Selection of cleanroom wipes

Cleanrooms and other controlled environments require stringent control of particles, residues and microorganisms to ensure desired product or process outcomes. Each industry has its own critical parameters: Ions and particles in electronics, microbes, endotoxins and particles in life sciences, fibres and silicone in automotive painting and graphics printing. The control of these critical parameters is very often achieved by the use of wipes, either dry or pre-saturated.

There is a huge range of wipes available to cleanroom users manufactured from a wide variety of substrates, made with different manufacturing methods, finished with different surface treatments to enhance particle pick up or increase sorbency, differing weights and size, level of cleanliness, and choice of impregnate. Wipes manufactured from recycled materials are also now available to provide a more sustainable option for contamination control in a cleanroom environment.

There are huge benefits to using a wipe in a cleanroom environment, they are convenient and easy to use compared to other methods of cleaning. Various studies have shown that wiping is a very effective way to control contamination on a hard surface. Mechanical action overcomes the various forces holding fine particles (including submicron particles) to surfaces. This, coupled with the fact that the structure of the wipe itself allows for entrapment of the particles and the subsequent physical removal of them from the surface, explains why wiping is so effective.

When used to apply disinfectants and detergents they reduce the environmental impact on the cleanroom itself as the application of potentially aggressive chemicals can be controlled. The use of pre-wetted wipes further increases the health and safety benefit by reducing the amount of airborne chemical in a cleanroom environment.

WIPE CHARACTERISTICS

The characteristics of individual wipes affect their performance. There is always a compromise to be made between the different characteristics, and the decision on which wipe to choose for a particular application is risk-based according to the relative impact on a product or process.

Comparing wipes from different sources is an inexact science due to the variability between different test methods and different testing equipment. Wipes are typically tested for particles and fibres of specific sizes, Non Volatile Residues (NVRs) in different solvents, specific inorganic ions and sorbent capability, volume and speed of liquid uptake.

Test methods for wipes have been designed by both manufacturers and end users, however, the most commonly used, internationally recognised standard test methods are those of the Institute of Environmental Sciences and Technology (IEST): IEST-RP-CC004: Evaluating Wiping Materials Used In Cleanrooms and Other Controlled Environments.

The test methods for particles and fibres often vary considerably and the results even more so. The test for residues and ionic contaminants are more established and repeatable. However, the only way to truly compare results for different wipes is if they have been tested to the same test method by the same laboratory.

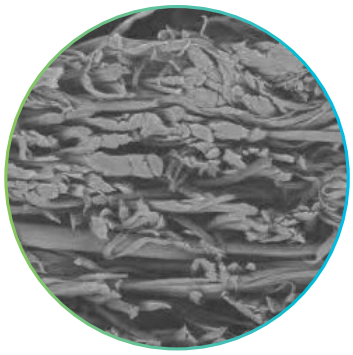
- Cleanliness: Every wipe will contain some contaminants, so it is important to minimise the deposition onto critical surfaces during wiping. Laundered, sealed edge synthetic wipes are the cleanest available option; however, they are also less sorbent and more expensive than wipes containing natural fibres. Test results are usually declared for particles and fibres, fibres generally referring to individual 'long' particles over 100 µm. Various test methods are available, using both wet and dry methods of particle release, often using optical microscopy, automatic particle counter, or scanning electron microscope to count the particles released.

- Sorbent properties: The ability of the substrate to absorb liquids into the hydrophilic fibre itself or adsorb liquids into the interstitial spaces between the fibres. Sorbent properties are critical for the removal of liquids, especially when wiping to dry. Wipes containing natural fibres have better sorbent properties, however, they tend to release higher levels of particulates and fibres. In general, synthetic wipes (polyester and polypropylene) tend to be more sorbent as the fibre size is reduced, with microfibre products being the most sorbent option. Test results are usually available for intrinsic and extrinsic sorbency and rate of sorbtion.

