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Microfibres: Eastman develops Cyphrex technology for filtration needs

Earlier this year Eastman Chemical Company launched Cyphrex microfibres. Mark Holmes talks to Eastman's Fred Dulin about the wide range of possibilities that these microfibres will bring to the filtration market by fine-tuning the fibres to meet specific end-use applications.

Eastman Cyphrex microfibres have been developed to offer a number of tunable fibre properties, including size, shape and material. By being able to vary such properties, the microfibres can be used by wet-laid nonwoven manufacturers to produce filter media that can now precisely meet the requirements of the end-use application.

Eastman Chemical Company

Well-known as a speciality chemicals company, Cyphrex is Eastman's first venture into microfibres and the filtration business. Headquartered in Kingsport, Tennessee, USA, Eastman is active in around 100 countries and had a turnover in 2012 of US$9.1bn. The company now employs approximately 14,000 people around the world following the completion of the acquisition of Solutia in

The corporate headquarters of the Eastman Chemical Company in Kingsport, Tennessee in the USA.

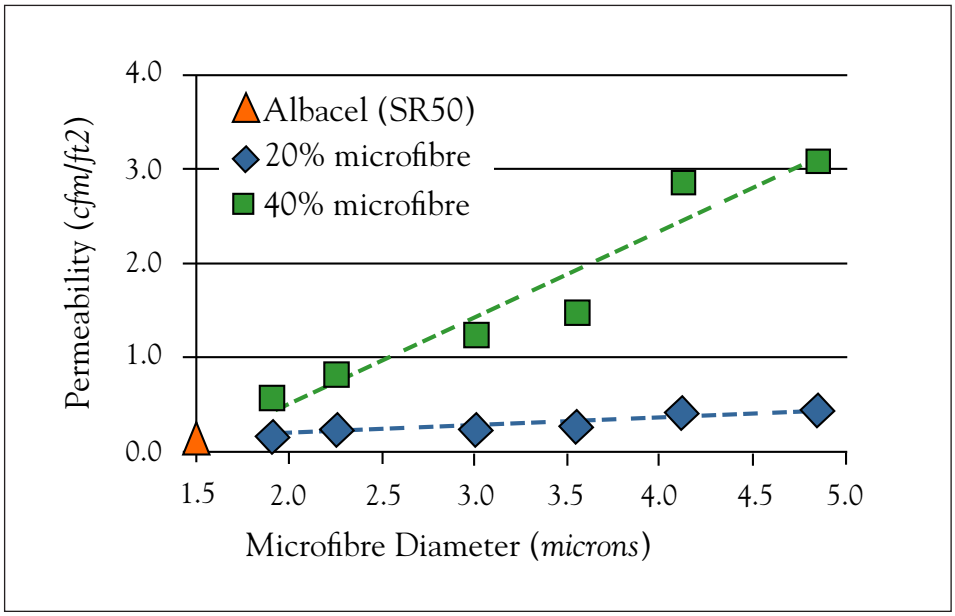

Figure 1.

