CHAPTER 2

Woven Fabric Media

The group of filter media that can be described as fabrics makes up the largest component of the media marketplace. Fabrics are made from fibres or filaments of natural or synthetic materials, and are characterized by being relatively soft or floppy, such that they would normally need some kind of support before they can be used as a filter medium.

The fibres or filaments can be made up into a fabric as they are, by means of some kind of dry-laying process, to produce a felt or similar material. Such 'non-interlaced' fabrics are generally referred to as 'non-woven', and they are covered in Chapter 3.

If the fibres or filaments are first spun into a continuous yarn, then the resultant yarn can be woven or knitted into a fabric, and such 'interlaced' materials are covered in the present chapter. If the material used in the weaving process is a single filament of wire or plastic, then the resultant material may be counted as a fabric, but is more often called a mesh, and as such is covered by Chapter 6.

2.1 Introduction

Textile fibres come from many sources:

Natural	vegetable	cotton, flax (linen), jute, wood cellulose
	animal	silk, wool, fur, hair
Artificial	natural resource	glass, ceramic, carbon, metal, reconstituted cellulose
	synthetic	thermoplastic polymers

Of the naturally fibrous materials, all have fibres that are extremely long by comparison with their diameters, except in the case of wood cellulose, where the manufacturing process produces fibres whose lengths are measured only in millimetres. Such fibres are too short to spin into a yarn, and are then only usable in wet-laying processes, to produce paper and related materials.

The remainder of the natural fibres have lengths measured in centimetres, and can be over 30 cm long in the case of wool, while silk can be produced as a single filament. The artificial materials can be produced as fibres of any length, or as continuous filaments.

Natural fibres have a diameter dictated by their source, and this is usually less than a millimetre. The artificial fibres and filaments are mainly formed by some kind of extrusion process from the molten state, such that their diameters can exist in a wide range, from much greater than those of natural products, to considerably finer.

The length and diameter of a natural fibre may be increased by converting the material into a yarn, although yarns may also be made up of filaments. Because of their much greater length, filaments may just be bundled together to make a yarn, although the bundles are usually twisted to give a reasonably constant diameter. The shorter, staple, fibres have to be twisted quite tightly, after being spun to line them up, in order to give adequate strength to the resultant yarn. ('Staple' was a term that related to natural fibres, but it has come to refer to any fibre of similar length, the synthetic fibre staples being produced by cutting the relevant filaments to the appropriate length.)

Yarns made from filaments are usually thin, smooth and of a lustrous appearance. Staple yarns are usually thicker, more fibrous (hairy) in appearance, and with little or no lustre. Yarns can also be made up from tapes of various kinds. In the case of filter media, these tapes would probably be fibrillated, or made of other perforated material.

Woven fabrics are then made up from single filaments, or multifilament yarns, or from twisted staple yarn. The last of these is normally used as a single strand, but two or more spun strands may be combined into ply yarns, where the strands are twisted together, usually (but not necessarily) in the opposite sense from the twist in each strand.

2.2 Properties of Yarns

Woven fabrics, then, are made up from yarns of one sort or another. It is usually the case that *warp* yarns (those running lengthways on the loom) are the stronger, while the *weft* yarns (those running across the loom) may be bulkier and less tightly twisted – weft yarns are often called filler yarns. It is quite common for the warp to be a single, relatively stout filament, while the weft is a yarn of some very different material. Equally, it is quite normal for both warp and weft to be made of the same filament or yarn.

The properties of a fabric, especially as regards its behaviour as a filter medium, depend very much on the way in which the yarns are woven together. Many properties, however, are intrinsic in the nature of the basic fibre or filament, and of the way in which it is made up into a yarn. The properties of the yarn are considered here, and those of the whole fabric in the next section. (The data given here on fibre properties are equally applicable to the same fibres when used in non-woven media.)

2.2.1 Chemical and physical properties of basic materials

The physical and chemical properties of a yarn are largely those of the fibres or filaments making up the yarn. In addition to the natural fibres (mainly cotton, but with some wool and silk), and a small, but growing, number of inorganic fibres, the bulk of filter fabrics is based upon an increasingly wide range of synthetic polymer fibres. The apparent range of synthetic fibres is the greater because of the very many trade names used for the same basic polymeric material. In order to simplify this complexity of names, Table 2.1 gives some of the more common trade names with their generic equivalents or basic polymers. Table 2.2 illustrates the basic chemical structures of the more common polymers used as fibres or filaments in filter media – the most widely used of these being polypropylene and polyesters. (The chemical nature of synthetic polymers is further explored in Chapter 8.)

A brief summary of the chemical resistances of cotton and the main polymers is given in Table 2.3, with much more detail of chemical solution behaviour given in Table 2.4.

A corresponding summary of basic physical properties for natural and synthetic fibres is given in Table 2.5. A major factor in the use of filter fabrics in gas cleaning is their ability to operate for considerable periods of time at moderately high (or even very high) temperatures. Table 2.6 recasts some of the physical and chemical data into a set of data for increasing operating temperatures.

2.2.2 Types and properties of yarns

The data of Tables 2.1–2.6 relate to the basic material of the fibres or filaments making up the yarns. There are also properties of the actual yarn to consider, namely strength, flexibility and tightness of twist.

There are, then, three basic types of yarn in wide use for filter media (Figure 2.1):

- monofilament, which is a single continuous filament of synthetic material (or silk);
- multifilament, which comprises a bundle of identical continuous filaments that may or may not be twisted; and
- staple, which is made from spun and twisted short fibres, either natural materials such as cotton and wool, or synthetic ones, which have been cut from extruded filaments.

There is a fourth, but much less common, type of yarn, made from fibrillated, or split-film, tape (such as the Fibrilon yarns of Synthetic Industries, shown in Figure 2.2).

