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Bulk bag unloading system contains toxic dust in fluoridation plants

For many years various Australian authorities have introduced fluoridation programs, backed by state government subsidies. ProMinent Fluid Controls Pty Ltd has supplied more than 60 fluoridation systems over the past 25 years mainly for rural water supplies in relatively small water treatment plants.

More recently, however, the company has supplied equipment for much larger plants, including five that started up in Queensland in 2008 ranging in size from approximately 125 MLD to 750 MLD, says Neville McKee, a ProMinent sales manager.

Toxic dust control
For larger plants, ProMinent has designed a fully automated process in which the Na$_2$SiF$_6$, is completely contained in a sealed transfer system from the time it is received until it is put into the mixing tank.

Sealing is important for dust control, because the plants use up to 875 kg/d of Na$_2$SiF$_6$, which is toxic and subject to strict regulatory control. Bulk bags of Na$_2$SiF$_6$ are unloaded into a transition or floor hopper, from which a flexible screw conveyor transfers the material to a storage hopper that feeds the mixing tank.

The major pieces of equipment are the bulk bag discharger, a dust containment system, and the flexible screw conveyor, all supplied by Flexicon Corp (Australia) Pty Ltd, Brisbane.

Bulk bags of 1 000 kg are lifted into place on the discharger frame by an electric hoist and trolley on a cantilevered I-beam.

Double wall Tele-Tube™ telescoping tube provides extra protection against dust leakage during transfer from the bag. The tube is secured to the bag spout by a Spout-Lock™ clamp ring that creates a dust-tight seal.

Powder is discharged from the bag into the transition hopper through a double-wall Tele-Tube™ telescoping tube. The tube is secured to the bag spout by a patented Spout-Lock™ clamp ring that creates a dust-tight seal.

The clamp ring, in the open position, is raised pneumatically to the bag spout. The spout is pulled over the rim of the tube’s inner wall and the ring is locked in place over it. At this point the pneumatic pressure that raised the tube is released, causing the telescoping tube assembly to exert downward pressure on the spout. The continuous downward pressure on the bag keeps the spout taut at all times and helps maintain a steady flow by preventing excess material in the spout from bulging outward and creating dead spots, or falling inward and restricting the flow.

The double-wall telescoping tube is a key element in the entire system, says McKee. In this design, errant particles are drawn into the duct collector through an annular gap that encircles the bag spout seal.

Flexicon’s Bag-Vac™ dust collection system is activated prior to connecting the telescoping tube to the bag. The system, attached to the discharger frame, conveys dust pneumatically to a water trap tank. Once the clamp ring has been secured, the dust extractor is turned on and the spout drawstring is untied, allowing the powder to flow into the transition hopper.

The dust extractor remains inactive throughout the unloading process. However, air displaced by the flow of material exits via the duct collection system. A filter prevents Na$_2$SiF$_6$ from being entrained in the outflowing air.

Stopping the flow is a cinch
A special feature of the unloader unit is a pneumatic Power Cincher™ flow control valve that can close the bag at any time, so that a partially empty bag can remain in place until more material is needed. This is important for the fluoridation plants, which use approximately 120 kg/d of Na$_2$SiF$_6$ per 100 MLD of water.

Promoting flow are Flow Flexer™ bag activators — two pneumatically driven plates that rhythmically raise and lower opposing bottom edges of the bag to direct material to the outlet. As the bag empties, the stroke of the plates lengthens, forming the bag into a steep V shape and promoting total evacuation.

The dust tight system is vented to a Bag-Vac dust collector that removes residual powder and collapses the empty bag prior to tie off, preventing dust generated when empty bags are flattened manually.

A flexible screw conveyor transports the Na$_2$SiF$_6$ from the floor hopper to a storage hopper that feeds the mixing tank.

A self-centred conveyor
As the screw rotates, it self-centres within the tube, providing ample clearance between the screw and the tube wall to prevent grinding of the product. A 4,0 kW electric motor, located above the discharge point, rotates the screw at a variable rate up to 6 000 kg/h. The flexible screw conveyor is inherently enclosed throughout its length to avoid airborne dust.

As the bag’s contents empty into the floor hopper, the conveyor is activated. The transfer of powder to the storage hopper continues until either the transition hopper is empty or the weight of the storage hopper reaches a preset high level, as indicated by four load cells underneath the hopper. The control system signals the conveyor to stop when the high level is reached.

From the storage hopper, a dry chemical feeder meters the fluoride powder into a mixing tank through a sealed unit that prevents the escape of dust. The flow of powder is automatically matched to the inflow of water to the tank in a ratio that results in a 0,2% Na$_2$SiF$_6$ saturated solution.

Finally, the solution is carefully metered into the fluoridation water supply by a peristaltic pump (or a progressive cavity standby pump). The dosage rate varies from 0,6 mg/l to 1 mg/l, depending on local requirements.

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