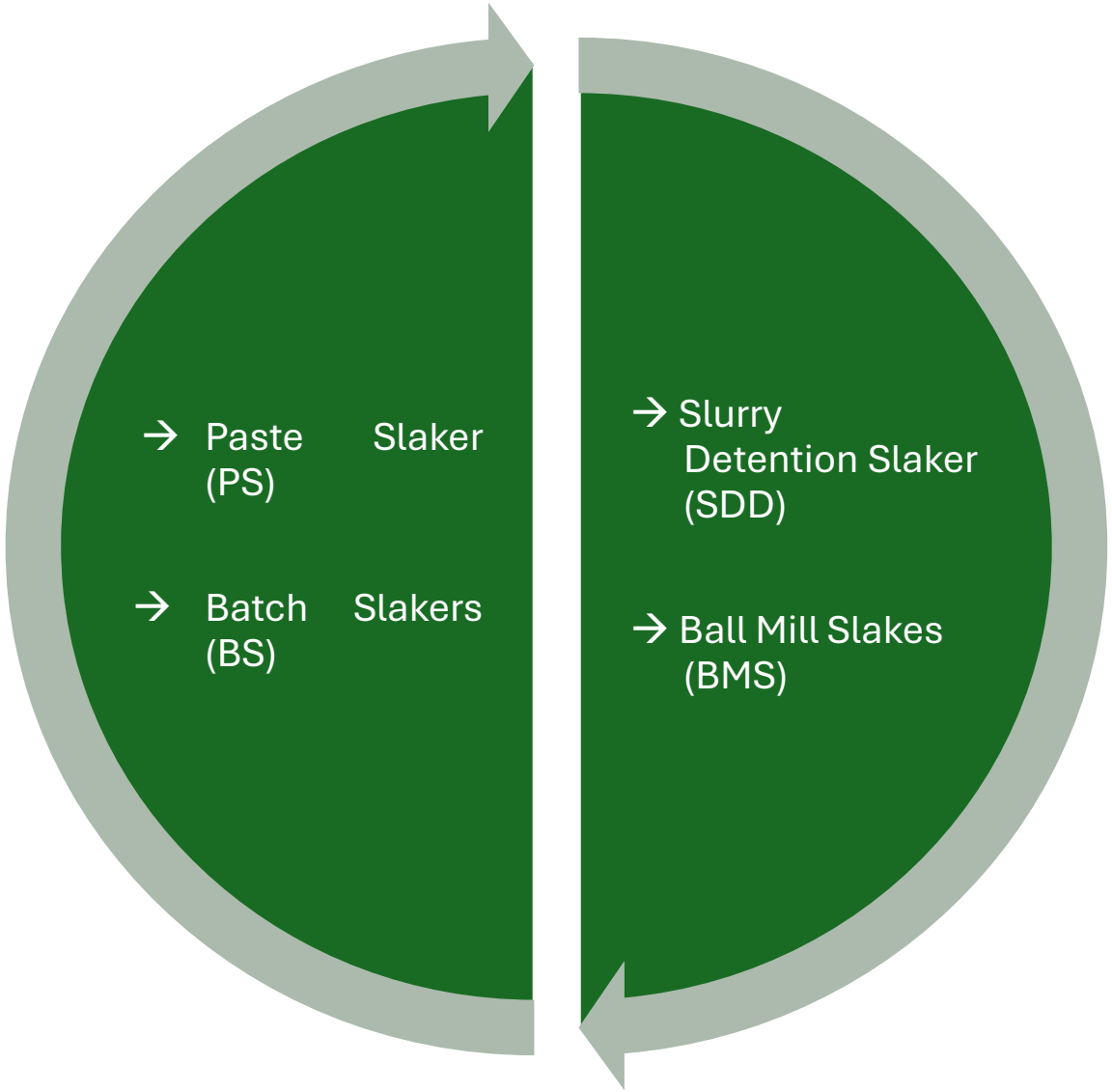
Depending upon uses such as in;

→ Sugar Mills

→ Water Treatment

→ Flue Gas sulfurization/ cleaning

→ Nutralisation/ Alkalinity inducer / Flocculant in Waste Water Pollution Control; ..... Several types of slakes are developed and employed.



