Deaerators – textile auxiliaries that can do (almost) anything

Deaerating agents have been part of textile finishing processes for many years now, and significantly improve the quality of the end result. Traditionally, they have been used to get unwanted air pockets out of the fabric before the start of the dyeing process. However, what is less well known is their versatility, and the way that they can be used to improve a number of wet finishing processes. Almost any fabric substrate, at any stage of processing and in any finishing process can be significantly improved by a deaerating agent. The chemical properties of these substances, how they work and what they can be used for will be outlined here. The advantages and disadvantages of different types of deaerators will be described, and finishes with a look at the current state of the art.

Wolfgang Höhn
Pulcra Chemicals GmbH, Düsseldorf/Germany

Chemical structure and basic principle of deaerators

Scientifically speaking, the term “deaerator” covers a very disparate group of process chemicals that vary hugely in terms of their molecular composition and applications. However, what all deaerators have in common is a combination of defoaming, penetrating, surfactant and emulsifying components that work together chemically and functionally.

The way in which these individual components combine, is what gives this class of product both its eponymous deaerating effect (Figs. 1 and 2), and its high level of stability, and in particular shear stability. It is these two characteristics that distinguish deaerators from the chemically and functionally related category of products known as defoamers. The defoaming components are typically based on silicone, mineral or plant oils, triisoalkyl phosphates, fatty alcohols and fatty amides, and on binary and ternary combinations of these. The concentrations of these substances in deaerators are significantly lower than they are in pure defoamers. In addition, a so-called penetrator ensures the agent penetrates better into the fabric. A further essential component are the emulsifiers, which as a rule are based on ethoxylated fats and fatty alcohols, often with the addition of alkyl/aryl sulfonates to make them temperature and electrolyte-stable. In certain cases, silicone surfactants (ethoxylated silicones) are also used to enhance the penetrative and defoaming effect. These emulsifiers are largely responsible for the surfactant effect. The chemical complexity and variety of the different formulations in commercial use is reflected by wide differences in performance profile between deaerators of different brands and especially different types.

How deaerators work

In simple terms, a deaerator combines the effects of a defoamer and a surfactant. Fig. 1 shows this in schematic form, using the dyeing of a yarn bobbin as an example. Whatever the condition or format of the fabric, the deaerator must ensure that unwanted air pockets are eliminated. This is achieved by defoaming, surfactant and penetrative effects. It is generally measured by assessing the fluid uptake of a bobbin that is fully im-
mersed in stationary cold fluid (Fig. 2). While these tests are differentiating and replicable, and do allow an assessment of the surfactant effect to be made, in certain circumstances this should be measured separately using the usual methods, such as DIN ISO 1822.

**Applications of deaerators**

Deaerators are suitable for use in a wider range of processes than practically any other textile auxiliary. While dyeing remains their primary area of application, they are also essential to pretreatment, printing, washing, finishing and coating processes.

The main process applications of deaerators are as follows:

**Discontinuous pretreatment/dyeing/finishing**

- For package systems (loose stock, rovings, bobbins, muffs, beams): deaeration and optimum penetration of the fabric; particularly important during dyeing. For best results, it is recommended to add the deaerator five minutes before the other (surfactant) auxiliaries. In yarn dyeing, the dye flow direction should be exclusively in/out at this stage.
- In jet dyeing: deaeration of the fabric for better dye retention without immersion. The defoaming effect complements the typical foam profile of (non-ionic) surfactants, which normally decreases as temperature rises. In this case, it is recommended to add the deaerator before loading the machine.
- In all discontinuous systems: prevention of cavitation, i.e. stopping liquid chemicals from vaporizing on the pump suction side and thereby keeping the liquid circulating properly. If deaerators are not used, a build-up of sufficient static pressure could result in foaming elements in the liquid (surfactants) or volatile compounds with a high vapor pressure (e.g. solubilizers or components of dyeing accelerators) causing the same problem.

**Continuous applications in pretreatment, dyeing and finishing (padding/maximum batch size/minimum batch size process)**

In this case, the combination of surfactant, defoaming and penetrative effect is a particular benefit over and above the basic deaeration. What is more, a deaerator emulsion is naturally less likely to separate in low-turbulence liquid flows than a liquid defoamer, a property which is particularly useful in continuous processes.

**Textile printing and coating/lamination**

Here, the focus is on deaerating the paste. Improving the solubility and penetration of the dye is desirable. Deaerators also have a positive effect on the flow behavior of print pastes.

**Garment washing and dyeing**

The keys here are an excellent surfactant and penetrative effect, combined with good enzyme tolerance. This improves the depth and evenness of garment dyeing, particularly in stitched hems.

**Advantages and disadvantages of different types of deaerators/historical overview**

Deaerators have been in use for more than 30 years, and throughout this period there have been different types of deaerators. Each type has its own advantages and disadvantages. For example, some deaerators are more effective in removing dissolved gases from water, while others are better suited for removing gases from the air. It is important to choose the right deaerator for the specific application.
have been both specialist and general-purpose variants, also both silicone-based and silicone-free types. Over the years, aerators have constantly been developed to improve their safety and efficiency.

**First-generation silicone deaerators**

This is the standard deaerator, and even today, it remains the most widely used. Depending on their silicone content, products may be more suited to jet or package dyeing. However, their stability in alkalis, electrolytes and especially in cyan and anthraquinone dyes can be highly variable. Moreover, silicone-based products are not used in certain areas, such as automotive applications and flame-retardant PET.

**Tri-isobutyl phosphate-based deaerators**

This type of silicone-free deaerator represents an interesting and complementary alternative to first-generation silicone-based products, particularly where a rapid surfactant effect is required. On the other hand, defoaming performance is poor, and in some products, the volatile, solvent-like tri-isobutyl phosphate can attack certain plastics, as well as causing undesirable emissions. However, tri-isobutyl phosphate-based deaerators are suitable for use in automotive applications and on flame-retardant PET, offer good stability in alkalis and electrolytes, and are not known to exhibit an intolerance to cyan dyes.

**Mineral-oil and plant-oil deaerators**

These silicone-free products are an alternative to conventional first-generation silicone deaerators that are suitable for the same sorts of application. While their universal effects are weak and they are not very stable in alkalis, they can however be used in automotive applications and on flame-retardant PET.

**Fatty alcohol deaerators**

This class of product is an evolution of tri-isobutyl phosphates, and represents a significant advance in terms of workplace safety (emissions) and material tolerance. They can be used without any problem in automotive applications and on flame-retardant PET. Like deaerators based on tri-isobutyl phosphate, they have a rapid surfactant effect, but their tolerance of alkalis and, in particular, cyan dyes is limited. Fatty alcohol deaerators have largely replaced tri-isobutyl phosphate-based products, but for many applications, they are not a viable substitute for silicone deaerators.

**Second-generation deaerators**

Breviol ELN from Pulcra Chemicals is a highly efficient universal deaerator. Extremely versatile and safe to use, it combines virtually all the key benefits of the four types of deaerator discussed above, thanks to a number of special additives in its formulation. It is manufactured using a sophisticated new emulsifying technology. It is also designed to support the latest requirements of users, such as easy automatic dosing.

The only slight limitation of Breviol ELN relates to its use in automotive applications and flame-retardant fibers (such as modified PET and viscose), where even tiny amounts of silicone oil can have a detrimental effect. For this reason, it is recommended that other types of deaerators, typically those based on fatty alcohols or tri-isobutyl phosphate, are used for these applications, because of their water vapor volatility when drying.