Bulk Bag Unloading System
Contains Toxic Dust in Fluoridation Plants

By David Boger

In the last few years, pace of fluoridation has quickened as various states have introduced fluoridation programs.
For many years various Australian authorities have been slowly installing water-fluoridation plants in a general endeavor to promote dental health. In the last few years, though, the pace of fluoridation has quickened as various states have introduced fluoridation programs, backed by state government subsidies. Queensland, for example, decreed in 2006 that 90% of Queenslanders would have access to fluoridated water by 2012. ProMinent Fluid Controls Pty Ltd has supplied more than 60 fluoridation systems over the past 25 years. Many of the earlier installations were for rural water supplies in relatively small water treatment plants. Initially, 25 kg bags of sodium silicofluoride powder (Na$_2$SiF$_6$) were manually loaded into a hopper; later installations used a vacuum loader designed by ProMinent. A dry chemical feeder meters the Na$_2$SiF$_6$ into a mixing tank of water, where it is dissolved before being added to the water supply. (Other chemicals used for fluoridation are sodium fluoride powder and hydrofluosilicic acid).

**Toxic Dust Control**

More recently, however, the company has supplied equipment for much larger plants, including five that started up in Queensland around the end of 2008. The plants range in size from approximately 125 MLD-750 MLD and serve more than 50% of Queensland’s population of approximately 4.5 million, says Neville McKee, a ProMinent sales manager. For plants of this size, 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 the moment 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 transition hopper is small, with a capacity of only 60 l. In contrast, storage hoppers may be as large as 8,750 l or more for a 750 MLD plant, and designed to hold up to seven days’ supply of Na$_2$SiF$_6$.

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. Powder is discharged from the bag into transition hopper through a double-wall Tele-Tube™ telescoping tube. The tube is secured to the bag...
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 Na₂SiF₆ per 100 MLD of water. The cincher also helps to keep moisture out of the bag and can isolate the bag in the case of an emergency.

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. An adjustable timer controls the frequency of the strokes. 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.

As mentioned earlier, a flexible screw conveyor transports the Na₂SiF₆ from the floor hopper to a storage hopper that feeds the mixing tank. The conveyor consists of a rotating, stainless steel spiral screw, housed in a 65 mm dia polymer tube. The lower end of the roughly 5 m long tube passes through the wall of the floor hopper, near the bottom, and the top end discharges the powder through a chute into the top of the storage hopper some 4.5 m above the plant floor.
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. The tank has a high-speed mixer and a retention time of 10 min. Finally, the solution is carefully metered into the flowing 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.

In rare cases a water treatment plant may have two independent pipelines, each with its own dosing system. This situation occurs, for example, when a town or city has grown and added more treatment capacity. These cases require separate storage hoppers and dosing systems for each pipeline says McKee. However, a single bulk bag discharger and one transition hopper can feed two storage hoppers by incorporating two separate flexible screw conveyors into the single common transition hopper. Feeding two storage hoppers is well within the capacity of the system. McKee points out that a single conveyor delivers material at a rate of around 5,000 kg/h, while the seven-day storage capacity of a large hopper is only about 8,750 kg.

The Flexicon system is the only one that ProMinent uses for fluoridation plants, says McKee. “We have only ever promoted Flexicon bulk bag unloaders with double-wall telescoping tubes for fluoride, as we found it to be the best available to handle a toxic powder with minimum risk of dust,” he says. “I think it would be a brave water supply authority to try a different brand at the moment, as we have promoted this since the application arose for bigger bulk type fluoride installations (about three years ago)."