AERODISP® Fumed Silica Dispersions as an Anti-Slip Agent for Paper Bags

Technical Information 1357

Evonik. Power to create.

Contents

AERODISP®

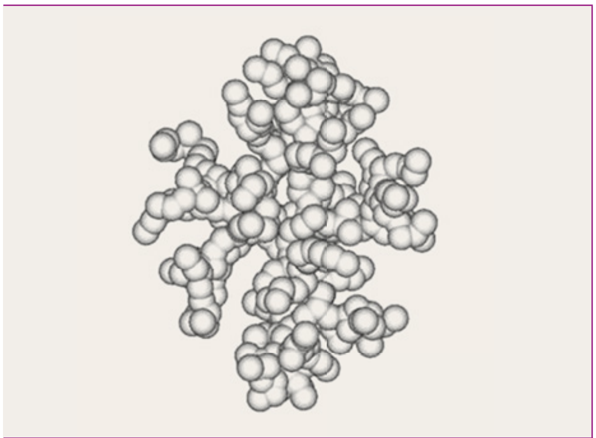
1. Introduction

Many of today's products are packaged in paper bags. With increasing automation, more stringent requirements are needed in the transport and storage of bagged products. It is reasonable for manufacturers, packagers and transporters to expect that bags stacked on a pallet will remain in position and not shift about when the product is transported and warehoused. To enable this, the bag must have an adequate level of static friction at the surface. Over the years, the common brown paper bag has been continuously upgraded to enhance its utility. Nowadays, it is common to see bags printed in various colors, not simply for content identification, but for brand recognition, consumer appeal and advertising. The inks used in the printing process will often reduce the static friction of the paper bag's surface.

To regain the friction, an aqueous colloidal silica dispersion can be applied during or after the printing process to increase the coefficient of static friction to a more suitable level. It is important to realize that colloidal silica consists of small, isolated, spherical particles. This is an inherent limitation of colloidal silica in effectively delivering high friction levels. Relatively high levels of colloidal silica are often necessary to achieve acceptable anti-slip properties.

Chemically, AERODISP® fumed silica dispersions are quite similar to colloidal silica but they differ in one important feature: the dispersed AEROSIL® fumed silica particles are highly structured (Figure 1)

Figure 1



Graphical representation of a silicon dioxide particle of AERODISP® fumed silica.

It is this structure that enables a much higher coefficient of friction to be achieved. This in turn allows more flexibility to significantly reduce the amount of silica needed per area of paper surface and thereby reducing the amount of water that is applied to the paper. In addition to the AEROSIL® structure enhancing the coefficient of friction, its fractal structure is also very efficient for absorbing liquids (e.g. inks and water) which prevents print ghosting and reduces encrustation on the machine.

2. Production and Properties

AEROSIL® is synthetic, amorphous silicon dioxide produced by hydrolyzing chlorosilanes in an oxyhydrogen flame, according to the chemical equation.

$$SiCl_4 + 2\,H_2 + O_2 \longrightarrow SiO_2 + 4\,HCl$$

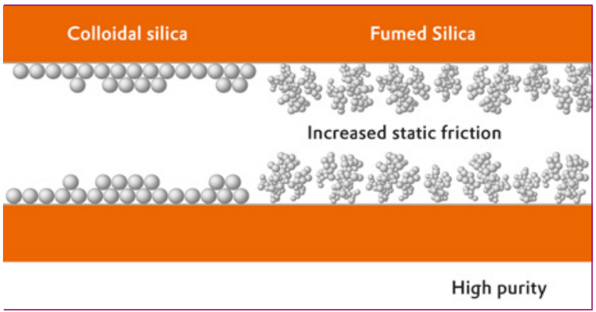
The production process was invented more than 60 years ago by Evonik's predecessor company Degussa and has been continuously improved over the years. Because it is produced by flame hydrolysis, AEROSIL® fumed silica is described as fumed silicon dioxide or fumed silica, and because of its fine particles, it is also known as highly dispersed silicon dioxide. The AEROSIL® process can also be used to produce other metallic oxides, such as aluminum oxides and titanium dioxide – products that Evonik markets under the brand name AEROXIDE®. Evonik also produces various mixed oxides.

The raw materials used are extremely pure. With a SiO_2 content of more than 99.8 % by weight (in relation to the ignited substance), AEROSIL® is one of the purest silica products on the market. Its heavy metal content is generally below the detection limit of conventional analysis methods.

