TECHNICAL INFORMATION 1425

DELIVERY OF SILICA GRANULATE IN BAG-IN-BOX CONTAINERS (EX TAIWAN)

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Contents

1 Introduction, general information

This Technical Information provides an overview of full bulk delivery of precipitated granulated silica in Bag-in-Box containers. These are marketed by Evonik Resource Efficiency throughout the world under the ULTRASIL® brand.

For the Bag-in-Box concept, 40-foot sea containers, either of common size or high-cube size, are used to transport free flowing bulk material as shown in **Figure 1**.
Inside the container a tailored polyethylene (PE) liner is fitted to keep the bulk material clean and dry during transportation.

Evonik Resource Efficiency has been employing the Bag-in-Box concept successfully for some time to ship granulated silica from Taiwan to our customers throughout Asia.

This mode of bulk delivery offers many advantages:

- Long-distance and overseas transport where shipment by silo vehicle is not an option,
- Container offers cost-efficient shipment,
- Handling in an enclosed system means dust-free loading / unloading and compliance with emission limits,
- Movement of large volumes with minimum man power,
- Reduced packaging costs,
- Reduced disposal of packaging material, or pallets,
- No negative effects on the product properties during transportation,
- Small storage footprint,
- New options for automatic processing.

Figure 1 40-ft container in fully tilted position (Courtesy of Frankenbach Container Service GmbH, Mainz-Kastel, Germany)

Bag-in-Box containers are unloaded into the customer's storage silos.

2 Technical requirements

40-foot high-cube (HC) containers conform to the international sea container standard (ISO) but offer 300 mm additional height compared to a normal 40-foot container. Standardized dimensions allow ISO containers to be shipped anywhere in the world by sea, rail, or road.

The external dimensions of a 40' HC container are:
Length 12,192 x Width 2,438 x Height 2,896 mm resulting in a volume of 76 m^3. (Standard containers are 2,591 mm in height and provide 68 m^3 of volume.)

The road vehicle with semitrailer must be equipped with a hydraulic tilting unit to achieve a minimum tilting angle of 40° and, ideally, of 45 °. This will ensure that the container is completely emptied.

The average filling quantity for ULTRASIL® 7000 GR silica can be seen in **Table 1**.

Table 1 Filling quantity per 40' HC container

Product	40' HC container approx. volume in m^3	Approx. load in mt
ULTRASIL® 7000 GR	76	16

2.1 Discharge of Bag-in-Box container

Bag-in-Box containers with ULTRASIL® GR grades are unloaded by gravity. For smooth and dust-free unloading, the receiving station (under ground) at the customer's premises must be compatible with the dimensions of the truck and the tilted container. The truck requires an approximately 19.0 m x 4.0 m footprint and 12.0 m clearance height for the fully tilted semitrailer (45 ° tilted angle).

The customer is provided with a stainless steel adapter. This connection device is attached to the PE liner spout.

During discharge of the granules, the liner has to be under ambient pressure. There must be no over or under pressure to prevent discharge problems and/or damage to the liner.

The corners of the liner are equipped with "airbags" which will be inflated at the end of the unloading process to ensure complete discharge of material.

Detailed technical information will be provided on request.

2.2 Receiving technology

A special coupling is needed to connect the container outlet to the acceptance nozzle at the customer's receiving station via a flexible discharge hose. As the distance between the PE liner outlet and the receiving port is reduced with increasing tilting angle, the length of the flexible hose and the parking position of the vehicle must be determined accurately.

For gravity unloading with container discharge the customer is advised to provide an underground receiving system. The opening at ground level must have a diameter of 400 mm.

Figure 2 shows an underground installation with a pneumatic pressure conveying system.