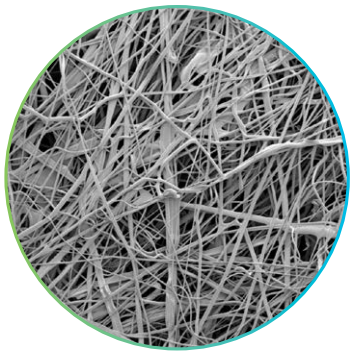
- Weight: Often expressed as g/m^2 this variable has an effect on sorbent capacity and cost

- Non volatile residues: NVRs are a measure of contamination which will not evaporate. It is a contaminant residue with indistinct dimensions and typically consists of hydrocarbons, silicones, dioctyl phthalates or other high molecular weight chemicals. Non volatile data is usually generated using both deionised water and isopropanol. Results are expressed in grams of extractables per square metre which is a useful guide to the relative purity of the wipe

Non woven polyester



Woven microfibre



Melt-blown polypropylene

- Metallic and other ions: Semiconductor and data storage industries are very concerned about ion contamination from a wipe, for the most sensitive industries wipes with individual ion levels below 1 ppm are utilised. Knitted laundered polyester wipes are able to meet this criterion. Sodium and chlorine are two of the ions of most concern. Ions are extracted in deionised water and quantitatively analysed by ion chromatography. Results are stated in parts per million (ppm). Ions are of little concern in a pharmaceutical or biotechnology environment

- Sterility and endotoxins: For aseptic applications wipes are sterilised, usually by a validated gamma irradiation or autoclave procedure. EU GMP stipulates that all products used Grade A and B environments should be sterile prior to use. Sterile does not necessarily infer the product is low in endotoxins so these must be tested and declared separately. The initial bioburden is generally lower for synthetic materials than those containing natural fibres, and this is critical to achieve low endotoxin levels

- Chemical compatibility: Pure synthetics like polyester non woven and knitted fabrics offer the greatest range of chemical compatibility, while those containing cellulose are susceptible to degradation by moderately caustic solutions

WIPE CLASSIFICATION

Wipes can be classified according to their cleanliness and physical characteristics, as described above. These characteristics are always determined by the following variables:

What material the wipe is made from

Synthetic, natural, or blended fibres can be used. Generally synthetic materials have longer fibres which are cleaner than natural fibres. Blends of materials are used to create compromises between cost, particles or efficiency.

Size of the threads

The definition of a microfibre is a fibre with less than 1 decitex per filament, where a decitex is a measure commonly used to describe the size of a filament or fibre. One decitex is 9/10 of a denier. Split microfibres have an expanded surface area that provides the ability to collect microscopic particles from a surface and dramatically increases a wipe's sorbency.

How the wipe is constructed

Wipe substrates can be created by knitting, a non woven process such as hydro-entangling, melt-blowing, chemical bonding or woven. Using chemical binders may not be suitable for use in all grades of room.

How the fabric converted into a wipe

Are the wipes knife cut or cut so the edges are sealed? This can be achieved by laser, ultrasonic or thermal means. Sealing the edges reduces the release of particles and fibres. A full sealed border on all sides can reduce the release of particles even further.

Has the fabric been treated or laundered?

Laundering the fabric in a cleanroom ensures low levels of ions, non volatile residues and particles. Sorption enhancers and particle attraction treatments can also be added during finishing.

CONSTRUCTION

How the wipe is constructed affects its cleanliness and performance characteristics.

Knitted wipes

Knitted wipes are created through a knitting process where many strands of yarn and filament are combined to create the material. Wipes can be knitted in a variety of ways to improve performance characteristics.

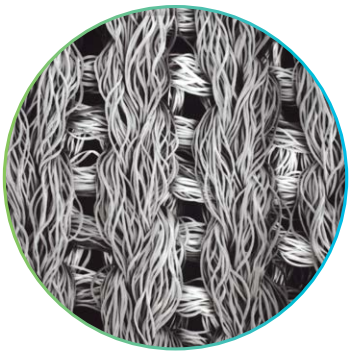
An interlock knit which is a variation of a rib knit, where any given stitch will reveal another knit stitch, makes the wipe more durable and provides a slightly heavier basis weight. A 'no run' interlock knit. is similar to the interlock knit but a periodic extra stitch is added that does not allow the fabric to 'run' or unravel if snagged. This makes the wipe very durable and suitable for use on a wide variety of surfaces. Knitted wipes are typically made from monofilament synthetic fibres i.e.,. polyester.

Non woven wipes

Non woven wipes are used for a wide range of applications in controlled environments including cleaning, application of disinfectants, removal of residues, spill control, transfer disinfection as well as for general purpose wiping. Non woven wipes offer a variety of performance characteristics and excellent value. Non woven wipes are webs or sheets made of natural or synthetic fibres that are bonded together by thermal, mechanical, chemical or solvent means.

