Textile fabrics are much more than just a piece of clothing or a consumer item. Regardless of whether it is a towel or a pair of trousers – modern consumers place great value on what a fabric feels like. The desired silky-soft feel can be achieved with special silicone additives that have extremely low interfiber friction. No other softener has yet matched this so-called “silicone hand.” Furthermore, silicone additives are a cost-effective variant for market-oriented fabrics: combined with esterquat, silicones provide pleasant and functional effects with an excellent cost-to-benefit ratio. But how do silicones interact with textile fabrics? Which advantages do they bring? And which consumer requirements can silicone additives fulfill? You’ll find the answers to these questions here; if you have any further queries, please contact us. Our experts will be glad to help you. You can contact us directly via: info.silicones@wacker.com

1. SILICONE PRODUCTS IN FABRIC SOFTENERS

1.1 Model of the Silicone/Fiber Interaction
The active ingredients in a fabric softener reduce friction between the individual fibers and between fibers and metal in order to counteract undesirable consequences of the washing process. Silicones are known to have significant lubricating and softening effects on textile fibers. This effect is often exploited in textile finishing.

Deposition of silicone polymers on the fibers results in a very good spreading action and excellent lubrication properties. This is due to the high flexibility of the Si-O-Si backbone of the silicone polymers. The various ways of functionalizing the polymers with amino groups, for example, means that they can be easily anchored to the fibers. Furthermore, the deposition behavior can be controlled by means of functional groups and the molecular weight.

The interaction between silicones and fibers has been investigated in detail, and the effects of such a finish are for the most part clear (for further details, see Points 1 and 2). Fabrics are usually treated with amino fluids, which are polydimethylsiloxanes functionalized with terminal amino groups on the side chains and backbone. The protonated amine nitrogen atoms of these silicones interact electrostatically with the negatively charged textile fibers thus anchoring the silicone molecule to the surface of the fiber. The resulting silicone loops are oriented away from the fibers:
The high mobility of the silicone loops means that the treated fibers can easily slide past each other, which also reduces fiber/metal friction. The extremely low interfiber friction bestows the textiles with the silky soft feel or “silicone hand” so valued by consumers and which has not been matched so far by any other fabric softener. The tactile properties are influenced by the length of the silicone loops (and thus also by the amine number of the respective amino fluid). A high amine number means the silicone loops are too short to induce a good soft hand.

### 1.2 Combination with Esterquat

Extensive tests have been carried out to study the performance of silicone emulsions in textile finishing compared to a typical softener containing organic softeners, particularly those using esterquat as the active ingredient. This included tests with mixtures of silicone products containing Triethanolamin based tallow fatty acid esterquat to find a more cost-effective alternative to the use of the relatively expensive silicones on their own.

The comparative tests showed that the combination of silicones and organic esterquat gave very good results with respect to the desired effects such as soft hand, hydrophilicity, and wrinkle-resistance. It is also a cost-effective and competitive alternative.

In general, silicones can be anchored more efficiently to fibers when they are used together with quaternary ammonium compounds. This is attributed to the fact that organic softeners have a good affinity to both the fibers and the silicones. The organic product thus provides basic softening properties and simultaneously assists in the attachment of the silicone product to the fibers. In contrast, the silicone product showed significant additional effects, even at low concentrations, and thus extended the functional spectrum of the organic softener.

The increasing raw material costs for bio-based and oil-based products also increase the price for esterquat. Silicone softeners are thus becoming increasingly competitive because, for identically priced formulations, the partial replacement of esterquat by silicones produces even better soft-hand effects and, if desired, additional effects are also possible.
2. EFFECTS

The appropriate combination of esterquat-based softeners with silicones results in specially selected effects for the use of these formulations in the softener cycle of washing machines.

2.1 Hydrophilic Softeners

New softener molecules provide the silky tactile properties typical of silicones while also maintaining high absorbency of the textile fabric. A concentrated aqueous macroemulsion of an amino-functionalized polydimethylsiloxane (trade name: WACKER® FC 218) produces a surface-based, flowing soft hand. Cotton thus remains highly absorbent, and even synthetic fibers gain hydrophilic properties.

Example: a combination of WACKER® FC 218 with Stepantex® VL90 on terry towels

The hydrophilicity of the tested towel increased as the amount of esterquat decreased. The soft hand reached an optimum level at a particular esterquat/silicone ratio.

