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Wipe performance goes under the microscope

Cleanroom wipes have developed considerably since their initial introduction. **Karen Rossington** looks at performance issues and improvements

Cleanroom wipes have their origins in the nuclear industry when the first critical wipes, made of cotton twill, were used to control removal of radioactive dust particles within the contained nuclear reactor environment. The emergence of microelectronic manufacturing required cleaner wipe options and the cotton twill was replaced by Nylon monofilament. By the mid 1980s polyester monofilament became the standard critical environment wipe. Only later, did the pharmaceutical and life science sectors – more concerned with viable contamination – adopted critical wipes. Today wipe production for all types of critical environment is big business and as manufacturing technology innovates, so the demand for cleaner wipes grows.

In 1998 Contec introduced the first pre-saturated wipes for cleanrooms to reduce solvent use and increase convenience in hand wiping. One of the quickest adopters was the medical device industry, which saw the productivity improvements and process controls that the technology offered. Sterile pre-saturated wipes were introduced in 1990 for the pharmaceutical industry and the developing biotech market.

Substrate innovations

In the late 1980s, microfibre was introduced. The definition of a microfibre is a fibre with less than 1 decitex per filament. A decitex is a measure of linear density that is commonly used to describe the size of a filament or fibre.[1] One decitex is 9/10th of a denier. To put this into perspective it is 1/16th the diameter of a human hair. The fibres can be combined to create yarn that can be then be knitted or woven into a variety of constructions. Microfibre fabrics can be broken down into two main types, splitable microfibre and straight filament microfibre.

Straight filament microfibres are usually made from 100% polyester. Splitable microfibre consists of very fine threads of polyester and polyamide (nylon) that are combined to form a single thread. The nylon is used to glue the fibres together until they are split later in the process. Split microfibre (Fig. 1) possesses numerous wedges rather than the rounded threads found in other yarns. It is these wedges that provide the ability to collect microscopic particles from a surface. This expanded surface area and the capillary action of the fine threads dramatically increases a microfibre wipes' sorbancy. A change in the percentage of the microfibre blend will yield slightly

Figure 1

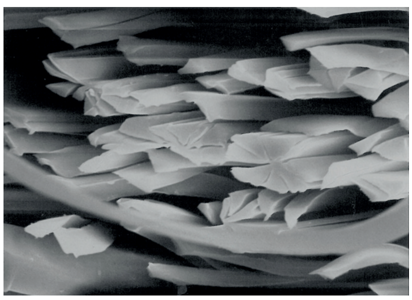

Figure 1 (right): Electron micrograph showing microfibre's wedge-shaped ends. Above: Cleanroom wipes need to arrive clean and leave dirty different properties. This split structure gives the wipe the ability to pick up particles even when dry, and it can easily remove residues often without solvent. The split fibres create microscopic 'hooks' which collect and hold dust, dirt and particles more effectively than rounded fibres such as cotton (see Fig. 2). The microfibres are also positively charged so attract negatively charged dirt electrostatically. Unused wipes are very soft so won't scratch and damage surfaces, however care should be taken when re-using wipes as the very structure which makes them so good at picking up particles also means that particles get stuck in the fibres which can then scratch a sensitive surface.

Microfibre has a high sorptive capacity, around 6 to 8 times its own weight in water. The fast wicking ability means a wipe can remove spills quickly and easily, so it is very suitable for 'mop to dry' situations.

However, in cleanroom environments there are some downsides to the use of microfibre, the fibres are less durable and also create much higher levels of fine particle contamination. The microfibre would need to be laundered to reduce these levels of contamination. Microfibre is high in cost so not ideally suited to being a single-use material. It is most relevant to applications where mop to dry or wipe to dry performance is paramount and the activity of continual re-laundering does not create problems. A split microfibre containing nylon is not compatible with bleach-based disinfectants.

