Converting liquids to dry flowable powders and retaining flavors on SIPERNAT® specialty silica and AEROSIL® fumed silica

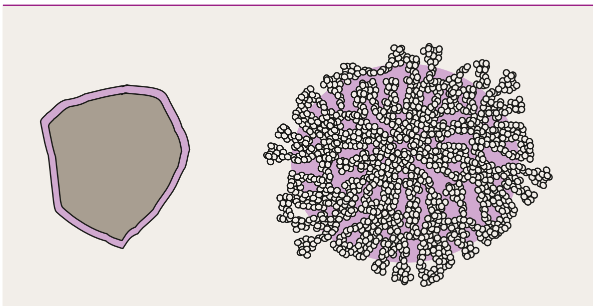
Technical Information TI 1367

Evonik. Power to create.

SIPERNAT® specialty silica and AEROSIL® fumed silica are referred to as a "carrier" when they are used to hold and absorb liquids in the production of a dry, free-flowing powder. Any size silica product can be used as a carrier; making either coarse or fine absorbates.

What makes SIPERNAT® and AEROSIL® products such efficient carriers for liquid ingredients? It is their tremendous amount of porosity, thus giving them high absorption capacity. If we compare SIPERNAT® products with other substances commonly used as carriers, such as maltodextrin, dextrose, starches, and other carbohydrate based powders, we see SIPERNAT® products have both external and internal surface area that can bind to liquids. Maltodextrin has a much lower absorption capacity because it has only external surface area available.

Figure 1
Schematic depiction of liquid at the surface of a non-porous carrier (left) and of liquid absorbed in the pores of SIPERNAT® (right)



Coarse absorbates use larger particles, like SIPERNAT® 22, SIPERNAT® 33 or SIPERNAT® 2200, which are more free-flowing and less dusty than other products. However, they may be too large for certain applications, such as food-coatings and instant beverages. Finer absorbates are made from SIPERNAT® 22 S, SIPERNAT® 22 LS, SIPERNAT® 50 S, and SIPERNAT® 500 LS also AEROSIL® 200. These particles agglomerate during the mixing process. They can be dispersed into food-coatings and instant beverages, but for some applications they may be too fragile or dusty.

Table 1
Typical data of some selected carrier silica types

	Particle size d50 [µm] Coulter LS 230, following ISO-13320-1	Absorption capacity – DOA* number [ml/100 g]
SIPERNAT® 350	4.5	170
SIPERNAT® 340**	20	235
SIPERNAT® 33	115	≥ 255
SIPERNAT® 2200	320	225
SIPERNAT® 22	120	235
SIPERNAT® 22 S	13.5	240
SIPERNAT® 22 LS**	9	235
SIPERNAT® 50	50	305
SIPERNAT® 50 S	18	290
SIPERNAT® 500 LS**	6	285
AEROSIL® 200	n.d.	255

* DOA = Dioctyl adipate
** Available in the US only
n.d. = not determined
For material, produced according to HACCP guidelines, please contact our responsible sales department.
Selected physico-chemical properties: the values depicted here serve as guides only and do not reflect actual specification.

Figure 2
Max. absorption of selected SIPERNAT® types. For fine particle silica the absorption capacity depends on the mixing conditions.

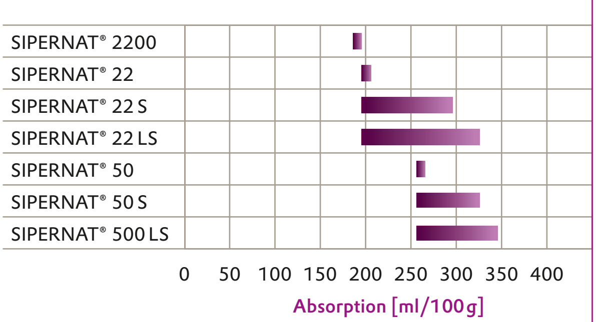


Table 1 shows some typical data of selected carrier silica types. For fine particle carrier silica however, the absorption capacity may vary a lot depending on the shear energy which is applied when the absorbate is made. With low shear energy it is possible to agglomerate the fine particle silica during the absorption process in a controlled way resulting in higher absorption capacities. This higher absorption capacity is lost when higher shear forces are applied. Figure 2 illustrates the absorption capacity for some selected carrier silica. The absorption capacity is given as max. volume of liquid in ml per g of silica before liquid soaks out under pressure.

