Additional Reading: Process Handling Overview

About This Document

NYCO has the benefit of many years of experience in handling NYCO's wollastonite products, not only in NYCO's production facilities, but also at numerous facilities where they are used. The purpose of this guide is to share some of this experience with NYCO's customers, agents and distributors for the successful storage, handling and transportation of NYCO's wollastonite products.

The guide provides some understanding and a basis for obtaining more definitive information or advice. This guide in no way represents a design basis for wollastonite handling systems. In consideration of the peculiarities of handling wollastonite, NYCO strongly recommends that design of new installations or modifications of existing installations be carried out by the appropriate material-handling professionals. NYCO also recommends that any test work deemed necessary by those involved in the design of such facilities be carried out on the appropriate NYCO products. NYCO itself does not provide these services, however, NYCO is aware of individuals and organizations that have had past experience with wollastonite handling systems.

The guide is organized into five sections: General Information, Conveying, Transfer, Storage and Transportation Concerns. In each section, a general description is given followed by a more detailed discussion. Where specific information is given, this is based on NYCO's experience and as such is offered as an example only. Situations and conditions at other's facilities will be different enough to warrant that a qualified materials handling professional make specific recommendations. NYCO strongly recommends that individuals with wollastonite handling experience be contacted within any equipment vendor's organizations. Contact NYCO for assistance in contacting the appropriate individuals.

Conveying Concerns

NYCO's wollastonite products can be moved horizontally or vertically with a variety of conveying equipment including:

- Vibrating Conveyors
- Screw Conveyors
- Bucket Elevators
- Air Slides
- Pneumatic Conveyors

The selection of the appropriate conveyor depends on the product, situation and application.

Vibrating conveyors commonly referred to as 'shakers' are efficient for transferring the coarser wollastonite products (200 Mesh or coarser) in the horizontal direction. These conveyors are generally coupled with a bucket elevator if a vertical lift is required.

Screw conveyors are commonly used for transferring the finer wollastonite products (325 Mesh or finer) in the horizontal direction. These conveyors are generally coupled with a bucket elevator if a vertical lift is required. Inclined screw conveyors have however, been successfully used with wollastonite products.

Bucket elevators are commonly used for vertical transfers of wollastonite products. These conveyors are generally coupled with either a vibrating conveyor or a screw conveyor if a horizontal transfer is also required.

Air slides are used in some situations for transferring NYCO's wollastonite products along downward slopes. Air slide gravity conveyors operate on the principle of fluidization. When air is introduced into wollastonite products that can be fluidized, it can be made to flow like a liquid, so it is possible to move it along low angle downward slopes. Air pressures of 35 kPa (5 psig) are typically required.

Pneumatic Conveyors are used for transferring any of NYCO's wollastonite products in both the horizontal and vertical directions. Coupled with a diverter, a pneumatic conveyor can send material to a variety of locations.

The two-phase systems are commonly employed although dense phase, and dilute phase and vacuum have also been used. Full dense phase systems are prone to plugging and full dilute phase systems can result in particle degradation.

Transfer Concerns

NYCO's wollastonite products can be successfully handled at transfer points using the following equipment:

- Chutes & Hoppers
- Rotary Airlocks
- Screw Feeders
- Bin Activators
- Loss-In-Weight Feeders
- Dust Collection
- Vacuum Cleaning Systems

Gravity chutes and hoppers are employed for simple transfers between conveyors and between storage and conveying equipment. Chutes and hoppers are to be designed with a minimum angle of 60^{O}. Valley angles are avoided if at all possible. Otherwise valley angles are the highest possible (minimum 60^{O}).

Rotary airlocks are utilized to transfer wollastonite products and at the same time isolate one system from another. Rotary Airlocks are also useful in preventing uncontrolled flow with products prone to 'flooding'. The housing and rotor of rotary airlocks are of heavy duty design, suitable for handling abrasive product and are machined to close tolerances to prevent excessive air leakage.

Screw feeders are utilized to transfer wollastonite products and at the same time provide volumetric metering. While Screw Feeders can be effective, they are limited in holding back wollastonite products that have a high degree of floodability. A variable pitch screw is recommended to produce a uniform draw of material across the entire hopper opening.

Bin activators are utilized to transfer wollastonite products from storage bins. Bin activators are capable of maintaining a controlled uninterrupted continuous flow. All discharge outlets are flanged with flexible joint connectors.

