



**SIPERNAT[®] specialty silica
and AEROSIL[®] fumed silica
in spray drying applications**

Technical Information TI 1365

Introduction

A very extensive range of products is obtained as powder by spray drying technology. Running a stable process and producing a free-flowing powder are common targets of all industrial spray drying applications.

The sticky behavior that some spray-dried products can present significantly affects the quality of the powder and the degree of wall deposition. At the end it can determine the success of achieving a satisfactory dried powder and of maintaining a workable production process.

SIPERNAT® specialty silica and AEROSIL® fumed silica can significantly improve both, the spray drying process as well as the quality and functionality of the dried powder in the long term, during transportation and storage when exposed to humidity, temperature and/or compression load.

Industrial Applications

Common spray drying applications for SIPERNAT® specialty silica and AEROSIL® fumed silica in different industry sectors are:

- Polymers and Resins (e.g. re-dispersible powders, cellulose ethers, superplasticizers)
- Food & Feed (e.g. tomato powder, soup mixes, flavor powders)
- Milk and Dairy Products (e.g. fat-enriched milk, milk powder, whey powder)
- Agrochemicals (e.g. fungicides, herbicides, insecticides)
- Pharmaceuticals (e.g. amino acids, enzymes, peptides)

Problems

Common problems that can arise in spray-dried products are:

- Process difficulties during spray drying due to thermoplastic behavior or electrostatic charging
- Poor flowability of the dried powder due to stickiness, hygroscopicity, electrostatic charging
- Caking tendency of thermoplastic and/or hygroscopic spray-dried powders during transportation, storage or further processing when exposed to humidity, temperature and/or compression load

Benefits...What can SIPERNAT® & AEROSIL® products do for you?

The benefits that can be achieved by using the right choice of SIPERNAT® specialty silica or AEROSIL® fumed silica in your spray drying process and products are:

- Longer and trouble free production runs
- Free flowing behavior of the spray dried product
- Prevention of caking of the product during transportation and storage

As a consequence, your process will be more efficient, with higher product yields, higher product quality, less maintenance efforts and cost savings due to less shut down for cleaning. In addition, due to the fact that in general the use of SIPERNAT® and AEROSIL® grades will increase the bulk density of the powder, the packing efficiency will also be improved, allowing more amount of product per package.

Another aspect to be considered is that SIPERNAT® specialty silica and AEROSIL® fumed silica can absorb liquid during the drying process. Furthermore, undesired effects e.g. lump formation due to not enough drying, could also be avoided.

Improvement of the processability

Example:

spray drying of vinyl acetate VeoVa acrylic terpolymer dispersion

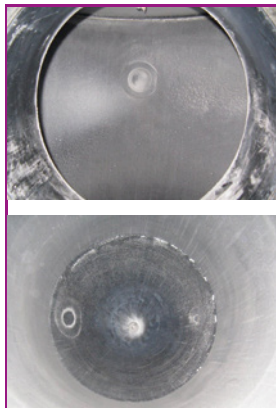


Figure 1a:
1% AEROSIL® R 972



Figure 1b:
w/o silica

Wall deposition observed in the spray drying tower after spray drying vinyl acetate VeoVa acrylic polymer dispersion when adding 1 wt% of AEROSIL® R 972 (a) and without the addition of silica (b)

- By adding SIPERNAT® specialty silica or AEROSIL® fumed silica directly into the spray drying tower a clear improvement of the spray drying process is achieved
- The tower remains clean from polymer adhesions at the walls which allows longer and trouble free production runs

Optimal Solution

Parameters to be considered when finding the optimal solution for a given spray drying system are:

- Feed location into the process
- Type of SIPERNAT® specialty silica or AEROSIL® fumed silica
- Amount added

SIPERNAT® specialty silica or AEROSIL® fumed silica can be fed into the spray drying process in different locations. The best feed location will depend on the material to be spray dried (water-based, solvent-based, glass transition temperature, etc.), the process configuration (co-current, counter-current, one stage, multiple stage, atomization system, etc.), the feeding system (injector, gravimetric, etc.), silica grade selected (hydrophobic, hydrophilic, precipitated, fumed) and expected performance.