Optimize flowability and dustiness with the right loading level

As loading level increases, flowability reaches an optimum depending on the properties of the carrier silica and the liquid being carried. When saturated the carrier flow becomes worse and dustiness is reduced. This effect is shown for two case studies in Figure 3 and Figure 4. The carrier should be chosen to match the liquid loading level you desire in your product since each carrier will exhibit an optimum loading level where efficiency, flow and dustiness are at their best.

Figure 3

SIPERNAT® 50 absorbate of a nutraceutical active ingredient. Dustiness is defined as the percent light scattering at 30 seconds when the sample is dropped in the sample chamber of a Palas Dustview™. Flowability measured by flow funnels, internal Evonik Industries method: PA IM-SI-PS-AT/CHEM 7009

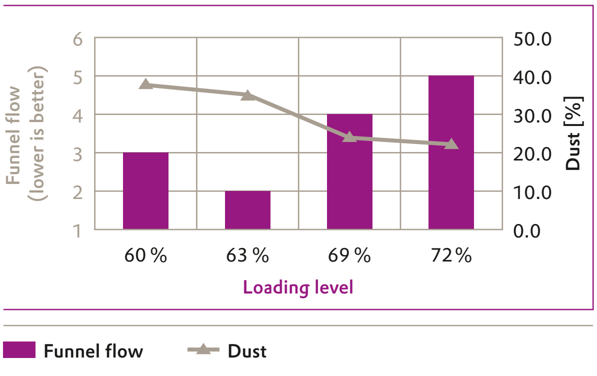
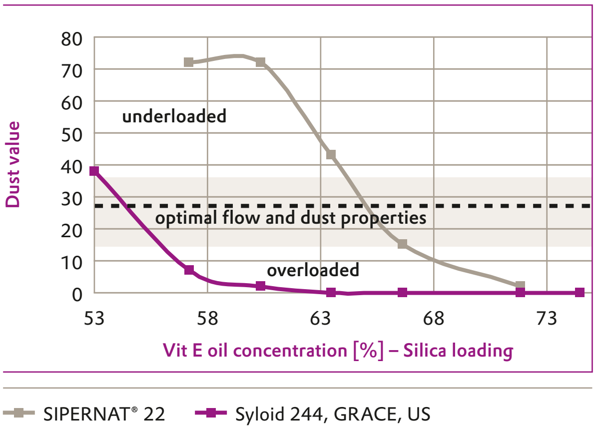


Figure 4

SIPERNAT® 22 versus competitive silica absorbing Vitamin E.
Test conditions:
Mixer: Somakon mixer with spray device
Mixing conditions:
700 rpm during spraying oil on the surface
30 min. at 400 rpm after spraying



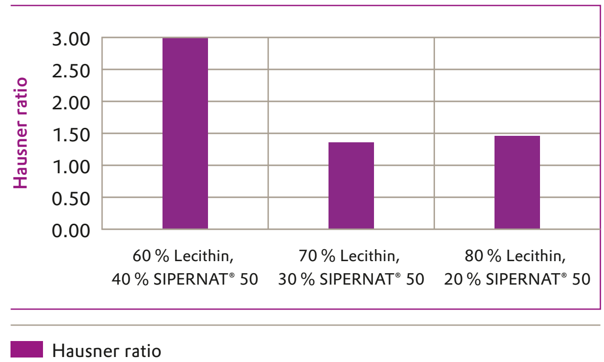
When mixing both SIPERNAT® specialty silica and other substances, dual carrier applications are possible. These types of carriers can optimize cost, absorption capacity, dustiness, and any number of other desired properties. For example, a dual carrier made of maltodextrin and SIPERNAT® 500 LS can optimize absorption capacity, costs, solubility, and flavor profiles. The specific combination of dual carriers is dependent on several factors and needs to be based on the desired finished product. These factors include:

- absorption capacity of each carrier material
- density of each carrier material
- density of the liquid to be plated
- volatility of the liquid
- amount of insoluble material that can be tolerated in the system

Some noteworthy observations when making absorbates:

- A low energy mixing device that fluidizes the dry carrier powder with minimum shear can work best, depending on the liquid's physical properties. These mixers include ribbon, plough-share® or V-type "liquid-solid" blenders. Also conical or Nauta®-type mixers are suitable.
- In some cases, high shear can be used with caution if the liquid has a high melting point and will solidify in agglomerates with silica particles surrounding the droplets. An example is given in Figure 5.
- Generally larger particle size gives better flow, but for some applications, such as instant beverages, small particles are desirable, which allow the powder ingredients to dissolve in the mixture, and will not affect flavor or texture.
- Consider protecting the liquid from oxidation. High surface-area materials can accelerate oxidation in unsaturated ingredients. In this case, choose a lower surface area SIPERNAT® or AEROSIL® product, or add an anti-oxidant to inhibit oxidation.

Figure 5
SIPERNAT®50 absorbates of sunflower lecithin. Hausner ratio approaching a value of 1 indicates good flow. Optimum at approximately 70 % achieved with high shear to disperse very viscous lecithin into small drops. Hardness of SIPERNAT® 50 helped to make absorbate successful. Flowability measured by flow funnels, internal Evonik Industries method: PA IM-SI-PS-AT/ CHEM 7009
Mixer: Kitchen Aid Blender,
Mixing Conditions: 20 min. at 7100 rpm and 10° C

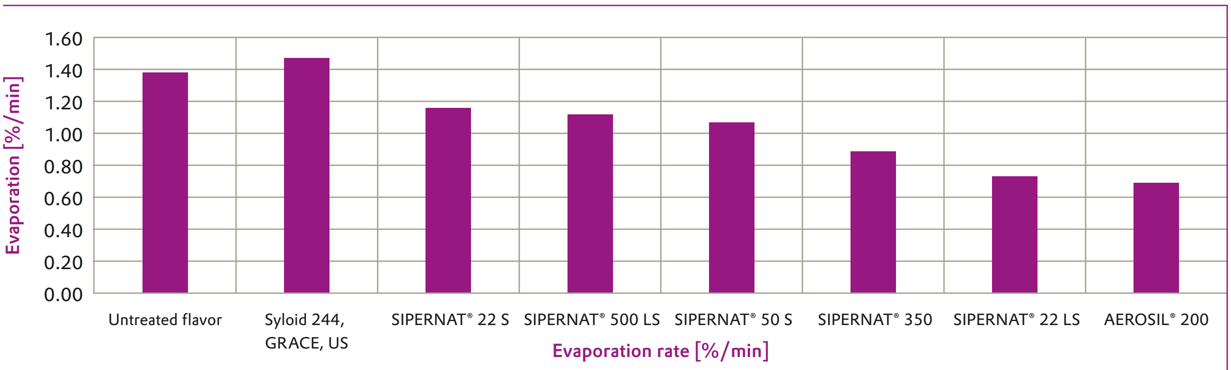


Flavor applications

Flavor control is critical in the beverage / food industries since evaporative losses of flavor will lead to a loss of flavor in the final product. This may occur during manufacturing or storage in the package. Ultimately, the result is degradation in product quality.

The kinetics of flavor degradation is of significant importance when choosing a substrate to carry liquid flavors. Encapsulation techniques can be used to control these losses. We can advise on various approaches for your application.

Figure 6
Evaporation rate of a flavor with various silica treatments at room temperature



In this study five SIPERNAT® specialty silica products and one AEROSIL® product were compared to a competitive silica and silica gel to investigate the evaporation rate of a volatile flavor compound. Thermo Gravimetric Analysis (TGA) was used to measure the loss of volatiles of the flavor. The results are shown in Figure 6.

All of the SIPERNAT® and AEROSIL® treatments released the flavor at rates slower than the evaporation of the original flavor compound. The evaporation rate was roughly proportional to the surface area of the carrier silica used. The least effective for reducing evaporative losses was the silica gel. The release rate of the flavor plated onto the silica gel is not different then when pure liquid is used. The use of SIPERNAT® specialty silica and AEROSIL® fumed silica as a carrier/plating agent reduces the evaporation rate of flavor to the headspace versus liquid flavor. These products can be combined with various encapsulation techniques to improve performance further.

There are many SIPERNAT® and AEROSIL® products with a wide variety of surface properties which could have interesting interactions with your flavor or fragrance.
Try them in your next formula. Evonik Industries AG has the solution for you.

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