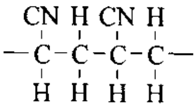
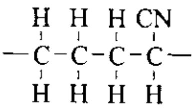
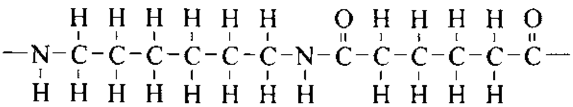
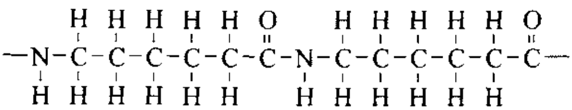
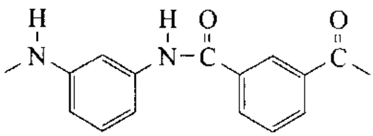
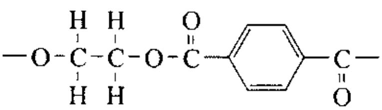
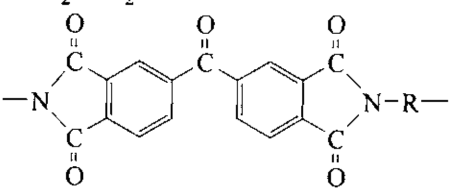
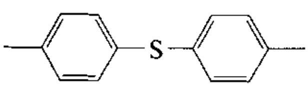
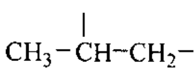
The physical differences among these types of yarn have a significant effect on the filtration characteristics of any fabric woven from them. Thus, a multifilament or staple yarn offers filtration capability not only between adjacent yarns, but also within the yarn itself.

Table 2.1 Generic equivalents of some trade names for synthetic fibres.

	acetate	acrylic	cellulose	ceramic	modified acrylic	poly-amide	poly-aramid	poly-ester	poly-imide	poly-vinyl alcohol	poly-vinyl chloride	polyvinyl-idene dichloride	polyvinyl-idene difluoride	poly-ethylene	poly-propylene	poly-phenylene sulphide	polytetra-fluoro-ethylene
Acribel		●															
Acrilan	●																
Amilan						●											
Arnel	●																
Beratex														●			
Capolan							●										
Celanese																	
Chlorofibre											●						
Clevy T											●						
Conex							●										
Courlene															●		
Courtelle		●															
Cremona										●							
Creslan		●															
Cryol						●											
Dacron								●									
Diolen								●									
Dralon		●															
Dynel					●												
Eltexil														●			
Enkalon						●											
Fortrel								●									
Fluon																	●
Grillon						●											
Harlan												●					
Herculon															●		
Kapron						●											
Kodel								●									
Kynar													●				
Lilio							●										
Merkalon															●		
Mewlon										●							
Moplen											●						
Nextel				●													

Nitrilon		●															
Nitron		●															
Nylon						●											
Nymerlon		●															
Nomex							●										
Orlon		●															
P84									●								
Perlon							●										
Phrilon							●										
Rastex																	●
Rayon			●														
Reevon															●		
Retractyl											●						
Rhovyl											●						
Rovana												●					
Ryton																●	
Saran												●					
Silon							●										
Solef													●				
Sulan															●		
Sythofil										●							
Tefaire																	●
Teflon																	●
Terylene								●									
Tergal								●									
Terital								●									
Thermovyl											●						
Trelon							●										
Trevira								●									
Trofil														●			
Tyvek														●			
Ulstron															●		
Vestan								●									
Verel					●												
Viking															●		
Vinal										●							
Vinyon											●						
Wolacryl		●															
Zefran II		●															

Table 2.2 Chemical nature of the major synthetic fibres

Name	Basic molecular unit	Comments
Acetate	Cellulose acetate	Derivative of natural cellulose
Acrylic		At least 85% of these acrylonitrile units
Fluorocarbon	$-CF_2-CF_2-$	Polytetra-fluoroethylene
Modacrylic		35–84% acrylonirile
Polyamides		liphatic polyamides Nylon 66
		Nylon 6
Polyaramid		Aromatic polyamide (Nomex)
Polyester		Ester of dihydric alcohol and terephthalic acid
Polythylene	$-CH_2-CH_2-$	PE
Polyimide		Derivative of tricarboxylic acid (P84)
Polyphenylene sulphide		PPS (Ryton)
Polypropylene		PP
Polyvinyl chloride	$-CH_2.CHCl-$	PVC
Polyvinylidene dichloride	$-CH_2-CCl_2-$	PVDC
Polyvinylidene difluoride	$-CH_2-CF_2-$	PVDF

Equally important are the effects of changes in the structure of a specific type of yarn, in respect, for example, of its fineness or size (thickness or diameter), the extent to which it is twisted during spinning (or setting up as a multi-ply yarn), and the number of threads or filaments that it contains. Some guidance on how these various parameters affect the filtration characteristics of the fabrics made from them is given in Tables 2.7 and 2.8, which are derived from work published by Ehlers in 1961[1]. Table 2.7 shows the overall effect of the type of yarn, as an order of preference of the three main types: staple, monofilament and multifilament, to achieve a specific filtration performance characteristic. Table 2.8 shows the effects on the same performance characteristics of the three yarn parameters: diameter, degree of twist and multiplicity of filaments.

It is very apparent from Tables 2.7 and 2.8 that no one type of yarn is perfect for all of the performance characteristics, and that an optimum choice will depend upon which of the performance factors is the most important in any one

Table 2.3 Summary of chemical resistance of fibres

Fibre type	Acronym or example	Chemical resistance rating against attack by the following					
		Biological agents	Mineral acids	Organic acids	Alkalis	Oxidising agents	Organic solvents
Cotton		Poor	Poor	Poor	Good	Poor	Good
Polyacrylonitrile	PAN	Excellent	Excellent	Excellent	Good	Excellent	Fair
Polyamide	Nylon	Excellent	Poor	Fair	Excellent	Fair	Good
Polyaramid	Nomex	Excellent	Fair	Good	Fair	Fair	Excellent
Polyester	PET	Excellent	Good	Excellent	Poor	Fair	Good
Polyethylene	PE	Excellent	Excellent	Excellent	Excellent	Fair	Fair
Polyimide	P84	Excellent	Excellent	Excellent	Poor	Fair	Fair
Polyphenylene sulphide	PPS	Excellent	Excellent	Excellent	Excellent	Fair	excellent
Polypropylene	PP	Excellent	Excellent	Excellent	Excellent	Fair	Fair
Polytetra-fluoroethylene	PTFE	Excellent	Excellent	Excellent	Excellent	Excellent	Excellent
Polyvinyl chloride	PVC	Excellent	Excellent	Excellent	Excellent	Fair	Excellent
Polyvinylidene dichloride	PVDC	Excellent	Excellent	Excellent	Excellent	Fair	Fair
Polyvinylidene difluoride	PVDF	Excellent	Excellent	Excellent	Excellent	Good	Good

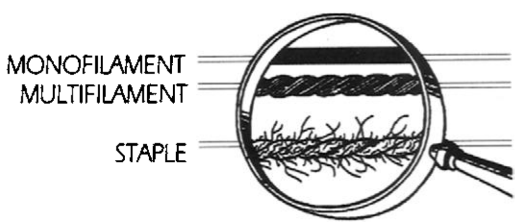


Figure 2.1. The three standard types of yarn.