Diverse product modifications
The properties of AEROSIL® and AEROXIDE® can be varied in many areas. For example, the specific area of AEROSIL® OX 50 is just 50 m^2/g, while the surface area of AEROSIL® 380 is almost eight times greater. AEROSIL® 200, the best known product, has a specific area of 200 m^2/g.

In addition, customized and stable dispersions of fumed silica are marketed under the brand name of AERODISP® and can be used just like colloidal silica.

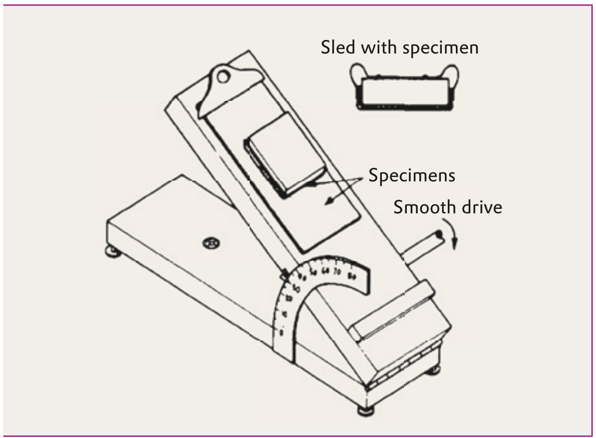
Figure 2



Model for increased static friction of a paper surface coated with AEROSIL® particles as opposed to conventional colloidal silica.

3. Measuring the Coefficient of Friction

Figure 3

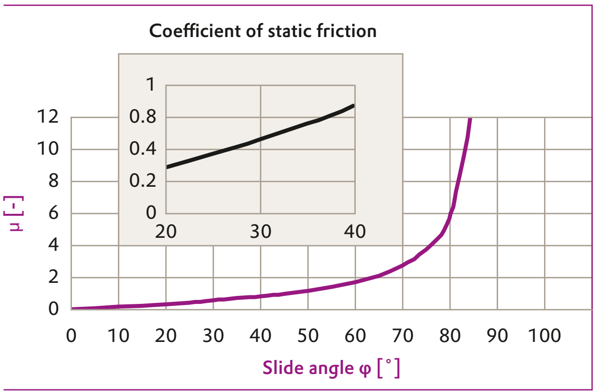


Static friction test device based on the TAPPI T-815 om-1 method.

The Coefficient of Friction (μ) can be determined by using TAPPI method T-815 om-1. In this test, an aluminum slide (200 g) wrapped in paper is placed on a surface covered with the same paper. A motor incrementally increases the angle of this surface. When the sled begins to slip the motor is stopped and the angle of inclination φ can be read. The static coefficient of friction is defined as the tangent of the angle measured for the paper surface.

$\mu = \tan(\varphi)$

Figure 4



Correlation between the friction coefficient μ and the slide angle φ for the entire angle range and for the angle range relevant for antislip applications.

Alternatively, the dynamic coefficient of friction (coefficient of sliding friction) can be determined. In this case you measure the force needed to keep a horizontal sled in motion. As no more acceleration work is required, the coefficient of sliding friction is always less than the coefficient of static friction.

4. Application Methods for AERODISP®

An AERODISP® fumed silica dispersion can be applied to the surface of paper bags in various ways. In the laboratory we have successfully tested spraying, applying by doctor blade and a 2-roller foulard method commonly used in the textile industry. However, in a production environment flexo printing is the method most preferred (Figure 5).

Figure 5

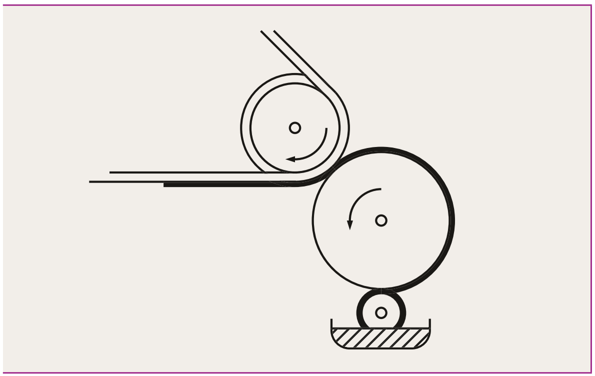


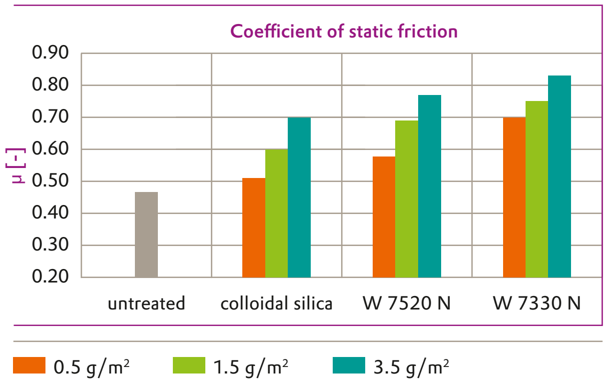
Diagram of a flexo-printing system suitable for applying AERODISP® as an anti-slip agent.