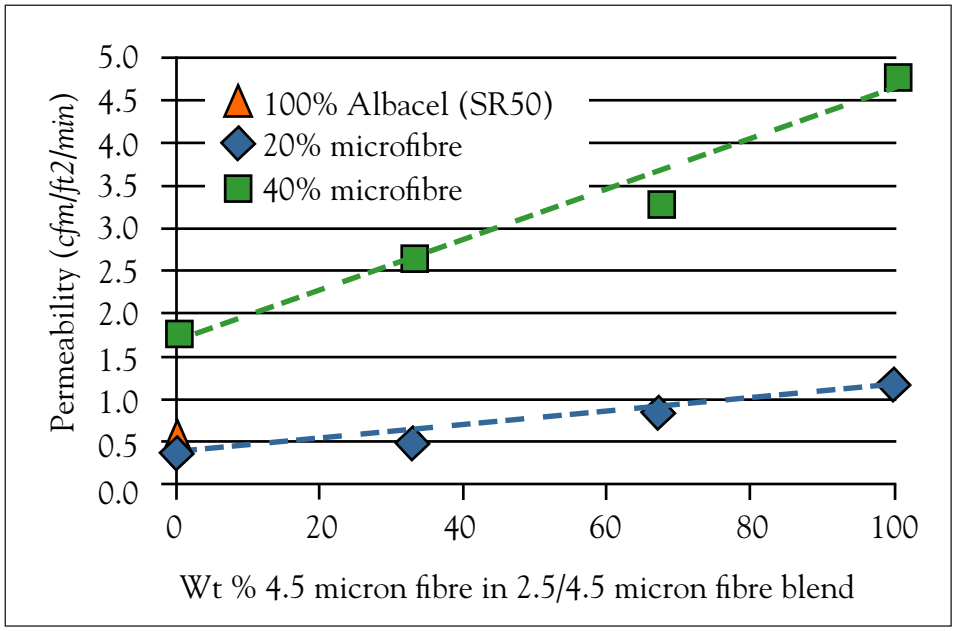

Figure 2.

Fred Dulin, director Microfibres Platform for Eastman Chemical Company.

2012. So why has Eastman moved into the filtration arena?

"It is a good fit for the company," explained Fred Dulin, director, Microfibres Platform. "Eastman has great strength in polymer chemistry and a good understanding of how to apply that depth of expertise in downstream applications. This is technology that Eastman has been practising for decades. We have had a number of plastics businesses over the years and so technology-wise it was an excellent fit for us. The other thing that makes it a good fit for Eastman is our background in materials for coatings and adhesives – formulated product businesses. While nonwovens are neither coatings nor adhesives, the formulator's mindset that is required to be successful in nonwovens is very similar to what you see in coatings and adhesives."

Eastman's development of Cyphrex microfibres has been several years in the making. Fred Dulin explained that the original work began around 7-8 years ago, which then fully moved into a microfibres effort about five years ago.

He continued: "We had considerable polymer expertise in-house, but we have also brought in technical development and marketing personnel from the nonwovens industry. Some of these people have 20 to 25 years' experience in formulating nonwovens. While nonwovens are not our focus, we felt that this was important to understand what was needed and be able to develop the right fibres for the industry."

Microfibre properties

Eastman Cyphrex microfibres are designed to target unique functionality by independently or simultaneously fine-tuning the microfibre size, shape or material.

Eastman adds that Cyphrex can help media manufacturers and their customers reach desired functional properties with a completely new set of tools, without forcing them to compromise performance in one area to make gains in another. The technology and processing techniques used mean that Eastman can produce these easily dispersible synthetic microfibres in uniform and precise lengths and diameters.

With an understanding of critical performance requirements for specific nonwoven applications, Eastman adds that it can design new microfibres that are targeted to satisfy those needs, by varying microfibre size, shape and material.

With round fibre cross-sections of less than 5 microns in diameter, Cyphrex microfibres offer a high surface area-to-mass ratio and a narrow diameter distribution. As a result of this uniformity, a range of desired functional properties can be achieved through blending different diameters of microfibres. In addition, the microfibres can be made in a variety of shapes, including round, flat, and wedge. By doing this it is possible to control fibre surface characteristics to affect key media properties.

With these different shapes, nonwoven attributes such as permeability, strength, and uniformity can be influenced in ways that changing fibre size alone may not allow.