2.2 Wrinkle-Resistant Finish

An exceptionally good wrinkle resistance can be achieved with WACKER® FC 201, which is a 60% aqueous emulsion of a low-viscosity silicone fluid consisting of two differently functionalized polydimethylsiloxanes that polymerize on heating. When added to the last rinsing cycle, the low-viscosity fluid penetrates the fibers. Subsequent ironing polymerizes the fluid into an end product with a high molecular weight.

This product increases the rebound resilience of the fibers by reducing interfiber friction. The effect is considerably greater for blended fabrics, such as cotton/polyester, compared to pure cotton textiles. The treated blended fabric is wrinkle-resistant after ironing.

A cotton-polyester garment that has been treated with this novel silicone product in the rinsing cycle and then ironed has visibly less wrinkles when worn than the untreated garment. Furthermore, the garment has significantly less creases when it is taken out of the machine after the next washing cycle.
2.3 Easy Ironing

Modern consumers have neither the time nor the desire for time-consuming and strenuous ironing – this rather unpopular work should be done as quickly and efficiently as possible. Special silicone products have been developed especially for this purpose. Used as softeners or as ironing sprays, consumers profit from the resulting time-saving easy-ironing effect.

The easy ironing effect is measured as follows:
A treated cloth made of cotton or blended fabric is stretched over a board that is then tilted at an angle of 6° or 7.5°. The time taken for a hot iron (cotton setting) to slide from the upper edge of the board to the lower edge is measured and converted into the gliding speed.

The products WACKER® FC 201 and WACKER® FC 218 produce a very good easy ironing effect in softener formulations.

Example: WACKER® FC 201/ WACKER® FC 218 in combination with esterquat in a softener formulation
The products WACKER® FC 213 and WACKER® E 22 are particularly suitable for ironing spray formulations. Even 0.5% in the formulation greatly improves the easy-ironing properties of the sprayed textile.

WACKER® FC 213 is an emulsion of an OH-terminated silicone polymer, and WACKER® E 22 is an emulsion of a high-molecular PDMS.

Example: WACKER® FC 201/ WACKER® FC 218 in combination with esterquat in a softener formulation

2.4 Fast Drying
Textiles still contain a lot of moisture after the spin cycle. The wetter the fabric, the longer the drying time on the clothes line and the greater the energy consumption and thus the electricity costs of tumble-drying.

Polarity-modified silicones, so-called superwetters, are thus used in the last rinse cycle. They result in a quicker and more effective dewatering of the fibers during spinning. Modification of the silicone backbone corrects the lack of resistance to hydrolysis shown by typical superwetters. This saves drying time on the clothes line and minimizes operating time and costs of tumble drying.
Example: Use of WACKER® SLM 21210 in the rinse cycle at a concentration of 1.0% active substance with respect to the fabric weight reduces the residual moisture of cotton and blended fibers. For example, by about 8% for cotton and about 16% for polyester/cotton.

2.5 Water/Soil Repellency
In order for functional sportswear to remain permanently water- and soil-repellent, these high-tech textiles must be periodically reimpregnated. Special products have been developed for this, including practical impregnation sprays or laundry impregnating agents that are added to the last rinsing cycle of the washing machine. These products “automatically” impregnate the fabric against dirt and moisture.

However, many of them still contain solvents or fluorocarbon resins, both of which are not recommended from the environmental point of view. WACKER Fabric Care products enable the production of impregnation sprays and laundry impregnation agents that do not contain solvents or fluorocarbon resins.

Extensive screening tests identified two silicones that work together to produce a significant hydrophobic effect on cotton and other fibers. Using a special stabilization method, for which a patent is pending, it was possible to develop an emulsifier-free silicone microemulsion that coats the fibers of a textile fabric with a perfect hydrophobic film that is not destroyed by surfactants.

The effectiveness of the recently developed silicone microemulsion (trade name: WACKER HC 303) was thoroughly tested on various textiles (cotton, synthetic fibers, membrane textiles). The microemulsion also makes suede/nubuck leather and hard porous substrates water-repellent, as demonstrated by comprehensive tests.

Example: Measurement of the penetration time of an 0.04 ml sized water droplet on cotton and blended fabric
3. SILICONES – A BETTER ALTERNATIVE

Tailored silicone products bestow textile fibers with special functions and effects, thus making it possible to fulfill particular customer requirements for the first time. The highest product quality, wide formulation flexibility, and simple processability lead to the best results.

WACKER can supply you with a cost-effective and market-oriented product spectrum with high-quality silicone additives for textile care as well as individual services tailored to your specific requirements.

Any questions? Our experts will be glad to help you. You can contact us directly via: info.silicones@wacker.com