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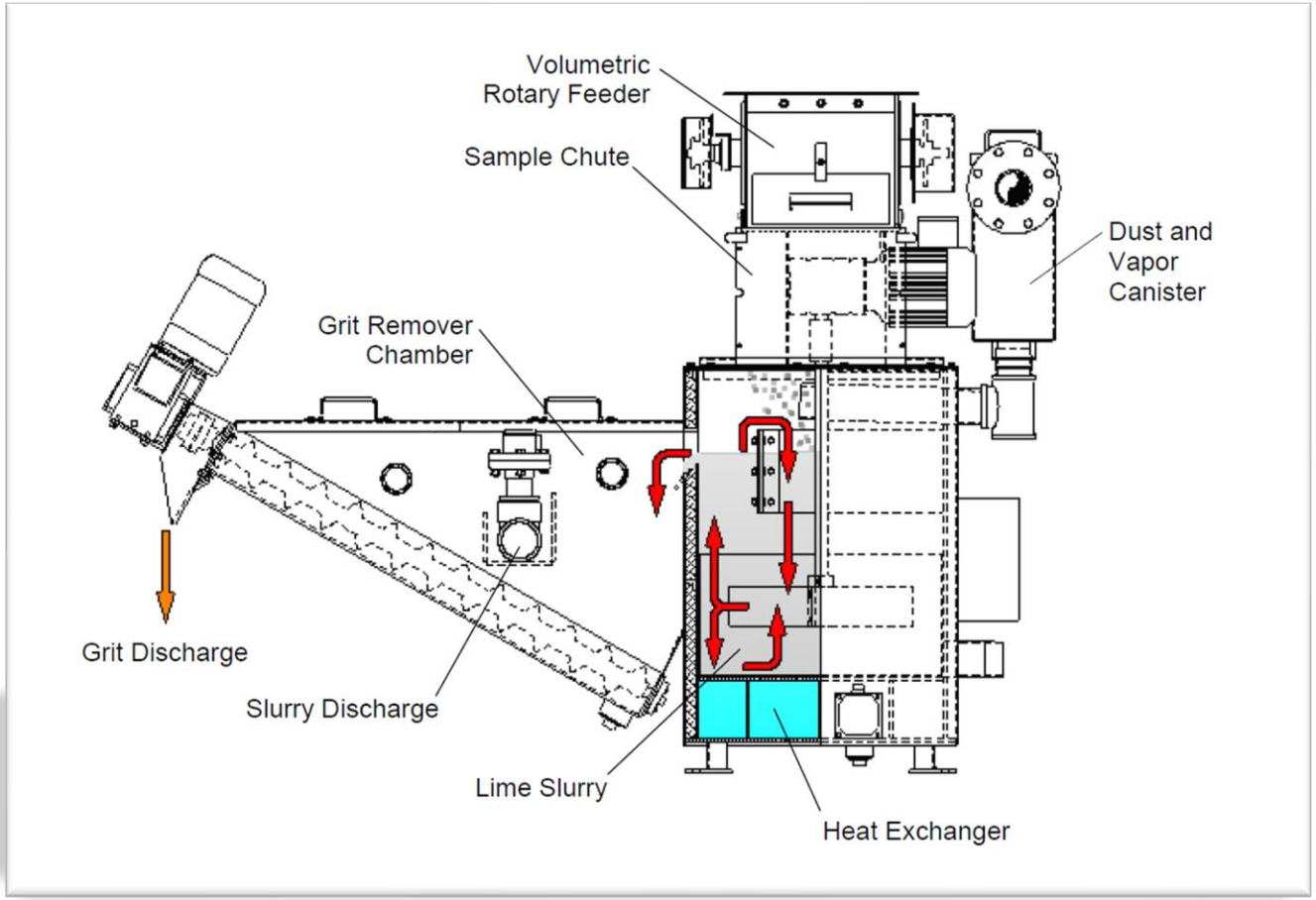
Slurry Detention Slaker [SDS]

Generally use 1 to 3.3 to 1 to 5 ratio of Quick Lime to water depending upon quality of quick lime and also known as “Detention Type Slaker” which has two to multiple chambers including Degritting chamber. With improved designs this type of slaker has become popular in past over a decade as uses of Milk of Lime have experienced better output than through other type of Slaking System.