The Cyphrex technology enables access to the widest range of synthetic polymers for microfibres. This ranges from the most commonly used materials, PET and polypropylene, to materials considered

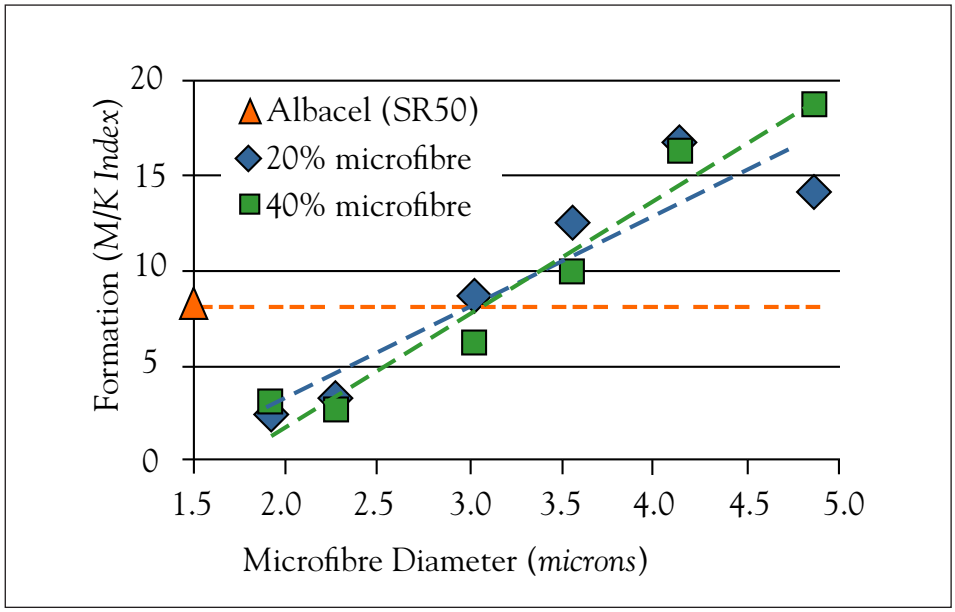

Figure 3.

specialities for nonwovens, such as nylon, PLA, copolyesters, and others. By having access to a broad set of polymers Eastman adds that it is able target the right functionality for the right application.

"What is important to remember is not that we can have this fibre, shape, size or polymer, but that we do it for a purpose," said Fred Dulin. "In other words, how do we adapt the fibre to suit the end application?

"For example, one of the ways in which you achieve strength in a nonwoven is from the intersection points of the fibres. So if you take a round fibre of a given diameter and a flat fibre with a similar cross-sectional area you actually get more surface-to-surface contact between fibres with the flat fibre. That surface contact creates additional friction and/or bonding surface, which helps lead to strength. This is how manipulating shape could help to enhance the properties you want. Another example in the filtration space is tortuosity. Manipulating the shape can make a more or less tortuous path through the filter media and properties of the filter can be fine-tuned for the application required.

"At effective diameters of 5 microns and below, we have been able to work with a number of different fibres and we have quite a lot of latitude to take the size up and down," he added.

"Our initial product is with a PET fibre, but we are working with others. In applications over the next year or so, we will be employing a number of different polymers, as well as manipulating both fibre shape and fibre size."

Enhancing functionality

Eastman adds that it has conducted research to measure how varying Cyphrex microfibre size, shape, and material enables the creation of nonwoven products with an endless array of formulations and performance advantages, such as pore size, permeability, formation and strength.

Influencing subrate permeability

The ability to control the permeability of nonwoven media is critical in many high value applications, such as filtration. PET microfibres of discrete diameters and 1.5 mm in length were blended with an NBSK cellulosic pulp (Schopper-Riegler® freeness of 50) at levels of 20 and 40 wt% based on total furnish solids (see Figure 1).

Eastman reports that significant improvements in the permeability of the otherwise, rather impermeable cellulosic sheet were observed and those were seen to be directly related to both the diameter of the PET microfibre and the amount of microfibre present. There is also a relatively linear response with respect to microfibre diameter. Eastman investigated whether the wide and useful range of permeability enabled by the 40% microfibre blends would necessarily require a number of fibre sizes to access that functionality. The discrete fibre diameters of Figure 1 were replaced with a blend of two differently sized microfibres - specifically with 2.5 micron and 4.5 micron diameters. As can be seen in Figure 2, the permeability of the small-large fibre blends mirrors the range provided by the discrete fibre diameters - suggesting a capability for synthetic microfibres to create an 'apparent' fibre size by simply blending two different materials. The first two fibres in Eastman's offering will allow nonwoven producers to accomplish just that.