Possible feed locations into the drying process are:

- 1 Through the head of the tower
- 2 At the top side of the tower
- 3 In the hot drying gas stream
- 4 Post-mixing step
- 5 In the dispersion/emulsion

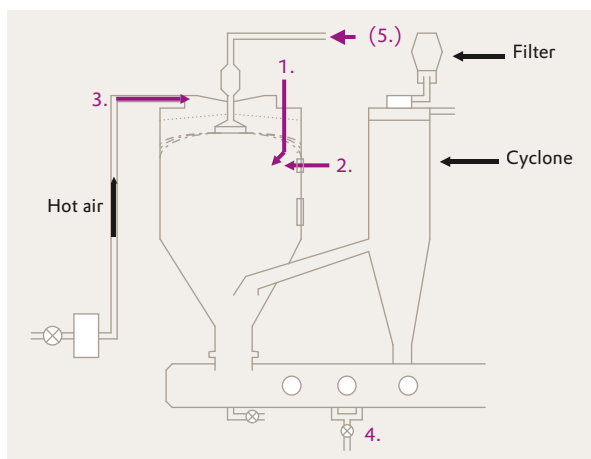


Figure 2: SIPERNAT® and AEROSIL® products can be dosed in different feed locations into the spray drying system

Generally speaking, for better processability as well as for better anti-caking performance of the dried product in the long term, the most effective locations to feed SIPERNAT® or AEROSIL® products are **number 1** and **number 2**, close to the atomizer in the wet zone, followed by location **number 3**, directly fed into the hot gas. In the upper part of the tower, silica is getting in contact with dispersion droplets or still wet powder agglomerates, which increases the probability that silica will stick to the droplet or wet agglomerate significantly. In case of collision in the dry zone, the interparticular forces will remain low and it is likely that a portion of the silica will separate again, not contributing so effectively to the protective layer. Clear advantages of adding silica directly into the tower are the improvement of the processability by keeping the tower and piping clean, free of powder depositions as well as the advantage of no additional mixing step required.

In case a direct addition into the spray drying tower is not possible, the silica can be added right after, when the product is coming out of the tower, before the cyclone (**location 4**). However, this requires an additional mixing step and does not help the spray drying process. This is a good solution for products not presenting difficulties during spray drying but having a high caking tendency during transportation and/or storage.

Another possibility is adding SIPERNAT® specialty silica and AEROSIL® fumed silica directly into the dispersion/emulsion to be spray dried (**location 5**). This might help to some extent during the spray drying process, however the expected anti-caking performance of the dried product is inferior compared to the other feed locations. This is due to the fact that a considerably amount of the added silica will be embedded within the droplet, not contributing to the coverage of the surface of the dried powder agglomerate.

Concerning the silica type often the use of hydrophobic grades results in a better processability as well as in a better anti-caking performance of the product in the long term than the use of hydrophilic grades. However, for Food and Feed applications there are regulatory restrictions for hydrophobic grades. Please, contact us for further details in this regard.

In Table 1 it is presented typical SIPERNAT® specialty silica and AEROSIL® fumed silica grades used in industrial spray drying applications.

Table 1: Typical SIPERNAT® & AEROSIL® grades used in spray drying applications

Silica Grades	Characteristics
AEROSIL® R 972	Hydrophobic fumed silica, excellent dispersibility, prevents moisture absorption during storage
AEROSIL® R 816	Extremely low hydrophobicity, fumed silica, excellent dispersibility
AEROSIL® 200 (F*)	Hydrophilic fumed silica, good dispersibility
AEROSIL® 380 (F*)	Hydrophilic fumed silica, good dispersibility
AEROXIDE® Alu C	Hydrophilic fumed aluminum oxide, very good dispersibility, neutralizes negative electrostatic charges
SIPERNAT® D 17	Hydrophobic precipitated silica, excellent dispersibility
SIPERNAT® 820 A	Hydrophilic precipitated sodium aluminum silicate, good dispersibility, high level of whiteness
SIPERNAT® 22 S **	Hydrophilic precipitated silica, good dispersibility, high absorption capacity
SIPERNAT® 50 S **	Hydrophilic precipitated silica, good dispersibility, very high absorption capacity
SIPERNAT® 340 **	Hydrophilic precipitated silica, good dispersibility high absorption capacity

* (F) Food grade; ** also available as food grade

For specific applications with special requirements a full range of specialties not listed in the previous table is also available.

The amount of SIPERNAT® specialty silica or AEROSIL® fumed silica to be used will depend on the application, the process configuration and the expected performance. As a guide typical working ranges are:

- Chemical applications: 0.5% – 5%
- Food applications: 0.5% – 1%
- Feed applications: 0.5% – 3%
- Agrochemical applications: 0.5% – 5%

Working Principle

The underlying working principle is that adhesive forces can be effectively reduced by increasing the surface roughness of the host powder particles. SIPERNAT® specialty silica or AEROSIL® fumed silica will create a protective layer on the surface of the solid particles which will avoid the agglomeration of the particles inside the tower and prevent adhesion of sticky product to the walls of equipment and piping. The free-flowing behavior and anti-caking properties of the final product will be also ensured.

As a general rule it can be said that the higher the surface coverage degree of the host powder particles and the more homogeneous this surface coverage is, the better the performance achieved.

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