These Slakers are available in as small capacity as 150 Kg/hr. and up to 2000 Kg/hr. Effwa design is improvised version of Slurry Detention Slaker with temperature control using vapour heat of condensation recovery and several other advantages. This type of slakers are popular for Water Treatment.



Note : The schematic is produced as reference from available literature

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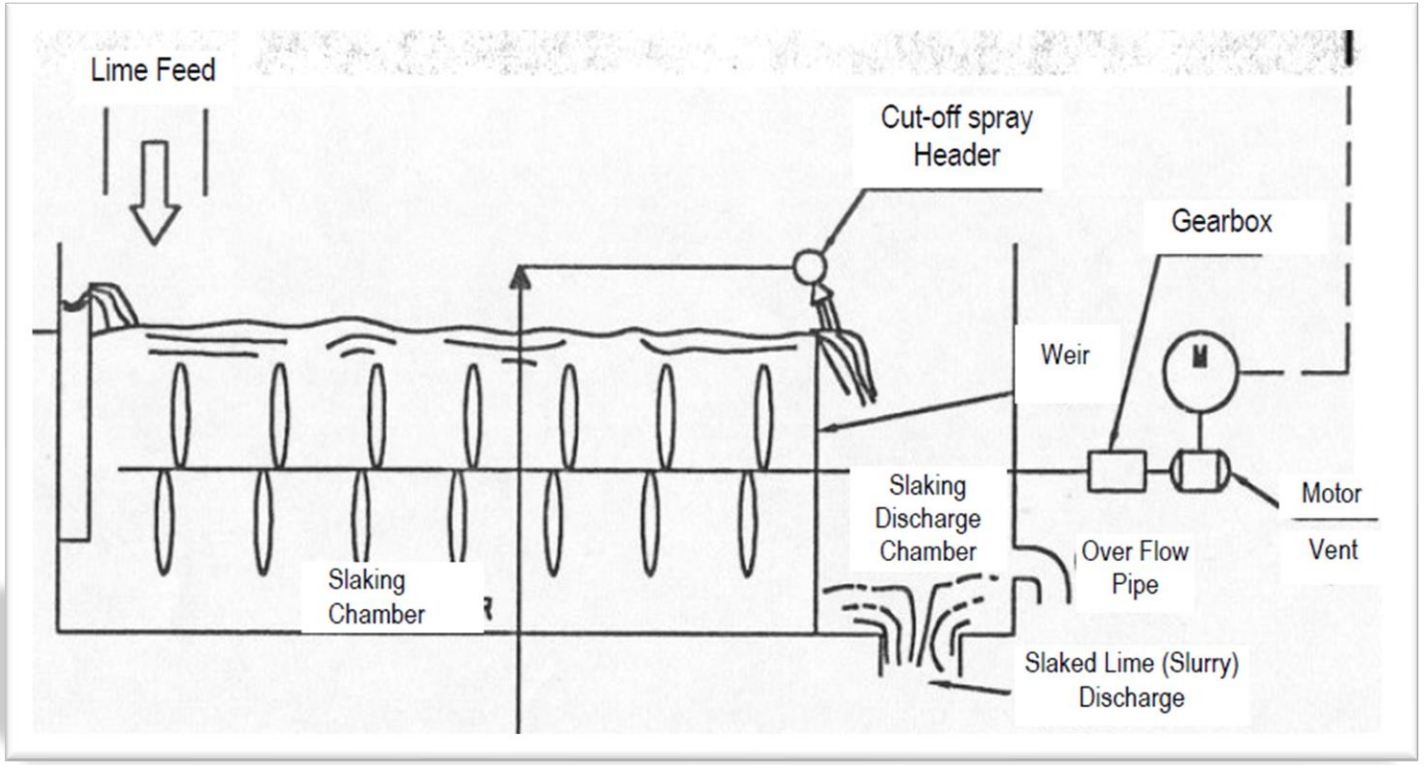
Paste Slaker [PS]