Most high quality nonwovens are made with a spun-laced process which hydroentangles the two fibres using high pressure jets of filtered water and cleans the fabric during the manufacturing process. No binders or additives are used resulting in a fabric which is low in fibres and residues.

100% woven cotton



'No run' interlock knitted 100% polyester

Non woven polyester/cellulose

Non woven wipes can be constructed from single fibre types such as 100% non woven polyester. Creating wipes in this way also allows synergistic blends of different fibre types to be created such as polyester / rayon or polyester / cellulose.

Another method of creating a non woven wipe is to use a thermal bonding process. This is commonly used for polypropylene wipes.

Woven
Wipes of a purely woven structure are not often used in cleanrooms. Wipes woven from cotton fabric in a twill construction are very absorbent and are excellent for spill pick up or general cleaning in lower grade areas.

TYPES OF FIBRE

Each type of fibre has a particular strength that makes it suitable for a different critical environment application. Synthetic man made fabrics tend to have longer fibres that are cleaner than natural fibres. Polyester provides durability, chemical compatibility and cleanliness. Polypropylene provides exceptional cleanliness and uniform application of fluids.

Fabrics made from recycled materials are now also available. For example, ReFIBE wipes are constructed from 100% post-consumer recycled plastic bottles (35+ bottles per pack of wipes) that have gone through a rigorous cleaning process before being converted to polyester chips. The chips are extruded and spun in a traditional yarn manufacturing process before being knitted into fabric using an interlock knit.

Natural fibres such as cotton and cellulose have higher particle counts than synthetic fibres but excel when it comes to strength, softness and absorbency. Cellulose is the most common natural fibre used in blended cleanroom wipes as it provides excellent sorbency. Wipes made solely from cellulose tend to be only used for very specific applications.

COMMON CLEANROOM WIPE FIBRES & CONSTRUCTION

'No run' interlock knitted 100% polyester
A sealed edge, laundered 100% knitted polyester is the cleanest wiping material available. Long monofilament fibres mean the structure is very strong and durable. Appropriate finishing treatment and laundering renders the material sorbent to aqueous solutions as well as solvents.

Non woven polyester/cellulose
This blended fabric creates a matrix that has good particle removal and entrapment properties. The cellulose element provides good sorption; however, it also releases higher levels of particles and fibres.

Non woven polyester
This material has good particle entrapment properties and yields lower levels of fibres and particles. Short length fibres mean the fabric is not resistant to abrasive surfaces. A solvent or surfactant must be added to 100% aqueous solutions to facilitate sorption by the wipe.

Non woven microfibre
The polyester/nylon fibre is extruded as continuous filament. It is then split by a hydroentangling process which simultaneously splits the fibres into individual wedges and entangles the fibres to give the fabric strength and integrity. This results in a cleaner non woven microfibre. Microfibre fabric is highly sorbent and also offers a metered release of a solution to a surface.

Melt-blown polypropylene
This has a uniformly flat surface achieved with microfibre sized filaments which give the fabric exceptional particle removal characteristics. The fine fibre structure also allows excellent sorbent capacity. When pre-saturated or used with a solvent, the fabric offers a unique uniform application, or 'metered release' of the solvents. Due to its hydrophobic nature the material needs treating to sorb 100% aqueous solutions.

100% woven cotton
Cotton is very strong and durable and resistant to high temperatures. The weave enables some particle entrapment, however, the material sheds higher levels of particles and fibres.

HOW TO DECIDE

Unfortunately, it is not as simple as choosing a Grade B wipe for a Grade B room or an ISO 4 wipe for an ISO 4 room. There is no such thing as a Class 'X' or Grade 'Y' wipe as it all based on relative cleanliness and the specific performance requirements needed.

Focus on the application, a wipe which is suitable for use in a Class 3 semiconductor cleanroom may not be suitable for use in a Class 3 aerospace environment. Pharmaceutical cleanrooms also need to factor in sterility and endotoxins, as well as particles. As can be seen from the characteristics above there may need to be a trade off in terms of cleanliness / sorbency
/ particle entrapment / residue removal and also budget. Invariably, the lower the number of particles and fibres then the higher the cost of the wipe. Through its Contamination Control Assessment programme Contec can help you decide on the most appropriate wipe for your application and budget.