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A review of dome storage systems

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argues the benefits of dome/reclaim storage systems.

Introduction

Thin-shell concrete dome structures are becoming more popular as a method for storing bulk materials. New technological advances in mechanical and pneumatic reclaim systems by various manufacturers have made dome storage an economical storage solution for cement, flyash, and a host of other products. As many companies search for a competitive and efficient approach to storing bulk materials, they find the combination of the dome and reclaim system are extremely versatile in meeting their specific needs. This article will focus on several dome/reclaim systems and their advantages in today's competitive market place.

Cement storage domes for North Texas Cement - Houston, Texas.

Filling and reclaiming

When bulk storage is involved, filling and reclaiming is always a major issue. Factors involved in choosing a reclaim system include initial cost, maintenance cost, power consumption, clean out ability, and automation. The shape and structural characteristics of the dome make it adaptable to a wide variety of automated material handling equipment. Pneumatic fluidising, mechanical screw, and the mechanical moving hole reclaim units have provided the basis of a complete system when installed inside of the dome.

These systems are designed to take advantage of the dome's superior volume-to-surface area utilisation. This combined with automated reclaim means that dome facilities are simple, efficient and allow nearly total clean out of the stored product.

Fluidising

Fluidising a material with air makes a product easy to move which normally would have a tendency to set. This is the idea behind the air conveyor method of reclaiming. It works especially well with products of very fine particle size such as cement or flyash. This type of reclaim unit requires the dome floor to be sloped at about 10° toward a central inverted cone where the material is accumulated then conveyed out from under the dome. The near total clean out is achieved with 65% coverage of the slope with the fluidising panels.

The system is computer monitored and controlled. Initially the product gravity flows into the centre collection cone. As needed, the rate of discharge is increased or decreased by the computer opening or closing air valves leading to the fluidising panels. The number and location of valves opened is programmed to achieve a systematic and uniform unloading of the structure. Controlling the reclaim process in this manner minimises the air volume and power requirements for fluidising during normal withdrawal. Multiple blowers permit several modes of fluidisation depending on the level of material in the dome. Power consumption for withdrawal can be as low as 0.1 - 0.2 kWh/t.

Inside the dome silo - segmented fluidised bottom. Left - side view, right - viewed from top of dome.

One solution to reduce the floor area while maximising storage capacity is to construct a dome silo: a hemispheric dome is built on top of a cylinder in the Monolithic™ process which Dome Technology employs. Capacities of 50 000 t or more are achievable using a minimum of land area with this approach.

Radial screw reclaiming

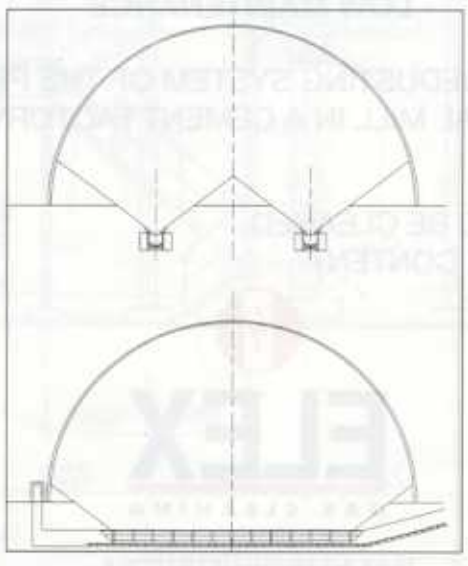
Another method of effectively retrieving bulk materials from a dome storage is with a radial screw reclaimer. A bridge truss which is attached to the base of the centre support column is raised and lowered by a hoist and cable system. This bridge truss supports the turning screw. The screw also rotates radially on the support column which is attached to the dome at its apex, utilising the dome's superior strength while sacrificing only a fraction of the dome's volume. The material is pulled to the centre of the floor by the radial screw to a controlled discharge opening and then onto a conveyer in a tunnel under the floor of the dome. When reclaim operations begin, an opening in the centre of the dome floor is opened and gravity pulls material into the main discharge hopper and onto the conveyor. Once the gravity phase is over the material rests at its angle of repose. Next the reclaimer screw is activated. When the bridge truss is lowered, the screw cuts into the resting pile and gently assists the material to flow down into the centre discharge opening. Only during the final reclaim of material from the dome will the open screw directly draw the material to the centre discharge opening.