Use water ratio 1 to 2.5 times and are compact in size and are designed with contact Lime of 5 to 6 minutes in slaking chamber. Since, in the Paste Slaker the paste is too heavy to flow under gravity a pair of Horizontal Rotating Paddle are provided to move the paste to next chamber where water is added to meet desired consistency and removal of grit.

However, it is still a requirement by those who own lime kilns and produce power from of Hydrated Lime to reduce logistic cost while comparatively large quantity of grit is used back in kiln.



Note : Conceptual diagram is available in literature

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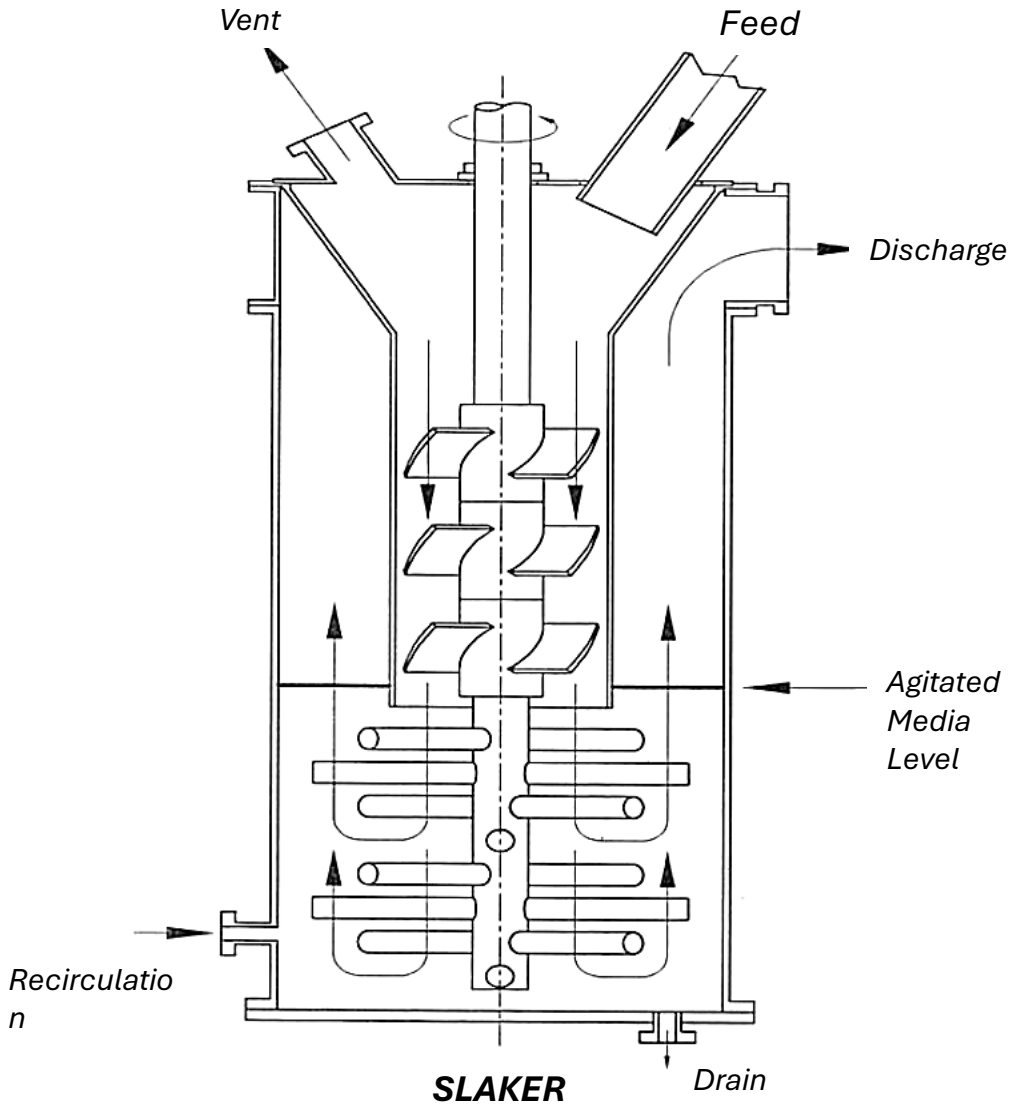
Ball Mill Slakers [BMS]