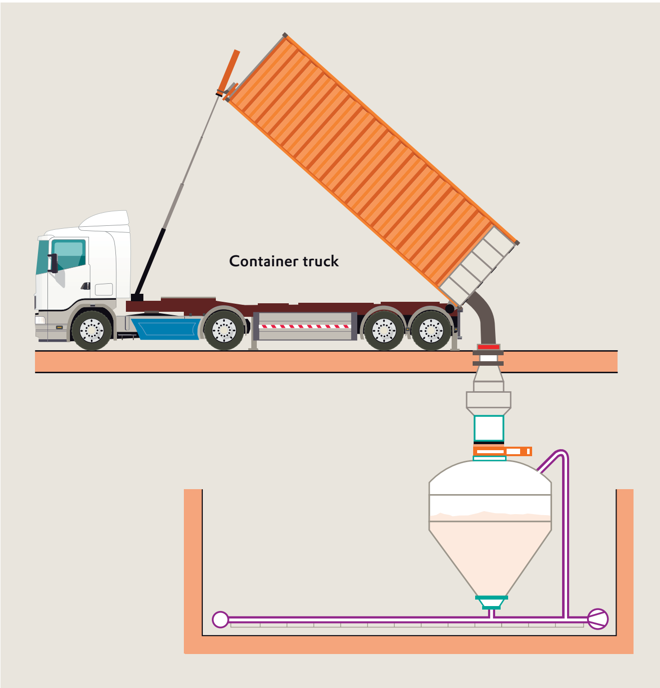


Figure 2 Schematic drawing of an underground system for gravity unloading into a dense phase conveying.

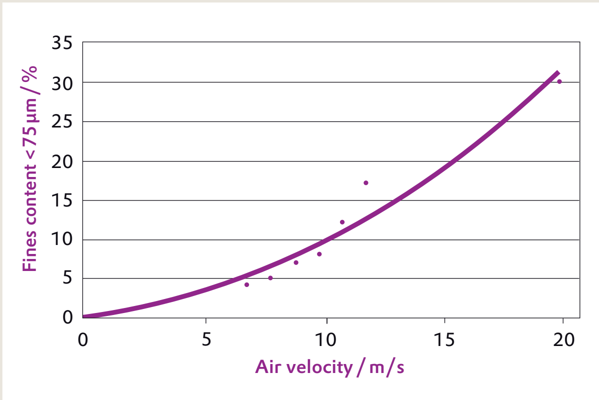
3 Overview of conveying systems for granulate

Granulated silica can be unloaded and then transported to the storage silo using pneumatic or mechanical conveying systems. Both variants, including their advantages and disadvantages, are described below.

3.1 Pneumatic conveying systems

Dense phase conveying is considered to be the most reliable and efficient form of pneumatic transportation for granulate, as dense plugs of silica are pushed through the pipeline with minimum mechanical stress to the granules. Designed as low-velocity conveying systems, they work with a high solid-to-air ratio of more than 8–15 kg product / kg air and air velocities of 12–16 m/s. Higher air velocities in the conveying line and long conveying distances should be avoided as this would cause significant comminution of the granulate particles and increased content of fine particles and dust, as shown in **Figure 3**. Lower velocities may cause a certain risk of blockages.

Figure 3 ULTRASIL® VN3 GR, increase in fines measured according to Ro-Tap (< 75 µm) at different conveying speeds and a constant conveying distance of 100 meters.



Dense-phase conveying of silica granulate is a very reliable method. It is enabled by injecting secondary ("bypass") air into the conveying line, as shown in **Figure 4**. Well-proven systems include Pneumosplit®, and Overflow®. If the conveying system is properly designed, plugs are dissipated even after a shut-down of the conveying process, thus ensuring rapid re-start. For silica granules, maximum conveying distances of 100–150 meters are recommended.

However, the conveying capacity decreases as the distance increases.

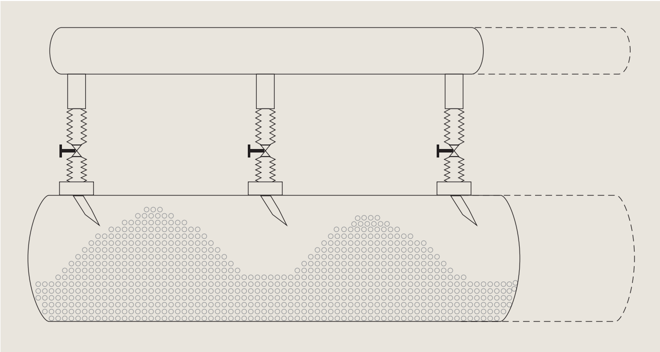


Figure 4 Principle of dense-phase conveying of granulated silica using secondary ("bypass") air injection to conveying pipe.

Although dense-phase conveying is regarded as the gentlest form of pneumatic conveying, the granules are still subjected to a considerable amount of stress. It is very important that the conveying system is designed precisely for the silica that is to be transported, to keep granulate destruction to a minimum and to ensure continuous operation. The formation of fines, which is always associated with pneumatic conveying systems, can cause problems in the downstream production processes. Because of this, it is advisable to keep the conveying distance to a minimum and to reduce stress on the granules by ensuring that the pneumatic system is adjusted optimally.

3.2 Mechanical conveying systems

Mechanical conveying of bulk materials using belts, screws, and bucket conveyors is the oldest technology for plant-internal transportation. Nevertheless, these conveying methods still have their uses.