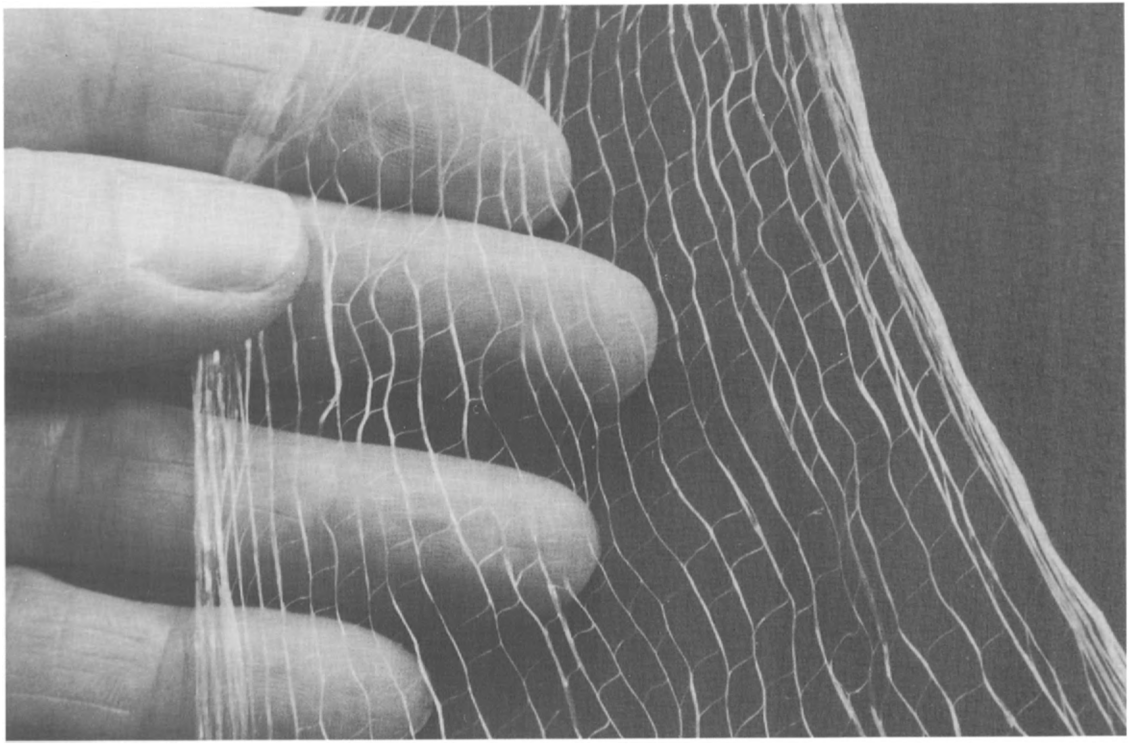


Figure 2.2. The fine structure of 'Fibrilon' fibrillated yarn. (Synthetic Industries, Inc.)[2]

Table 2.4 Fabric corrosion tables

Corrodent	Fabric											
	PET	PP	Nylon-6	Nylon-66	LDPE	HDPE	ETFE	ECTFE	Nomex	Cotton	PVDF	Felt
Acetaldehyde in water	R	R	NR	NR	R				NR			
Acetamide	NR	50	R	R	R	R	R	95	R	NR	NR	
Acetic acid, glacial	R	95	NR	NR	R	65	R	95	R	NR	55	NR
Acetic acid, 50–95%	R	95	NR	NR	R	65	R	95	95	NR	95	NR
Acetic acid, 10–50%	R	R	95	95	R	65	R	95	95	NR	R	NR
Acetic anhydride	NR	40	95	95	NR	NR	R	95	95		25	
Acetone	25	R	20		NR	50	R	65	40	R	NR	R
Acetyl chloride	25	NR	NR	NR	NR	NR	R	65	120	NR	50	
Acetophenone		NR	R	R	NR	NR	R	65	R		R	
Acrylonitrile	20	R	25	25		R	R	NR	40		50	
Acrolein	40	40	NR	NR		25			NR			
Acrylic acid	R	40	NR	NR					NR	NR		NR
Adipic acid		40			60	R	R	65		NR	R	NR
Allyl alcohol		60	25	25		60	R	R	40	R	95	R
Alum	65	105	NR	NR		60	R	R	NR		R	
Alum chrome		105	NR	NR		70	R	R	NR		R	
Alum potassium		105	NR	NR		60	R	R	NR		R	
Aluminium chloride	75	R	NR	NR	R	60	R	R	NR	NR	R	
Aluminium fluoride		R	25	25	NR	NR		150	40	NR	R	
Aluminium hydroxide	R	95	R	R	R	65	R	R	NR	R	R	
Aluminium nitrate		R	25	25		60	R	R	40	NR	R	
Aluminium potassium sulfate		R	NR	NR	NR	NR	R	R	NR	NR	R	
Aluminium sulfate	R	R	60	60	R	60	R	R	70	NR	R	NR
Ammonia, anydrous		105	25	25	NR	60	R	R	NR	NR	R	NR
Ammonia gas, dry	65	R	95	95	NR	60	R	R	65	NR	R	NR
Ammonium bifluoride		R				60	R	R		NR	135	NR
Ammonium carbonate	R	R	R	R	R	60	R	R	95	NR	R	NR
Ammonium chloride	75	R	NR	NR	R	60	R	R	NR	NR	R	NR
Ammonium hydroxide, saturated	R	R	R	R	R	60	R	95	95	NR	R	NR
Ammonium hydroxide, 10–25%	R	R	R	R	R	60	R	R	95	NR	R	NR
Ammonium nitrate	60	95	95	R	25	60	R	R	40	NR	R	NR
Ammonium persulfate	80	105	NR	NR		65	R	R	NR	NR	R	NR
Ammonium phosphate	60	105	25	25	25	60	R	R	65	NR	R	NR
Ammonium sulfate	75	95	NR	NR		25			NR	NR	R	NR
Ammonium sulfide		105				60	R	R		NR	R	NR
Ammonium sulfite	R	105	25	25	NR	60	NR	NR	40	NR	125	NR
Ammonium thiocyanate	25	60	25	25		60	R	R	25	R	R	
Ammonium thiosulfate		65	NR	NR					NR	R		
Amyl acetate	25	NR	65	65	NR	40	95	40	65	R	95	R
Amyl alcohol	R	95	95	R	R	60	95	R	25	R	135	R
Amyl chloride		NR	NR	NR	NR	NR	R	R	NR	NR	R	
Aniline	R	NR	NR	NR	NR	50	120	40	NR	R	20	R