Figure 2

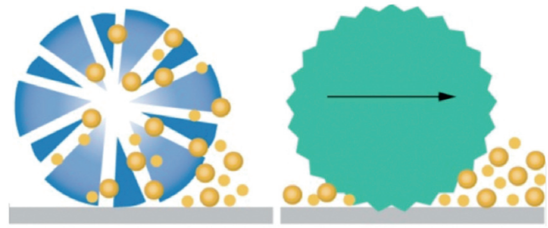

Figure 2: Schematic showing how split fibres (on left) create microscopic hooks that collect and hold dust, dirt and particles in contrast to rounded fibres (right)

Risks of re-laundering microfibre

Microfibre is not a low cost option – table 1 gives a comparison of various blends of microfibre against 100% polyester and the corresponding attributes. In many instances, this high initial cost is balanced by re-laundering and where relevant the re-sterilisation of the mop or wipe. Mops in particular are laundered and reused. However, in a cleanroom environment this is not without risk. Microfibre is very delicate and can be easily damaged by high heat or harsh chemicals, this can lead to a mop or wipe degrading over time and affecting both the cleaning ability and the sorbent capacity of the mop over time.

As cleaning is carried out from the cleanest to the dirtiest area within a cleanroom complex the soil load on mops can be significantly different. It is not easy for the laundry to guarantee getting all the mops back to the same level of cleanliness every time. The structure that makes the microfibre so good at picking up particles and retaining them for removal from the surface, also makes it equally difficult for them to be cleaned as small or microscopic particles remain embedded in the wedges of the microfibre structure. A question that should be asked when re-laundering is 'what other products are the mops washed with?' Mops and wipes often do not make up enough volume for a full wash load and so laundries will often combine mops and wipes (of all colours) into one wash load. This can lead to cross contamination that can leave particles or other contaminants trapped in the microfibre product and returned to the critical environment.

Recent developments

The drive for a product that could provide the benefits of microfibre while minimising the downsides led to the introduction of the first new category of wipe in almost 30 years. MicroGenesis by Contec, combines the best features of knitted, nonwoven and microfibre technologies to deliver unprecedented performance to critical wiping applications.

Table 1: Comparison of different microfibre blends and their corresponding attributes

	MicroGenesis	Goldsorb	MicroSilk II	Finesse	Polynit HS
Substrate	Polyester microfibre/ polypropylene base	50% Polyester microfibre/50% polyester blend	80% Polyester/ 20% nylon	30% Polyester microfibre/ 70% polyester	100% Polyester
Attribute (units)					
Relative cost	££	£££	££££	££££	££
Basis weight; nominal (g/m²)	120	148	222	152	140
Sorbency in water					
Intrinsic (mL/g	5.00	3.65	1.61		2.39
Extrinsic (mL/m²)	575	542	356	407	357
Sorptive rate (sec)	1	<1	1	<1	1
Non-volatile residue					
in deionised water (g/m²)	0.015	0.004	0.025	0.19	0.012
in isopropanol (g/m²)	0.015	0.008	0.346	0.11	0.01
Particles (Biaxial shake)					
P $\geq$ 0.5μm (x 106/m²)	10.0	8.70	32.8		5.30
Particle $\geq$ 5μm (x 106/m²)		0.18		0.028	
Fibres > 100μm (x 103/m²)	10.0	0.16	1.14		0.30

The MicroGenesis wipe is designed with a micro-terry pile to give the fast and efficient pick-up and particle retention for which microfibre is known. However the wipe comprises a 100% polyester microfibre yarn knitted into a thermally bonded polypropylene substrate, which limits the amount of microfibre required and makes the wipe more suitable for single use (Fig. 3). This structure applies microfibre only to the wiping surface where it is needed while sealing the base of each stitch in a thermally bonded base. This more cost effective structure still delivers the required amount of microfibre to pick up and retain microscopic particles, dust and light oils from critical environments.

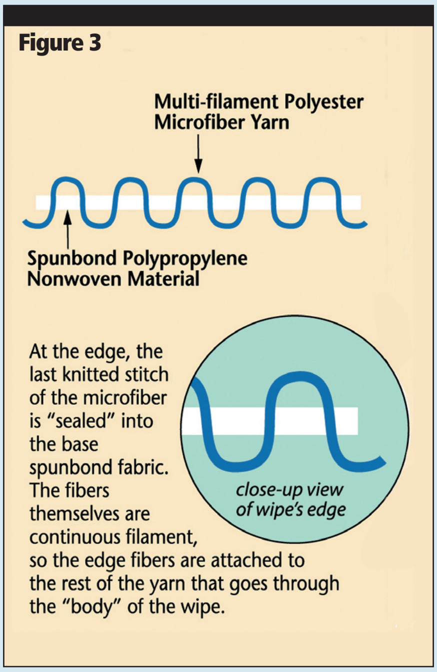

Figure 3: Schematic showing sealed body construction used in the MicroGenesis wipe