If especially gentle conveying is required, such as when handling synthetic silica granulate, so-called Z-bucket elevators are recommended, such as shown in **Figure 5**.

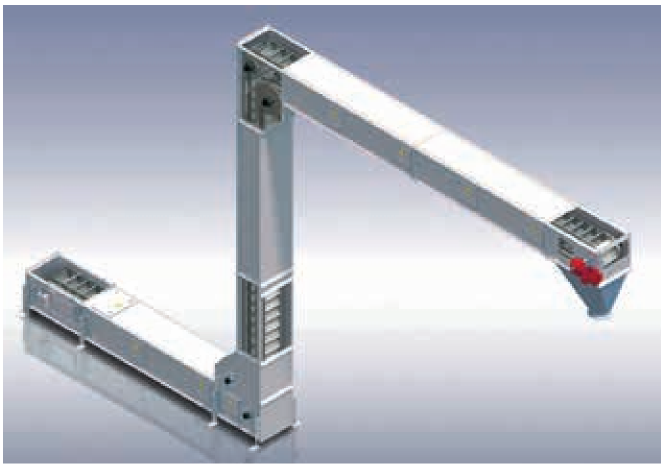


Figure 5 Continuous bucket conveyor for gentle transportation of synthetic silica granulate (Manufacturer: NERAK GmbH, D-29313 Hambühren, Germany)

Bucket conveyors have different vertical and horizontal sections adapted to the customer's individual requirements. Conveying heights of up to 50 m are possible.
Typical conveying speeds are between 0.3 and 0.65 m/s.

Bucket conveyors are the gentlest conveying technology if the product has to be transported mainly over vertical distances, which gives them a clear advantage over the pneumatic systems described in Section 3.1.

Tube chain conveyors and screw conveyors can generally be used only for short distances, as they cause increasing particle attrition as the conveying length and slope increase. As with pneumatic conveying, it is important that the systems are dimensioned properly with regard to the maximum acceptable conveyor speed, as otherwise the granulate is subjected to too much stress and can be destroyed.

For more information about different conveying systems, refer to Technical Bulletin number 28:
"The Handling of Synthetic Silica and Silicates".

4 Requirements for storing granulated silica in silos

A storage silo is mandatory to receive Bag-in-Box deliveries. In general, granulate should be stored in round silos with an axisymmetric cone (see **Figure 6**). They are usually constructed from aluminum alloy ALMg3 / 5052 or stainless steel 1.4571 / 316 Ti. Practical experience has shown that a discharge cone with an angle of about 60 ° to the horizontal is sufficient for unrestricted silica flow, if suitable discharge aids, such as fluidization nozzles, are installed.

For more information about the construction of silo systems and storage of silica grades, refer to our Technical Bulletin number 28: “The Handling of Synthetic Silica and Silicates”.

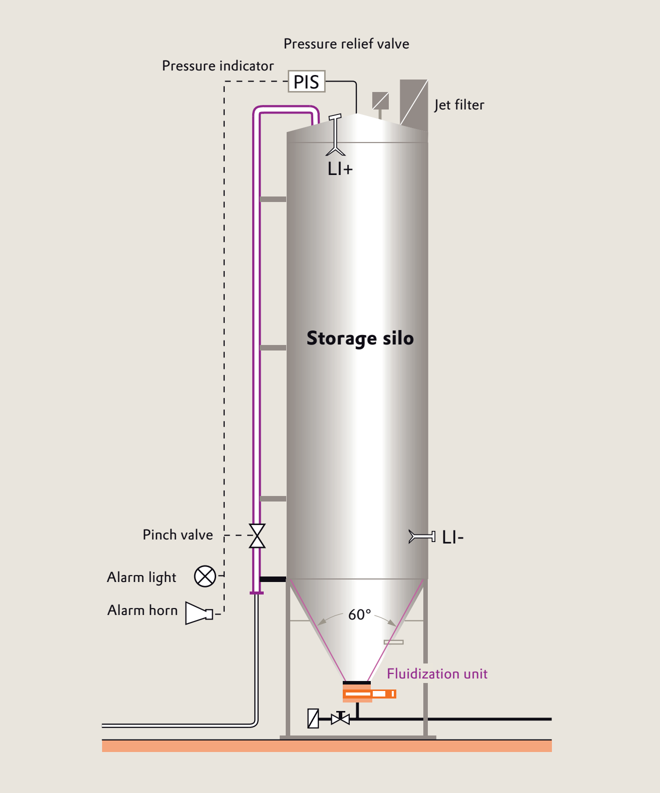


Figure 6 Storage silo with 60° cone and integrated fluidization unit; pressure monitor with loading switch-off function, and mechanical overpressure safety device and limit switch.