Table 2.4 (*continued*)

Corrodent	Fabric											
	PET	PP	Nylon-6	Nylon-66	LDPE	HDPE	ETFE	ECTFE	Nomex	Cotton	PVDF	Felt
Antimony trichloride	R	R	NR	NR	NR	60	50	20	NR	NR	20	NR
Aqua regia	25	NR	NR	NR			40	40	65	NR	20	NR
Arsenic acid		R	20	20	NR	NR		R	40	NR	R	NR
Barium carbonate	R	R	25	25	R	60	R	R	120	R	R	R
Barium chloride	R	105	R	R	25	60		R	R	NR	R	NR
Barium hydroxide	NR	105	25	25	25	60		R	25	NR	R	NR
Barium sulfate	NR	105	25	25	25	60	R	R	95	NR	R	NR
Barium sulfide		R	25	25	25	60		R	95	NR	R	
Benzaldehyde	NR	25	65	65	NR	NR	95	95	65	R	70	R
Benzaldehyde in water	R	R	R	R	R			20	R	R		R
Benzene	NR	NR	R	R	NR	NR	95	95	R	R	50	R
Benzene sulfonic acid	R	R	NR	NR	NR	50	NR	95	NR	NR	25	NR
Benzoic acid	R	80	25	25	25	70	50	120	95	NR	120	NR
Benzoyl chloride	25	25	NR	NR		25		65	NR	NR	50	
Benzyl acetate	R	R	R	R	R	65		65	R	NR		
Benzyl alcohol	25	50	95	R	NR	NR		95	R	R	R	R
Benzyl chloride	R	NR	R	R	R	65	120	40	R	NR	R	NR
Bismuth acetate	R	R	R	R	R	65		65	R	R		R
Bismuth subcarbonate	R	R	R	R	R	70			R	R	R	R
Boric acid	95	95	NR	NR		60	55	25	40	R	R	R
Bromic acid		60				60		120		NR	105	NR
Bromine, liquid	25	NR	NR	NR	NR	NR		65	NR	R	60	
Bromine, water, saturated	NR	20	100	R	NR	NR	95	40	R	R	R	
Bromacetic acid	R	25	NR	NR	25	40			NR	NR	NR	
Bromobenzene	R	25	R	R	25	40		20	R	R	R	
Butyl acetate	R	R	R	R	R	R	125	40	R	NR	60	NR
Butyl alcohol	50	95	95	R	R	60	50	R	120	R	135	R
Butyl phthalate		80	R	R					R	R	25	
Butyric acid	R	80	NR	NR	NR	NR	50	120	NR	NR	115	NR
Cadmium chloride	R	R	R	R					R	NR		NR
Calcium acetate	R	R	25	25	R	R			95	NR	135	NR
Calcium bisulfite	NR	95	65	65	20	60		R	95	NR	R	
Calcium carbonate	R	R	R	R	60			R	R	R	R	R
Calcium chlorate		115				60		R			R	NR
Calcium chloride	R	105	R	R	R	60	R	R	R	NR	R	
Calcium hydroxide	R	105	65	65	R	60		R	NR	NR	R	NR
Calcium hypochlorite, saturated	R	R	NR	NR	R	60	50	R	NR	NR	R	NR
Calcium nitrate	75	105	NR	NR		60		R	NR		R	
Calcium oxalate	R	105	NR	NR	R	R			NR			
Calcium oxide	20	115	25	25	20	60		R	40		R	R
Calcium sulfate	75	105	25	25	60	R	R	R	65	R	R	R
Caprylic acid	R	60	R	R	25	60		65	R	NR	105	NR
Carbolic acid (phenol)	NR	80	NR	NR	NR	NR	R	95	NR	NR	105	NR
Carbon bisulfide (disulfide)	20	NR	25	25	NR	NR	R	95	120		NR	

Table 2.4 (*continued*)