Influencing substrate uniformity

Eastman adds that nonwoven uniformity ('formation') is an attribute of some importance as it can influence a wide range of functional media characteristics which can be negatively impacted by 'defects' in the substrate. These characteristics can range from relatively simple appearance requirements to rather complex filtration phenomena. Formation can be evaluated visually (by those sufficiently experienced) or instrumentally (for example, with a M/K Systems, Inc. Formation Analyzer). In a manner similar to the permeability study, the impact of PET microfibres of discrete diameters and 1.5 mm in length on the formation of a cellulose/synthetic blend was evaluated (see Figure 3).

The formation is significantly influenced by the fibre diameter (or more accurately, the fibre aspect ratio). Unlike permeability, the substrate uniformity is relatively unaffected by the amount of microfibre present in the nonwoven - at least at the levels of microfibre addition which were evaluated.

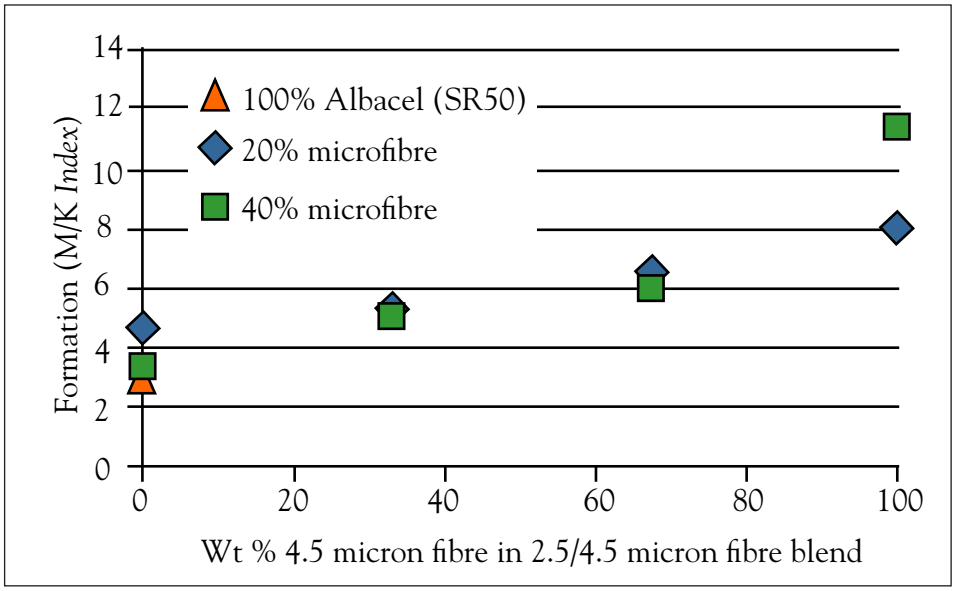

Figure 4.

As was done with the permeability evaluation, the discrete fibre diameters of the 40% microfibre data set of Figure 3 were replaced with a blend of 2.5 and 4.5 micron diameter microfibres. In the same way, the big-small fibre blends provide the same improvements in formation as the discrete fibre diameters/ aspect ratios (see Figure 4).

According to Eastman, this demonstrates that significant value can be created in nonwoven formulations through specific design of fibre size characteristics through insights provided by industry-standard application development capabilities.

Processing

The way in which Cyphrex microfibre is manufactured is also key to its success. Eastman adds that the microfibres satisfy the ever-increasing performance needs for demanding rolled goods and media markets – especially for customers who benefit from precision and uniformity in wetlaid nonwovens. Highly uniform bicomponent fibres (*islands-in-the-sea*) are produced using a proprietary removable sea material. The spun bicomponent fibres are then precisely cut to prescribed lengths. Finally the proprietary sea polymer is removed with hot water (and not the aggressive chemicals often used in other microfibre operations), producing the Cyphrex microfibre pulp. This means that each microfibre retains its integrity through manufacture, resulting in highly uniform microfibres.