BMS are available in vertical or horizontal configuration for large size slaking in range of 10 MT to 50 MT / hour normally used in Mineral Processing Industries and Integrated Steel Plants where calcination Kiln are inhouse facility for conversion of Lime Stone ($CaCO_3$) to CaO.



Note : Effwa does not manufacture this type of slaker

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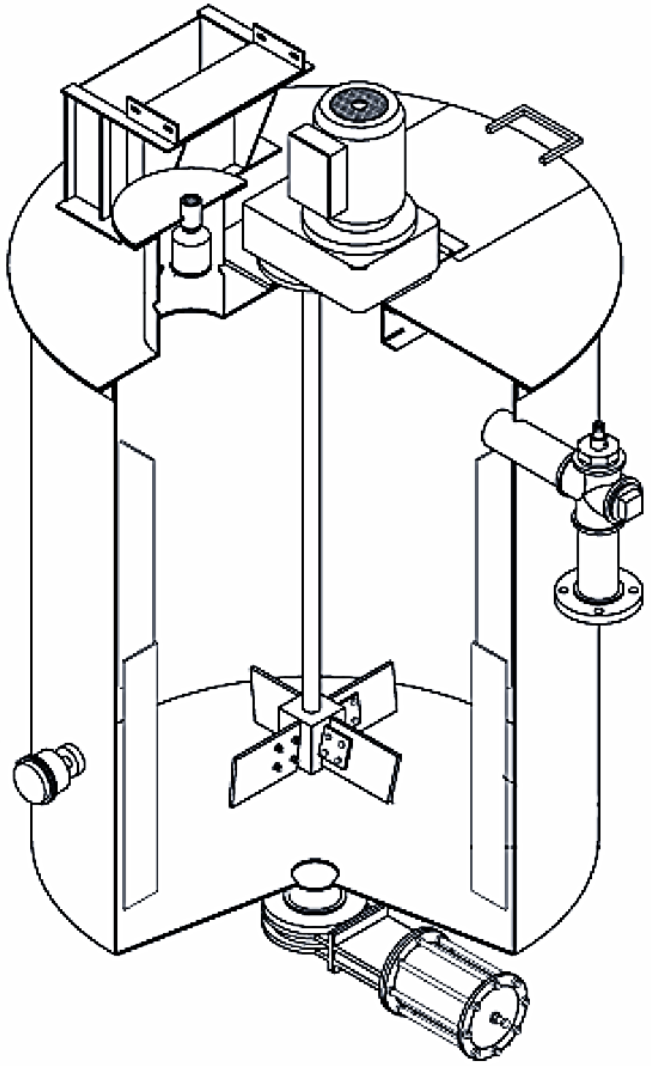
Batch Slaker [BS]

Generally operational condition makes it different to Slurry Slaker and as name suggests the operator decides the size of batch of Milk of Lime to be made. Predetermined quantity of water and quick line are mixed in a reactor and agitated until mixture temperature reaches to 170° F – 180° F. Once the designed temperature is reached, the slurry is transferred to “Degritter” and Milk of Lime is further transferred to user tank.

This slakers are suitable for small size ie. 50 to 200 kg per batch and is cumbersome process involving manual intervention.