Corrodent	Fabric											
	PET	PP	Nylon-6	Nylon-66	LDPE	HDPE	ETFE	ECTFE	Nomex	Cotton	PVDF	Felt
Carbon tetrachloride	R	20	R	R	NR	NR	95	95	R	R	R	R
Carbonic acid	100	115	40	40	20	60		R	R	R	R	R
Castor oil		140	25	25	R	65		R	65	R	R	R
Cellosolve	NR	95	R	R	NR	NR	95	95	R	R	R	R
Cetyl alcohol	R	R	R	R	R	R			R	R		R
Chloroacetic acid	25	80	NR	NR	NR	NR	50	120	NR		95	
Chloroacetic acid, 50% water	NR	25	NR	NR	NR	NR		95	NR		100	
Chloric acid 20%	NR	60	NR	NR	25	60		65	NR			
Chlorine dioxide 15%		NR			NR	NR	NR				95	
Chlorine gas, dry	20	NR	NR	NR	NR	25	120	115	NR		100	
Chlorine gas, wet	20	NR	NR	NR	NR	65	95	95	NR		100	
Chlorine liquid		NR	NR	NR	NR	NR		120	NR		105	
Chlorine water, saturated	20	95	NR	NR	NR	NR	40	40	NR		105	
Chlorobenzene	R	40	R	R	20	20	R	65	R	R	105	R
Chloroform	R	40	50	R	NR	NR		95	R	R	100	R
Chlorosulfonic acid	NR	NR	NR	NR	NR	NR	95	95	NR	NR	40	NR
Chlorox bleach sol. 5.5% chlorine		80	NR	NR					NR	R	115	R
Chormic acid 50%	R	65	NR	NR	60	60	40	120	NR		115	
Chromic acid 30–50%	R	65	NR	NR	60	60	NR	R	NR		115	
Chromic acid 10%	R	105	NR	NR	60	60	50	120	NR		115	
Chromic chloride	25	R	NR	NR	R				NR			
Chromyl chloride		60									50	
Chromium trioxide	NR	40	NR	NR	NR				NR		75	
Cinnomylic acid	R	40	R	R	20	60			R	NR		NR
Citric acid	R	105	20	R	R	60	50	R	R	NR	120	NR
Cresol	NR	60	NR	NR	NR	NR	R	95	NR		105	
Cresylic acid	R	40	NR	NR	NR	NR		NR	NR	NR	105	NR
Crude oil	75	60	65	65		60	95	95	95	R		R
Cupric carbonate	R	R	R	R	R	60			R		125	
Cupric chloride	R	R	NR	NR	R	60	R	R	NR		R	
Cupric cyanide	R	R	20	20	R	60			65		R	
Cupric fluoride		105			20	60		R		NR	R	NR
Cupric sulfate	95	105	NR	NR	20	60		R	NR	NR	R	NR
Cyclohexane	NR	NR	R	R	NR	25		R	R	R	R	R
Cyclohexanol		70	R	R	NR	60		65	R	R	105	R
Cyclohexanone	R	40	R	R	NR	NR	150	20	R	R	50	R
Cyclopentanone	R	NR	R	R	NR	NR			R	R		R
Cymene	R	25	R	R	NR	NR			R			
Detergents	60	115	40	40	R	65	R	95	R	R		R
Detergent solution, heavy duty	50	65	40	40				R	R	R		R
Dextrose		105				65		120		R	105	R

Table 2.4 (*continued*)

Corrodent	Fabric										
	PET	PP	Nylon-6	Nylon-66	LDPE	HDPE	ETFE	ECTFE	Nomex	Cotton	PVDF	Felt
Diacetin (glycerol acetate)	R	R	R	R	R	R			R			
Diallyl phthalate	R	NR	R	R	NR	NR			R	NR		NR
Dibutly phthalate	20	50	25	25	NR	NR			65	NR	NR	NR
Dibenzylamine	R	NR	R	R		25	NR		R	NR		NR
Dibenzylketone	R	R	R	R		25			R	R		R
Dibromobenzene	R	40	R	R		25			R			
Dibutylamine	R	40	R	R		25	NR		R	NR		NR
Dichloroacetic acid	40	40	NR	NR		40			NR	NR	60	NR
Dichlorobenzene	R	60	R	R	NR	25		20	R	NR	50	NR
Dichloroethane (ethylene dichloride)	NR	25	20	20	NR	NR		R	65		R	
Dichlorotheylene		80	25	25	NR	NR	30	20	65		50	
Diesel fuels	75	40	R	R	25	60	95	95	R	R	R	R
Diethanolamine	R	R	R	R	R	65	NR		R			
Diethylamine		40	R	R	NR	NR	NR	20	R		50	
Diethylene glycol	R	R	R	R	R	65	50	20	R	R	NR	R
Dimethylaniline		70	R	R		25	R	95	R		105	
Dimethylformamid	20	60	R	R	20	60	95	40	R		NR	
Dimethyl pthalate	R	60	25	R	NR	NR	R	95	R		40	
Dinitrobenzene	R	20	R	R	NR	NR			R			
Dioctylphthalate	20	NR	60	60	NR	NR	R	R	80		25	
Dioxane	20	60	R	R	NR	60	95	95	R		NR	
Diphenyl (dowtherm)	NR	NR	R	R	NR	NR	R	95	R			
Diphenylacetic acid	R	R	25	25	R	65						
Diphenylamine	R	NR	R	R	NR	NR	NR		R			
Disodium phosphate		95			R	R		R		R	70	R
Epichlorohydrin	R	70	R	R	25	65	R	95	R		115	
Ethyl acetate	NR	60	95	R	NR	NR	75	95	R	R	60	R
Ethyl alcohol	R	R	R	R	60	R		R	R	R	100	R
Ethyl benzene	R	NR	R	R	R				R	R		R
Ethyl benzoate	R	R	25	25		R	50			NR		NR
Ethyl carbamate (urethane)	R	40	R	R	R	65			R			
Ethyl carbonate	R	R	R	R	R	65			R			
Ethyl chloride	R	R	R	R	R	60	95	R	R		R	
Ethyl chloroacetate	R	25	20	R	NR	NR	95	65	R	R	60	R
Ethyl phenylacetate	R	R	R	R	R	60		20	R	NR	R	NR
Ethyl ether	R	25	20	R	NR	NR	95	65	R	R	60	R
Ethyl propionate	R	25	R	R	25	50			R			
Ethylene bromide	R	NR	R	R	NR	NR	65	R	R		R	
Ethylene chloride	NR	NR	R	R	NR	NR	50	R	95		R	
Ethylene chlorohydrin		95	NR	NR	NR	NR		20	NR		80	
Ethylene diamine		60	NR	NR		60	50	NR	NR	NR	25	NR
Ethylene dichloride	NR	NR	20	20	NR	NR	95	95	95		R	
Ethylene glycol	95	R	95	95		60	95	95	95	R	R	R
Ethylene oxide	20	NR	40	40	NR	NR	95	95	65	R	100	R

Table 2.4 (*continued*)