"The gentler water opening process that we use also means that we have a greater range of options," said Fred Dulin. "For example, one of the more exotic things we can do is create PLA (polylactic acid made from renewable resources) as a microfibre. We are trying to understand where the best opportunities for PLA are, but we certainly think there are possibilities there."

Eastman adds that Cyphrex microfibres integrate easily into existing wetlaid processes and often provide more efficient and effective dispersion when compared to some other synthetic microfibres. Unlike many other synthetic fibres, Cyphrex microfibre pulps are also compatible with other fibre materials, such as cellulose and glass.

"What we heard from the industry was that it was often challenging to process synthetic fibres in a wetlaid process," added Fred Dulin. "We have been able to overcome this with this material and the way we manufacture it. We are also getting a lot of feedback that it blends very easily with other fibres."

Kingsport

All manufacturing is currently undertaken within Eastman in the USA. Mr Dulin commented: "As the business expands, we will try to understand where the needs are and where the manufacturing is needed to satisfy that. We can use the global reach of the Eastman Chemical Company to meet those needs."

Eastman Cyphrex synthetic pulp.

Eastman has also made a significant investment in laboratories for the microfibre venture. These include a fibre development laboratory for microfibres and a wetlaid applications laboratory, as well as testing facilities for those materials.

"We are able to work on a quick cycle for the development of fibre prototypes and the development of a nonwoven that may use those fibres. This allows the rapid testing of these materials and reworking them to get the right fibre for the right application, as frequently as is needed," he said.

"These facilities are not just for the fibre development, but go one step beyond and help us understand the development of the nonwoven. We tend to have be a more fruitful discussion if we can talk to the customer about the properties that they want to achieve in their nonwoven material or even the end-use filter. It is much faster if we can focus on the end result that is needed. We can then work backwards to develop a fibre that helps meet those needs."

New fuel filtration media uses Cyphrex microfibres

Ahlstrom has collaborated with Eastman Chemical Company to use Cyphrex™ microfibres in a new fuel filtration media, Ahlstrom Captimax. The media is suited for fuel filters in passenger and commercial heavy-duty vehicles and off-road machinery. It is currently being evaluated for use in hydraulic applications.

By using Eastman Cyphrex microfibres, Ahlstrom created media for a filter that allows manufacturers to obtain optimum micron efficiency ratings and dust holding capacity without making compromises. Ahlstrom Captimax provides a balance of good small-particle retention and the potential for longer media life. The media also lets fuel filtration system suppliers maintain existing capacity levels but decrease the package size. In addition, the media can allow for increased efficiency with better options to filter fine particles to protect fuel injectors in vehicles and machines.

"Using Eastman Cyphrex microfibres in Ahlstrom's new diesel fuel filtration media changes the filtration landscape," said Gary Blevins, vice president, marketing and commercial for transportation filtration, at Ahlstrom. "This media can offer both high efficiency and high capacity. We've given our customers the ability to make filters to the specifications they need, allowing them to develop products outside the standard constraints from the media."

Ahlstrom Captimax provides high efficiency allowing engines to perform at their maximum. This capability has been proven with particle testing before and after fuel is filtered through the media. It can have the same dirt capacity and a reduced filter package. Or a filter can have a package of the same size with increased capacity. Adjusting capacity can extend the time between filter replacements to help keep vehicles and machines in operation longer or better align with the timing of other vehicle or machine filter replacements.

"The new media offering from Ahlstrom marks the first product to be brought to market with these microfibres," said Mark J. Costa, executive vice president, Eastman Chemical Company. "Our collaboration will provide countless benefits for manufacturers and end users. We're confident the two companies will work together in the future."

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