5. Test Results

AERODISP® fumed silica dispersions are composed of structured particles that are lacking in colloidal silica products. In laboratory testing, concentrations ranging from 30 to 50 % by weight (both diluted and undiluted) were evaluated. Paper treated with AERODISP® required considerably lower quantities of silica per square meter of paper to achieve the same coefficient of friction as obtained with colloidal silica.

The high efficiencies of AERODISP® dispersions are particularly obvious when compared to colloidal silica at lower concentrations (Figure 6). To achieve a coefficient of friction of 0.7 ($\varphi = 35°$) with colloidal silica, it requires 3.5 g/m^2 of SiO_2 (dry) to be applied to the paper as compared to only 1.5 g/m^2 when using AERODISP® W 7520 N. This is a 57 % reduction in the amount of silica required, providing a significant potential cost savings. AERODISP® W 7330 N is even more efficient with just 0.5 g/m^2 SiO_2 (dry) needed to achieve the same effect.

Figure 6



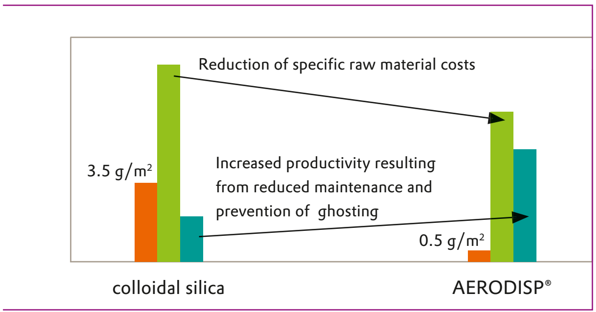
Comparison between the friction coefficients that can be achieved with colloidal silica, AERODISP® W 7520 N and AERODISP® W 7330 N with different weights of application.

AERODISP® fumed silica dispersions can be applied as received or diluted to any concentration with de-ionized water. Soft municipal water can also be used, however, hard water containing lime can destabilize most colloidal systems and should be tested in your application first.

6. Economic Benefits

Although colloidal silica products are generally less expensive than AERODISP® fumed silica dispersions, they are also much less efficient as demonstrated in figure 7. The higher coefficients of friction that are achieved with AERODISP® allow for significant reductions in the amount of silica. Dramatic savings can be achieved by reducing raw material usage, storage and handling.

Figure 7



- SiO_2 used per m²
- Specific raw material costs
- Machine productivity

Relative economic benefits of AERODISP® compared to colloidal silicas at a glance.

Figure 8 Undesired ghosting can be prevented with AERODISP®

Additional savings can be gained through the following technical benefits:

- Less downtime and maintenance, increased productivity and throughput: Reducing the amount of SiO_2 needed will lessen problems with soiling and incrustation of the application system. This can translate to less down time for maintenance issues and increase productivity and throughput.
- Prevent ghosting and maintain press speeds: The structure of AERODISP® fumed silica particles can inhibit ghosting (Figure 8) on the flexo-printing press. When high coefficients of friction are required, it is common to use high quantities of colloidal silica. The problem can sometimes be solved by slowing down the press speed leading to reduced productivity and increased costs. These issues can be avoided by utilizing the structure of fumed silica to achieve friction targets, prevent ghosting and maintain press speeds.

Table 1 lists AERODISP® products which we especially recommend as anti-slip agents. The primary particle size is for reference purposes only since AERODISP® particles do not exist in this form. For Anti-Slip applications, the average aggregate size provided above is a more appropriate property. In addition, we have many products in our portfolio not listed here which may be of unique interest for more specialized anti-slip applications. Further information can be found in our product overview, technical literature or on our website: www.aerosil.com

Table 1

	Unit	AERODISP® W 7520 N	AERODISP® W 7330 N
SiO_2 content	wt. %	20	30
Stabilizing agent		NaOH	NaOH
pH		9.5–10.5	9.5–10.5
Viscosity	mPas	< 100	< 1000
Average primary particle size	nm	12	16
Average aggregate size	nm	120	120
Density	g/cm³	1.12	1.20

AERODISP® fumed silica dispersions especially recommended as anti-slip agents

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