Corrodent	Fabric											
	PET	PP	Nylon-6	Nylon-66	LDPE	HDPE	ETFE	ECTFE	Nomex	Cotton	PVDF	Felt
Fatty acids	95	95	NR	NR	NR	50	50	95	20		R	
Ferric ammonium sulfate	R	R	NR	NR	R	60			NR	NR		NR
Ferric chloride	R	R	NR	NR	R	60	20	95	NR	NR	R	NR
Ferric chloride 50% water		105	NR	NR			95	95	NR		R	
Ferric hydroxide					R	R				R		R
Ferric nitrate	75	95	NR	NR	25	60	50	R	NR		R	
Ferric sulfate	75	95	20	20		65	50	R	25	NR	R	NR
Ferrous chloride	R	R	NR	NR	R	60	50	R	NR		R	
Ferrous nitrate		95			R	65		R			R	
Ferrous sulfate	R	R	NR	NR	R	60		R	NR		R	
Fluorine gas, wet	20	NR	NR	NR	NR	NR	NR	NR	NR		25	
Fluoboric acid	20	R	NR	NR		60		20	NR		R	
Formaldehyde 35–50% solution	R	R	95	R	R	60	95	95	R		R	
Formic acid, anhydrous	NR	80	NR	NR	NR	60	95	120	NR	NR	60	NR
Formic acid 10–85%	R	R	NR	NR	R	60		95	NR	NR	115	NR
Fuel oil	65	70	25	25	NR	NR	R	R	40	R	R	R
Furfural	20	NR	NR	NR	NR	NR	95	40	NR		40	
Furfural alcohol	R	25	R	R	25	65			R			
Gallic acid	R	R	20	20	R	60		65	40		50	
Gasoline	R	NR	R	R	NR	NR	95	95	R	R	R	R
Gasoline	R	NR	R	R	NR	NR	95	95	R	R	R	R
Gelatin	95	R	NR	NR	R	65		120	NR	R		R
Glucose (corn syrup)	20	R	20	20	R	65		R	25	R	R	R
Glycerine (glycerol)	R	R	R	R	R	60	50	R	R	R	R	R
Glycolic acid		R			R	65	95	40			50	
Glycols	20	R	R	R	R	65		95	R	R	R	R
Heptane	20	NR	R	R	NR	60	95	40	R	R	R	R
Hexachlorobenzene	R	40	NR	NR	20				NR			
Hexane	R	40	R	R	NR	NR	115	95	R	R	R	R
Hydraulic oils	95	65	20	20	NR	NR		40	25	R		R
Hydraulic oils (water base)	95	65	20	20	NR	NR		40	25	R		R
Hydrobromic acid dilute to 50%	R	95	NR	NR	R	R	R	R	NR	NR	R	NR
Hydrochloric acid 50%	R	40	NR	NR	60	60	R	95	NR	NR	R	NR
Hydrochloric acid 25–38%	25	95	NR	NR	R	65	R	95	NR	NR	R	NR
Hydrochloric acid dilute to 20%	R	95	NR	NR	R	65	R	95	NR	NR	R	NR
Hydrocyanic acid	20	105	NR	NR		65			NR	NR	R	NR
Hydrofluoric acid 50–100%	NR	95	NR	NR	20	20	20	120	NR	NR	100	NR
Hydrofluoric acid dilute to 40%	NR	105	NR	NR	R	60	R	120	NR	NR	120	NR
Hydrogen chloride gas, dry		R			60	60					R	
Hydrogen fluoride					NR	NR						

Table 2.4 (*continued*)

Corrodent	Fabric PET	PP	Nylon-6	Nylon-66	LDPE	HDPE	ETFE	ECTFE	Nomex	Cotton	PVDF	Felt
Hydrogen peroxide 90%	20	50	20	20	NR	35	50	65	25		55	
Hydrogen peroxide 50%	20	50	20	20	NR	40		65	25		115	
Hydrogen peroxide dilute to 45%	50	50	20	20	NR	60		65	25		120	
Hydrogen sulfide, dry	20	105	NR	NR	25	60	R	95	NR		R	
Hydrogen sulfide, wet	20	105	NR	NR	20	60	R	95	NR		R	
Hydrogen sulfide, aqueous solution		80	20	20	20	60		65	40		105	
Hydroquinone		60				R		120		R	120	R
Hydrochlorous acid		60				60		R		NR	R	NR
Iodine	R	R	NR	NR	NR	NR	R	120	NR		70	
Iodine solution, water		20	NR	NR	NR	NR	120	120	NR	R	70	NR
Iodine solution, alcohol	20	NR			NR	NR		95		R		R
Isopropyl alcohol	NR	95	NR	NR	R	80	50	20	NR	R	125	R
Isopropyl ether		NR	20	20	NR	NR		20	25	R	25	R
Jet fuel, JP 4 and JP 5	20	20	35	35	R	70	50	R	40	R	100	R
Kerosene	95	40	R	R	NR	NR	R	R	R	R	R	R
Ketones, general	NR	NR	65	65	NR	NR	95	95	95	R	40	R
Lactic acid	R	R	95	R	NR	NR	R	R	95	NR	40	NR
Lanolin		R			R	R	R	R		R	R	R
Lanolin oil		R			R	R	R	R		R	R	R
Lauric acid		75				60		120			115	
Lead acetate	R	95	40	40	R	95		R	R	NR	R	NR
Lead chloride	R				25	60		R				
Lead sulfate			20	20	25	65		R	95	R	120	
Linoleic acid		60	NR	NR	NR	NR		120	NR		120	
Lithium bromide					25	60		65		R		R
Lithium chloride	R	R	R	R	R	60	50		R			
Magnesium carbonate	40	105				65	50	R		R	R	R
Magnesium chloride	R	R	R	R	R	65	R	R	R	NR	R	NR
Magnesium hydroxide	NR	120	20	20		65	50	R	NR	R	R	R
Magnesium nitrate		120	20	20		65	50	R	40		R	
Magnesium sulfate	75	105	20	20	60	65	50	R	40		R	
Maleic acid	NR	105	NR	NR	60	65		120	20		R	
Malic acid		50	NR	NR	60	65		120	20		R	
Mercuric chloride		105	NR	NR		65	50	120	NR		120	
Mercuric cyanide		105			60	65		120			120	
Mercuric nitrate		105			60	65		120			120	
Mercurous nitrate		60			60	65	50	120			110	
Mercury	75	105	60	60	60	65		R	60		R	
Methanol (methyl alcohol)	R	R	65	R	R	60	50		R	R	R	R
Methyl acetate	R	40	R	R	25				R	NR		NR
Methyl bromide	NR	NR	NR	NR	NR	NR		R	NR		R	
Methyl bromoacetate	R	R	R	R	R	60			R			
Methyl cellosolve		105					R	R		R	R	R