SLAKER

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Factors affecting quality of Milk of Lime

Slaking Temperature affects particle size and specific surface area of hydrated lime which is related to duty condition. The optimal temperature may range between 170° F to 210° F depending upon feed quality of quick lime in terms of form (Blocks >2" or Powder <1 mm uniformity co-efficient). However, the relationship between temperature vs particle size & specific surface area is not linear.

In some cases, we observed when slaking at high temperatures around boiling point of water, hot spots can develop within the slurry, which causes hydrate particles to crystallize and agglomerate forming larger, flat particles with reduced specific surface area. This problem is more likely to happen in "Paste Slakers" since mixing is not vigorous thus normally causes localized heating as the process is exothermic.

As water at ambient temperature is mixed, it is desirable to have preheater for water as optional or is interlocked with final milk of lime temperature.

Lime to Water Ratio affects slaking time due to temperature as resultant. Higher the temperature, shorter will be slaking time for consistent particle size & specific area of feed. Controlling a constant lime to water ratio may not guarantee optimal temperature as it shall vary depending upon feed water temperature and quality and lime reactivity thus requiring adjustments. As mentioned the best way to control the ratio shall be through temperature control in extinguishing chamber.

Degree of Agitation, during the slaking process has impact on end product quality. Too little agitation results into an uneven temperature within Slaking Chamber thus causing Hot & Cold spots. Hot spots result into generation of Hexagonal crystals of large size with reduced specific surface area and agglomeration of particle and cold spots result into either drawing or unhydrated particles of quick lime ie. increased quantity of grit as lost material.

Factors affecting quality of Milk of Lime

Viscosity, with increased viscosity impurities are like to increase as general concept. However, increased viscosity may also suggest (if slaking process is at optimal temperature) good quality of milk of lime as its linearly related to particle size, specific surface area. The range of 45 – 700 centipoises is normal operating range.

Slaking Time, normally high – reactive lime requires 120 to 180 seconds however, 5 to 10 minutes is safer range to design the system.

Water Chemistry, water with higher dissolved solids generally causes excessive foaming resulting operational issues. Water with >500 ppm of sulfates are not recommended for use particularly in case of Paste and Slurry Type Slakers. The prime reason being the sulfates cover the surface of quick lime particles, thus does not allow water to penetrate into the pores resulting retarted slaking process. Chlorides in water do not affect the process and even sea water could be used in slaking, provided resultant slurry or Milk of Lime with high level of chlorides does not has collateral impacts. Ball Mill or Batch type slakes are least affected.

Water Temperature has a great impact on slaking process. The feed water temperature and lime to water ratio inversely affect the slaking time. Water at ambient temperature must not come in contact with quick like to avoid “Drawing” ie. formation of coarse particles with reduced surface area thus low reactive. The water temperature in case of slurry detention type and other all type must be maintained at + 150o F.

Dissolved Oxygen excessive oxygen in water results into formation of $CaCO_3$ thus, preferably de-aerated water may be preferred in case of high – tech applications like in Nuclear Plants.

Effwa Slakers : Salient Features

1. Auto controlled ratio of water and quicklime
2. Adjustable feed rate of quicklime. The capacity Turndown up to 25% of designed capacity
3. Vapor condensation through Heat Exchanger and recovery of condensate as Hot Water, mixed in Slaking Chamber
4. Variable speed control of Paddle Mixer in Extinguishing Chamber depending upon the particle size of quick lime.
5. Screw Grit separator with feature of grit washing thus negligible loss of useful lime content
6. No Hot or Cold spot due to pre heated water thus consistent high quality of Milk of Lime
7. Dust free operation
8. Available in Capacity of 150 Kg/hr up to 2 MT/hr
9. Pretested, ready to ship unit
10. Material selection : SS – 316; SS – 316L, CSRL
11. Display of operating parameters on Control Panel
12. System can be operated for short time and shut down without keeping agitation ON.
13. Auto emptying of all compartments and use of content at end of operation through command from Control Panel