When ULTRASIL® granulate is delivered, a storage silo volume of at least 150 m^3 is required.

Table 2 Filling quantity per 40’ HC container

Bag-in-Box container volume	Minimum storage silo volume	Free volume before unloading
73–76m^3	150 m^3	100–120 m^3

The silo volume must be dimensioned to hold the required reserve for uninterrupted production from the date of reordering until the next delivery arrives plus the required volume for complete unloading of the delivered amount of silica. For the latter, it is important to provide sufficient silo volume for silica in its fluidized state. This is important because the volume of fluidized silica during unloading is larger than the volume of settled granulate during transport.

5 Technical unloading concepts

A few of the many conceivable unloading options are described here. The parameters listed below apply to all the examples that are described:
During unloading, the trailer is tilted from 10° when the unloading process starts to 45° for complete emptying of the container. At least 12 m headroom is required for the fully tilted container on trailer.

The capacity of the receiving system must be designed for emptying the Bag-in-Box container within 45 to 90 minutes, depending on the silica that is used.

Option 1:

A silo container is unloaded via an underground receiving station, as shown in **Figure 7**. The Bag-in-Box container is connected to an intermediate hopper. From there, the Z-bucket elevator conveys the granulate into the storage silo. A rotary valve or a screw feeder has to be installed between the hopper and the conveyor to ensure an even flow of material into the Z-bucket elevator and to avoid overflow.

The second conveying step (from storage silo to day bin) in all examples shown here, is carried out by a pneumatic dense-phase system.

Option 2:

Option 2 describes unloading via a pneumatic dense-phase conveying system with integrated pressure vessel, as shown in **Figure 8**. The granulate flows gently into a pressure vessel, into which compressed air is injected. Using conveying and bypass air, the granulate is transported through the pipeline evenly and in a controlled manner.

As opposed to conveying with a rotary valve, conveying with a pressure vessel allows higher conveying pressures. This enables lower air consumption and conveying speeds.

Two pressure vessels in parallel can be used to reduce unloading times. With this method, the two vessels are alternately filled and emptied with compressed air.