Loss-in-weight feeders are utilized to transfer wollastonite products and at the same time provide gravimetric metering. Loss-in-weight feeders are designed to control the mass rate of discharge to the equipment includes the inlet flange, hopper, bin discharger, load cells and associated electronic controls.

Dust pick-up points are provided at transfer points to minimize concentrations of nuisance dust in the working environment. Dust is picked up via hoods and ducts and the dust-laden air is delivered to baghouses for cleaning. The clean air is exhausted to the atmosphere through fans and stacks. The collected product in the baghouses is discharged by a bin activator and rotary valve and conveyed to the appropriate location. Ducts are constructed from mild steel. Direct impact areas of ductwork and components are ceramic lined to minimize wear.

Industrial type vacuum cleaning systems are used for general cleanup and disposal of dust, dirt and other contaminating materials. These systems can be either stationary or portable. Portable systems are mounted on wheels and tires for ease of towing or lifting from one area of the plant to another using a forklift.

Systems include a centrifugal separator to remove large particulate, complete with abrasion resistant liner, inlet nozzle and quick connecting coupler. A secondary linear separator removes medium sized particulate. Final dust collection is with a bag type dust collector complete with bags and automatic bag shaker.

Storage Concerns

NYCO's wollastonite products can be stored in a variety of ways including:

- Storage Bins
- Bulk Bags
- Small Bags

When handling NYCO's wollastonite products in bins, hoppers and processing vessels the flow characteristics are not unlike those of other bulk solids. Storage and handling systems should be designed to accommodate or overcome these characteristics to have problem-free flow. Flow problems encountered in bins and hoppers are as follows:

1. No-flow (arching)
2. Insufficient flow rate
3. Flooding
4. Inconsistent flow rate
5. Rat-holing

The pressure exerted on bulk solid changes as it moves from one portion of a flow channel to another. The strength and density of the bulk solid change as the pressure changes. When the pressure acting on a bulk solid flowing in a hopper consolidates it to a point where its strength can support an arch, flow will stop. Flow properties for a specific bulk solid are a function of consolidating pressures, temperature and moisture content (humidity included). Flow properties determined experimentally include angles of friction, repose and discharge. From these the critical hopper opening for arching can be determined. For a fibrous material such as NYCO's wollastonite products, critical flow angles can be quite severe. In general, the finer the grade and the higher the aspect ratio, the worse the flow properties are. Arching, ratholing, and limited solids flow become more problematic with the finer and higher aspect ratio grades.

Wollastonite bulk solids can become significantly aerated during conveying. At rest (such as in a storage bin) they de-aerate. Coarser materials de-aerate rapidly, however finer materials de-aerate over a longer period of time. As the material is deposited into the top of the bin, additional incoming material slows the de-aeration process. As the material moves to the bottom of the bin the static weight of material above it increases the pressure and the bulk density increases. In the hopper section, the pressure decreases and so does the density. Consequently, the powder expands and the voids become larger. When the air pressure in the voids drops below atmospheric, ambient air tries to flow in from the outlet. The upward rush of air and the pressure gradient limits the flow rate. It takes time for the air pressure in the voids to reach the ambient depending on the permeability of the material. The time required limits the flow rate from the hopper outlet and thereby limits the exit velocity. This flow rate may be insufficient for what is actually needed.

The upward rush of air into the hopper may reach a velocity sufficient for fluidization of the powder. The bed begins to expand and the solid particles lose contact with each. A layer of air encloses each solid particle and a steady stream of aerated powder can flow out seemingly like water. This phenomena is called 'flooding'. Flooding can also be caused by funnel-type flow in the bin. As the powder empties from a central flow channel, it may create voids that collapse from time to time, causing aeration of the powder. If a rathole is formed, a sudden slide of material at the top may entrap air inside the pipe, fluidizing the powder and flooding out the outlet. Flooding can also result from insufficient retention time of aerated materials. If the retention time in the bin does not allow for de-aeration (such as when filling an empty bin), then flooding can result. Wollastonite materials, particularly the finer products, can be considered 'floodable' powders. A

minimum level must be maintained in the bin to allow for de-aeration. At least 15 to 20 minutes should be considered necessary to allow for de-aeration.