The radial screw reclaimer will handle a wide variety of materials from fine particle size to larger sized ores and metal concentrates. Once the gravity phase of the reclaim operation is over, the screw can be directed to reclaim from any direction in the dome, reclaiming older material or trouble spots. The movements of the reclaim screw and reclaim rate are computer monitored and controlled to maintain the desired flow rates. Products that do not free flow well or are erratic in their flowability are handled well by the screw reclaimer.

Moving hole

The moving hole feeder system is yet another successful method to reclaim materials from domes. This system is configured by putting a uniquely designed flow control apparatus over a conventional conveyer belt. Sloping floors guide the material down to the flow control and conveyor belts. The design of the trap doors or moving holes is unique in that the holes can open or close without the friction of dragging parts against the material. The hole simply drops away from the product allowing it to drop onto the conveyor. This unique design allows material to be drawn from the full outlet area without any stagnant pockets which could reduce the effective opening. A steady, consistent flow of material enables dependable metering, low power consumption, and reduced maintenance.

The moving hole relies entirely on gravity to discharge material via a number of slots along the full length of the hopper or bin. These slots are traversed back and forth by hydraulic cylinders in an essentially frictionless manner. The lack of friction between the stored material and the feeder deck avoids any compaction of the material. Since the moving slots traverse the entire area, an effective discharge of the entire area is achieved.



Sketches of 'moving hole' installation.

Advantages of bulk storage domes

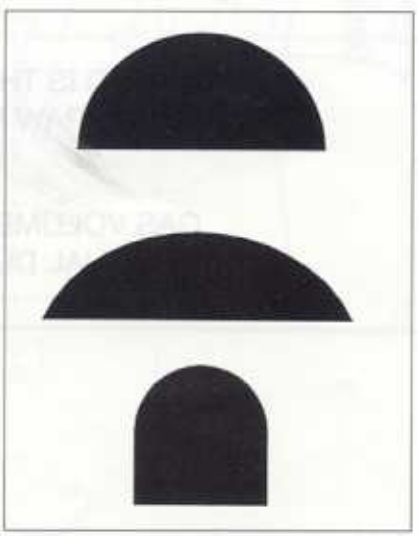
The Monolithic™ dome can be configured into a wide variety of shapes and sizes to accommodate different storage constraints. The most common is the hemisphere. This is the most economical to build and gives the best volume-to-surface area ratio. Hemispheres up to 350 ft (106 m) in diameter can be built with this process. Even larger domes will now be possible using the new Crenosphere™ or crinkled dome technology.

Another common shape used in bulk storage is the dome silo. This is a hemisphere on top of a cylinder, used where land space is restricted and yet a large amount of storage is required. By building up instead of out to achieve the needed capacity, the area of land required is minimised. All three methods of reclaiming mentioned here work well with both the hemisphere shape and the dome silo shape.

The low profile dome is used where land area is not so restricted and the soils are poor. The low profile dome is where only a 1/3 or 1/4 sphere is used but the diameter of the floor area can still approach 300 ft (91 m) or larger using the Crenosphere™ technology. The dome cost per ton of storage is slightly higher by spreading out the pile, but the load to soil is reduced and often means the difference between pilings and no pilings.

A big advantage of building a dome structure is the speed and efficiency of the construction process. After the ring beam footing is in place, an airform, made of heavy duty, impermeable, polyester reinforced vinyl fabric, is inflated with dual inflator fans to a predefined internal air pressure. From this point on, the construction takes place on the inside of the dome. This tough airform serves to protect the crew during the construction process so that construction continues regardless of the weather. The Airform is left in place at completion and serves as a waterproof covering over the concrete dome.

Once the airform is inflated to the correct pressure, polyurathane foam is sprayed in a 2 in. (5 cm) layer to the interior surface of the inflated airform. The polyurathane foam is a quality insulation that protects the stored contents from condensation. Next, a framework of light steel reinforcing bars is attached to the interior surface to help stiffen the structure. Layers of shotcrete and additional



Hemisphere, low profile 1/3 sphere, and dome silo profile examples.