Table 2.4 (*continued*)

Corrodent	Fabric											
	PET	PP	Nylon-6	Nylon-66	LDPE	HDPE	ETFE	ECTFE	Nomex	Cotton	PVDF	Felt
Methuyl chloride	20	95	20	20	NR	NR		R	25		R	
Methyl ethyl ketone	R	60	R	R	20	25	R	65	R	R	NR	R
Methyl isobutylketone	NR	NR	40	40	NR	20	R	40	65	R	40	R
Methyl methacrylate										R	50	R
Methyl urea	R	R	R	R	R	60			R			
Methylene chloride	NR	NR	NR	NR	NR	NR	R	20	NR		40	
Mineral oil	R	R	95	R	NR	65	R	R	R	R	R	R
Monoacetin (glycerol acetate)	R	40	25	25	20	60			40	R		R
Morpholine		65	R	R	60	60	40	40	R	R	NR	R
Naphtha	R	50	R	R	NR	NR	R	R	R	R	R	R
Naphthalene	20	20	25	25	NR	25	R	R	40	R	R	R
Nickel chloride	NR	105	NR	NR		60	50	R	NR		R	
Nickel nitrate		105				60	50	R			R	
Nickel sulfate	R	R	R	R	R	60	50	R	R		R	
Nitric acid anhydrous		NR	NR	NR	NR	NR	NR	50	NR	NR	65	NR
Nitric acid 70%	20	NR	NR	NR	NR	60	NR	50	NR	NR	65	NR
Nitric acid 50%	20	60	NR	NR	NR	60	NR	50	NR	NR	65	NR
Nitric acid, 5–40%	20	50	NR	NR	NR	60	NR	100	NR	NR		NR
Nitric acid, red fuming		NR			NR	NR	NR	100	NR	NR		NR
Nitrobenzene	R	20	95	R	NR	NR	R	40	R	R		R
Nitrobenzoic acid	R	40	NR	NR	20	25						
Nitrotoluene	R	R	R	R	NR	NR			R			
Nitrous acid		NR	NR	NR	NR	NR			NR	NR		NR
Nitrus oxide		NR	NR	NR	NR	NR		20	NR	NR	NR	
Octyl alcohol	R	R	R	R	R	65			R	R		R
Oleic acid	R	75	75	R	NR	NR	50	120	R	NR		NR
Oxalic acid	R	50	NR	NR	R	60		65	R	NR		NR
Ozone	R	NR	NR	NR	NR	NR	50	R	NR		R	
Palmitic acid	75	70	20	20		20		120				
Paraldehyde	R	R	R	R	R	70			R			
Peracetic acid 40%		NR	20	20	NR	NR				NR		NR
Perchloroethylene	95	NR	95	R	NR	NR	95	95	R		R	R
Perchloric acid 70%	NR	NR	NR	NR	NR	NR	95	95	NR	NR		NR
Perchloric acid 10%	NR	60	NR	NR	NR	20	95	95	NR	NR		NR
Petroleum ether	R	20	R	R	70	60			R			
Phenol (carbolic acid)	NR	80	NR	NR	NR	NR	R	95	NR	NR		NR
Phenoxyacetic acid	R	R	25	80	R	60				NR		NR
Phenol ether	R	NR	R	R	NR	NR			R	R		R
Phosphoric acid 10–85%	R	95	NR	NR	R	60	120	95	NR	NR	R	NR
Phosphorous oxychlorine		NR			NR	NR	60					
Phosphorous pentoxide		70				60		120				
Phosphorous trichloride	R	NR	NR	NR	NR	20	R	95	NR			
Phthalic acid (aqueous)	R	R	20	20	R	60		65		NR		NR
Picric acid	NR	60	NR	NR		60		20	25	80		80
Potassium acetate 50%		95	95	95		20		20	R			

Table 2.4 (*continued*)

Corrodent	Fabric											
	PET	PP	Nylon-6	Nylon-66	LDPE	HDPE	ETFE	ECTFE	Nomex	Cotton	PVDF	Felt
Potassium bicarbonate	60	110	20	20	20	65			65		R	
Potassium bichromate	NR	110	NR	NR	25	65		120	NR		R	
Potassium bisulfate	R	R	25	25	R	70		120	40	NR		NR
Potassium bromide	20	110	NR	NR	25	65	NR	R	NR		R	
Potassium cabonate	NR	R	R	R	R	65		R	R	NR	R	NR
Potassium chlorate	20	110	NR	NR		65	NR	R	NR		R	
Potassium chloride	75	110	20	20	65	R	R	20	40		R	
Potassium chlorite	R	R	R	R	R				R			
Potassium chromate		110				65		R			R	
Potassium cyanide	20	110	20	20		65		R	65		R	
Potassium dichromate	R	110	NR	NR	20	65		R	NR		R	
Potassium ferricyanide	75	110	20	20	60	65		R	25		R	
Potassium hydroxide 5–90%	R	60	R	R	R	60	50	110	NR	NR	75	NR
Potassium hypochlorite		70			NR	NR					95	
Potassium nitrate	75	110	20	20		65		R	40		R	
Potassium permanganate	R	60	NR	NR	NR	65	40	40	NR		R	
Potassium sulfate	20	110	60	60		65		20	R		R	
Potassium sulfide		110	20	20		65			95		R	
Propionic acid	R	25	R	R	20	40	50		R			
Propyl alcohol	20	110	NR	NR		65			NR	R	50	R
Propylene glycol	NR	R	R	R	20	60	50		R		125	
Pyridine	R	80	20	20	20	60	115	95	40		NR	
Resorcinol	R	110	20	20	20	60	50		40			
Salicylic acid		60	20	20		60	50	65	65	NR	100	NR
Silver cyanide		110				65		R			100	
Silver nitrate		95	20	20		65	50	R	40		R	
Sodium acetate	R	R	R	R	R	70	50	R	R		R	
Sodium benzoate	R	R	20	20	R	60	50	R	40		R	
Sodium bicarbonate	40	110	95	95		55	R	R	40	R	R	R
Sodium bisulfate	R	R	20	20	R	65		R	40		R	
Sodium bisulfite	R	R	20	20	R	65		R	40		R	
Sodium borate	20	80	20	20		65		R	40		R	
Sodium bromide	R	R	R	R	R	65		R	R		R	
Sodium carbonate (soda ash)	R	R	R	R	R	65	R	R	65	NR	R	NR
Sodium chlorate	20	110	NR	NR	R	65		R	NR		R	
Sodium chloride	R	R	R	R	R	65	R	R	R	R	R	R
Sodium chlorite		50			NR	NR					115	
Sodium cyanide	R	R	20	20	R	65		R	40		R	
Sodium dichromate	20	60	NR	NR		65		60	NR		95	
Sodium ferricyanide		110				65					R	
Sodium ferrocyanide	75	50				60					R	
Sodium fluoride		110	NR	NR		65			40		R	
Sodium hydroxide (caustic soda) 70%	NR	R	R	R	R	65	50	65	NR	NR	60	NR