Particle attraction

There are other developments that can provide a wipe with exceptional pick-up and retention of particle properties without the use of microfibre. All fabrics can be treated to improve different elements of their performance. One patented treatment by Anticon, which permanently bonds to the fabric, traps 35 times more particles than an untreated wipe and retains 95% of the particles that are trapped. Interestingly, this performance is enhanced and not degraded in the presence of alcohol or solvent. The Institute of Environmental Sciences and Technology (IEST) test methods for wipes indicate how many particle and fibres a wipe releases but there is no standard test method to show how many particles a wipe picks up. To prove that the wipe was truly achieving this level of particulate pick-up, Peter Kang and David Hildreth developed a new robust test method.[2] In general, the testing process was very similar to IEST-RP-CC-004.2 sec 5.2 in that it used the same specified shaker, same duration of shaking time and a laser particle counter.

In the test, two different types of standard test dust were used, A C Fine Test Dust and Carbon Black Particles. Suspensions of both particles were made up in deionised (DI) water. An ultrasonic bath was used to ensure the particle aggregates were broken up as much as possible. The particle concentration of the suspension was measured and then a weighed dry wipe was added. The suspension was shaken for 5 minutes on a biaxial shaker. The wipe was removed and added to a jar containing clean DI water where the particle count had already been measured. The weight of the wet wipe was recorded and the jar with the wipe in it was shaken on the biaxial shaker for 5 mins. The wipe was then removed and discarded. The particle concentration in both jars was recorded. This procedure was repeated with a jar containing only particle suspension to determine the amount of particle break up or redistribution, and with a jar containing only clean DI water and wipe to determine the number of particles released from the wipe.

The definition of particle capture and release in this experiment was as follows:

The total number of particles generated = the initial number of particles in the suspension, the number of particles released from the wipe during biaxial shaking and the number of particles created from the break-up of larger aggregates.

If the number of particles captured is negative, meaning that more particles were released into the water than removed, then the number of particles captured is defined as zero:

The number of particles captured by the wipe = initial particles in solution + particles released from wipe + particles created from particle break-up – particles after biaxial shake.

Conversely, if the number of particles released is negative, then it is defined as zero since no particles were released:

Number of particles released = particles after biaxial shake – particles in wet wipe – particles released from clean wipe.

For purposes of the tests, small particles were defined as

"The treated wipes captured over three times more small particles than traditional wipes, releasing only 14% of the particles they captured"

0.5μm or larger, and large particles as 5.0 μm and larger. Initial concentrations for small and large particles were approximately 3,000,000 and 10,000 particles, respectively.

The test results for A C Fine Test Dusts showed treated wipes captured over three times more small particles than traditional wipes, releasing only 14% of the particles they captured. Additionally, the test results for large particles showed that treated wipes captured over 35 times more particles than the other wipes tested. Only a very small percentage of those captured particles were released. Test results for small and large carbon black particles showed that treated wipes captured four times more small particles and 7.5 times more large particles than the other wipes tested. The treated wipes released 2% of the captured small particles and in the large particles tests, results showed treated wipes released 3% of the captured particles.

So the test results showed that for both particle sizes the treated wipe both captured and retained significantly more particles than an untreated wipe.

To paraphrase Peter Kang, cleanroom wipes need to arrive clean and leave dirty. The ideal product performance for a cleanroom wipe is that it does not add to the contamination while performing the removal of particles, spills, biofilms or dirt. Various innovations in both wipe substrates and wipe treatment have aided in this, creating wipes that are ideal at not only particle pick-up but retention of those particles until the wipe is removed from the cleanroom. The test methodology outlined by Kang and Hildreth gives a way of comparing wipes against these parameters of capture and release. Alternative ways of blending microfibres have allowed the creation of wipes with microfibre properties at the cost of a disposable wipe.

REFERENCES

1 Textile Terms and Definitions, 11th Edition, The Textile Institute
2 P.K. Kang and D. Hildreth Testing Wipers for Particle Retention and Attraction, *Controlled Environments* http://www.cemag.us/article/testing-wipers-particle-retention-and-attraction

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