Due to the flow characteristics of many of NYCO's wollastonite products, the hopper outlet openings required for mass flow are larger than practical. As a result storage bins are straight-sided with 60^{O} or greater conical hoppers. For emptying there are several reliable methods in use, including:

1. Live-bottom bin activators
2. Vented matliners
3. Screw discharge systems

The hopper outlet opening may be large enough that the material exiting overloads the downstream materials handling equipment. The conveying action may induce fluidization and result in uncontrolled flow. Orifice plates are commonly installed to correct this situation from occurring.

Material entering the bin is displacing air and is also de-aerating. Bins must be equipped with adequate venting arrangements, as normal for feeding with pneumatic conveyors, but even if filled with screw or belt conveyors.

A positive cut-off gate is essential to stop 'flooding' if it occurs. These gates are also useful for performing maintenance on handling equipment downstream of the bin outlet.

Bulk Bags

NYCO's wollastonite products are packaged in a variety of bulk bags of various sizes up to two metric tonnes. The size of the bag required depends on the bulk density of the product. Bulk bag sizes range from 25 to 85 cu.ft. Bulk bags are normally top filling and bottom dumping. It is recommended to have bags with large bottom openings for ease of emptying and to minimize dust generation. Bulk bags settle during transport and storage as the material de-aerates and this can cause problems for the user in emptying the contents later. Bulk bag dumping equipment appropriate for wollastonite products is recommended for the efficient emptying of bulk bags. Fresh material is easier to empty. Material that has been standing in a warehouse for over a month typically will not flow properly out of the bag and will require extra time and effort for emptying.

Small Bags

NYCO's wollastonite products can also be supplied in 25kg or 50lb paper bags, palletized and stretch wrapped. Emptying bags can be a problem if the product is compacted. Time must be allowed for emptying, especially if the bag is undersized. Products can also be supplied in "pulpable" bags where the package can also be used in the user's process.

Transportation Concerns

NYCO's wollastonite products can be moved from one location to another by a variety of transportation modes including:

- Shipping Containers
- Bulk Truck
- Bulk Rail

Shipping Containers

Packaged product is normally moved in containers. As with any containers, these can be moved by truck, rail or ship. Dunnage bags are used as required to minimize damaged packages. As packaged product, container shipments are normally limited to less than 25 tonnes.

Bulk Truck

Bulk trucks can be utilized for most products if equipped with the appropriate devices for loading and unloading.

The ideal way to load bulk trucks is with a truck loading bin that is suitably equipped with a loading spout and material flow aids. Loading bulk trucks can also be accomplished by conventional conveying equipment: screw, vibrating, or bucket elevators. Pneumatic conveying is less desirable due to the increased dust handling required. When transferring from bulk bags, conveying from bulk bag dumping is also a concern. Whatever method is used to load the truck, fluidization must be sufficient to prevent hang-ups yet achieve the desired loading.

Transportation of wollastonite products in bulk trucks results in compaction and de-aeration. This will vary depending on the duration and distance of transportation, the road surface and the driver.

For unloading, the bulk truck is best equipped with airflow systems designed for handling powder materials. Air is injected inside the tank from the end, from the hatches, and also from the outlet pipe. Typically systems are used for fluidizing powders which are not free flowing. A grounding cable is recommended to dissipate static charge build-up, which can also lead to arching and hang-ups.

The unloading of a bulk truck requires some experience in order to be problem free. A first principle is that it needs to be uninterrupted. Any interruption, shock or too high air pressure inside the tank is likely to compact the material and cause a blockage.

Bulk Rail

Bulk rail cars can be utilized for most products if equipped with the appropriate devices for unloading.

The ideal way to load bulk rail cars is with a loading bin suitably equipped with a loading spout and material flow aids. Transferring from pneumatic discharge bulk trucks can be accomplished with the appropriate equipment. When transferring from bulk bags, conveying with the appropriate equipment is advisable. Whatever method is used to load the rail car, fluidization must be sufficient to prevent hang-ups yet achieve maximum loading.

Transportation of wollastonite products in bulk rail cars results in compaction and de-aeration. This will vary depending on the distance and the length of time required for transportation. Generally pneumatic discharge rail cars are required. Bottom dump hopper rail cars may however be suitable for some products. If bottom dump hoppers are desired, then NYCO should be contacted.

For unloading, the discharge conveying systems must be designed for handling powder materials. A grounding cable is necessary to dissipate any static charge build-up.

The unloading of a bulk rail car requires some experience in order to be problem free. Any disruption can potentially compact the material and cause blockages.