Option 1

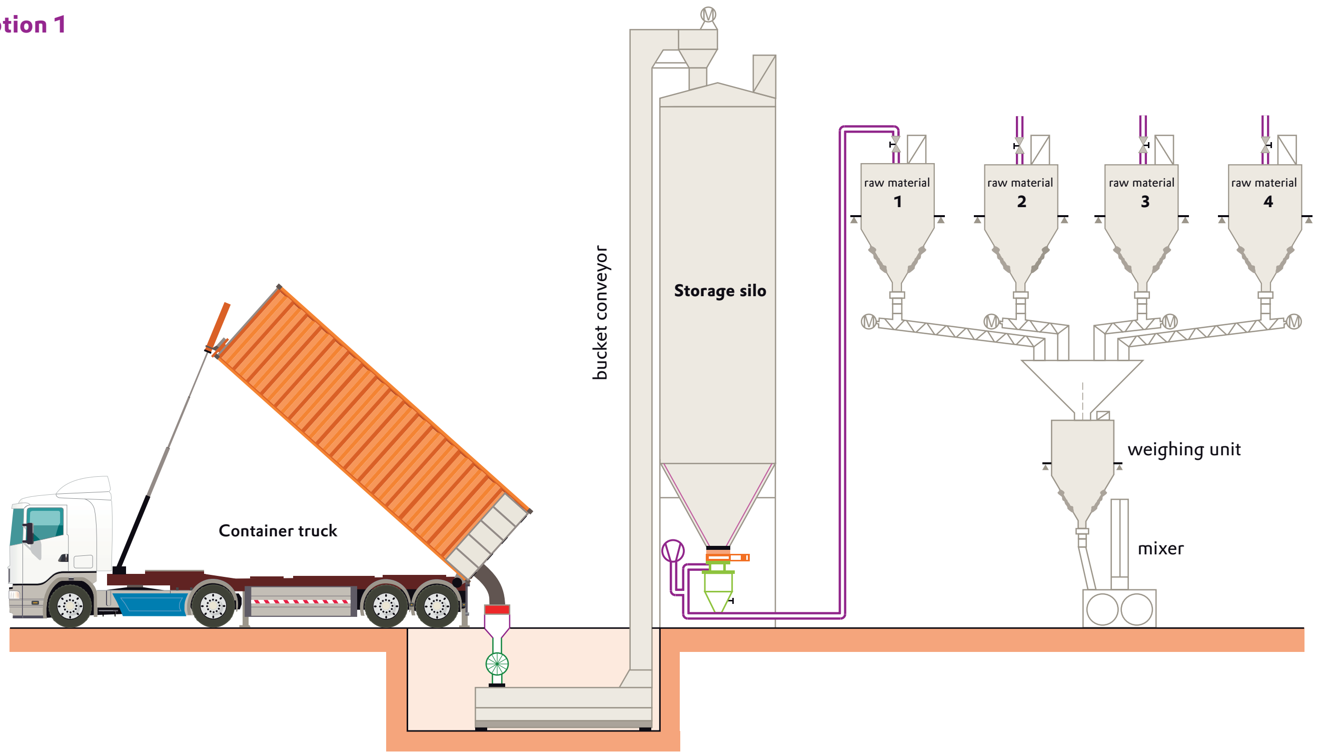


Figure 7 40-ft Bag-in-Box container being unloaded into a storage silo via a pneumatic dense-phase conveying system with integrated pressure vessel

Option 2

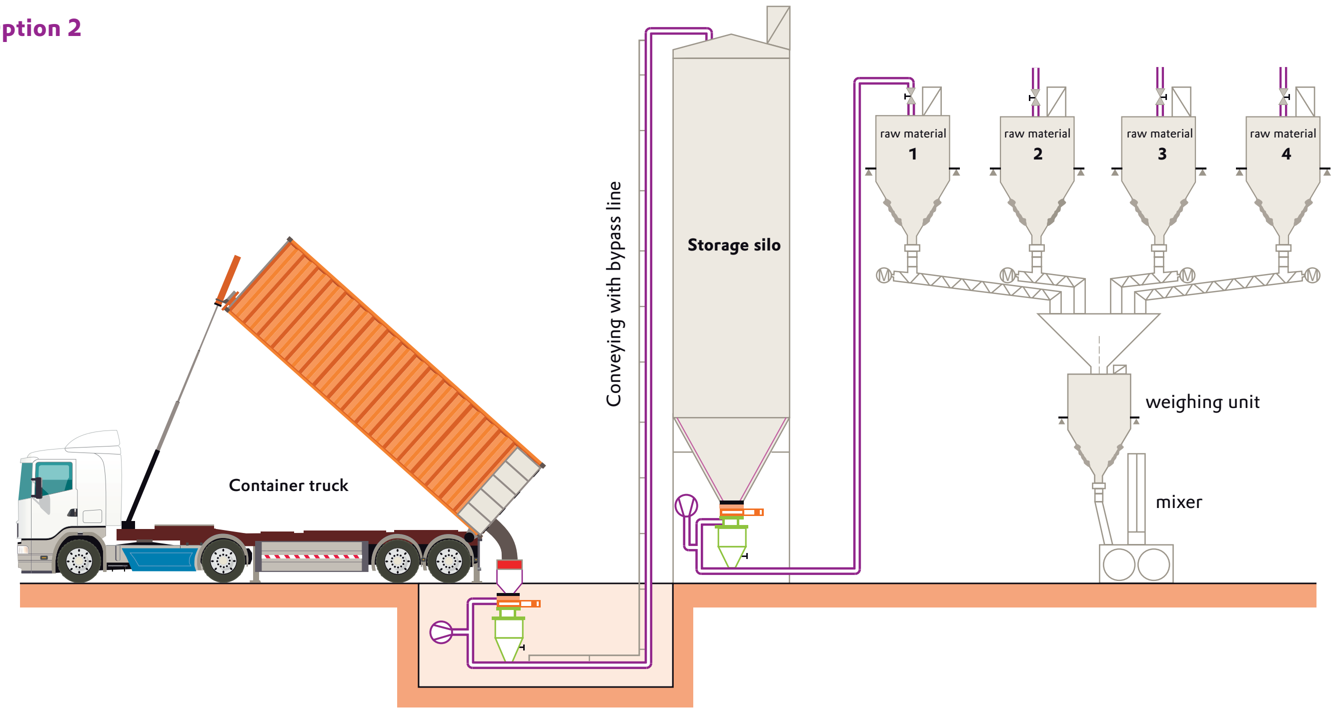


Figure 8 Unloading a Bag-in-Box container into a storage silo via a pneumatic dense-phase conveying system with integrated pressure vessel.

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