Table 2.4 (*continued*)

Corrodent	Fabric											
	PET	PP	Nylon-6	Nylon-66	LDPE	HDPE	ETFE	ECTFE	Nomex	Cotton	PVDF	Felt
Sodium hydroxide (caustic soda) 50%	NR	R	R	R	R	65	120	120	65	NR	100	NR
Sodium hydroxide (caustic soda) 10–30%	55	R	R	R	R	65	120	95	65	NR	130	NR
Sodium hypochlorite	70	120	NR	NR	20	65	95	95	NR		R	NR
Sodium nitrate	R	R	70	70	R	80		R	40		R	
Sodium nitrite		110				65		R			R	
Sodium peroxide		100	20	20		60		R	40		R	
Sodium silicate	20	110	25	25		65		R	40		R	
Sodium sulfate	R	R	R	R	R	65	R	R	R	NR	R	NR
Sodium sulfide	R	R	R	R	R	80	R	R	R		R	
Sodium sulfite	25	50	95	R		60		R	R		R	
Sodium thiosulfate	20	60	20	20	20	60	R	R	40		R	
Stannic chloride	75	110	20	20		65		R	40		R	
Stannous chloride	75	110	NR	NR		65		R	NR		R	
Stearic acid	20	80	60	60		60	50	65	95		R	
Stoddard solvent (mineral spirits)	R	40	R	R	20	35	R	R	R	R	120	R
Succinic acid	R	60	20	20	20			120	65		120	
Sulfamic acid	NR	R	NR	NR	R				NR	NR	95	NR
Sulfur dioxide (dry)	75	70	NR	NR	20	70	NR	R	20		100	
Sulfur dioxide (wet)	25	70	20	20		40	R	R	20		100	
Sulfur trioxide	20	NR	NR	NR	20			20		NR	NR	
Sulfuric acid 100%	NR	NR	NR	NR	NR	NR	R	R	NR	NR	NR	NR
Sulfuric acid 10–98%	NR	50	NR	NR	NR	NR	R	R	NR	NR	65	NR
Sulfuric acid 80%	NR	70	NR	NR	NR	NR	R	120	NR	NR	95	NR
Sulfuric acid 70%	NR	70	NR	NR	NR	60	R	R	NR	NR	110	NR
Sulfuric acid 60%	NR	95	NR	NR		60	R	R	NR	NR	110	NR
Sulfuric acid 10–50%	70	95	NR	NR		60	R	R	NR	NR	105	NR
Sulfurous acid		110	NR	NR		60		120	NR	NR	100	NR
Tannic acid	65	110	20	20	25	65		120	40		110	
Tanning liquors		60	20	25	25	60		120	40			
Tartaric acid	75	110	60	60	20	60	50	120	95		120	
Tetrachloroethylene	R	25	R	R	20		50		R	R		R
Tetrachloroethane	20	95	R	R					R		120	
Tetrahydrofuran (THF)	NR	NR	R	R	NR	NR	R	40	R		NR	
Thiocarbamide (thio urea)	R	25	R	R	20				R			
Titanium tetrachloride		40	20	20	NR	NR	50		65		65	
Toluene	R	NR	95	R	NR	NR	110	95	R	R	95	R
Tribromobenzene	R	25	25	25	25				40			
Tributyl phosphate	NR	50	60	60	20	60		20	65		50	
Trichloroacetic acid	R	60	NR	NR	R	30	R	40	20	NR	60	NR
Trichloroethylene	R	NR	R	R	20	30	95	40	R	R	125	R
Triethylamine	20	NR	25	25		25		NR	25	NR	50	NR
Trisodium phosphate	20	110	30	30		60	R	95	40		R	
Turpentine	65	40	65	65	NR	NR	95	95	R	R	R	R

Table 2.4 (*continued*)

Corrodent	Fabric											
	PET	PP	Nylon-6	Nylon-66	LDPE	HDPE	ETFE	ECTFE	Nomex	Cotton	PVDF	Felt
Urea	20	110	40	40		60	50	120	65		120	
Valeraldehyde	R	NR	NR	NR	NR				NR			
Water, demineralized, distilled, salt, and sea	R	R	20	20		60	R	R	R	R	R	R
Xylene	R	NR	95	R	NR	NR	95	95	R	R	100	R
Zinc chloride	95	R	NR	NR	R	70	50	95	R		R	
Zinc sulfate	R	R	20	20	R	60	50	R	R		R	

Key to tables

R=recommended for use up to maximum operating temperature (°C) allowable for the fabric
200=recommended only to this indicated temperature
NR=not recommended
blank=no data avaiable

Summary of fabrics

Abbreviation	Generic equivalent	Maximum operating temperature (°C)
PET	Polyester	150–175
PP	Polypropylene	120–125
Nylon-6	Polyamide	105–125
Nylon-66	Polyamide	95–120
LDPE.	Low density polyethylene	65–75
HDPE	High density polyethylene	95–110
ETFE	Polytetrafluoroethylene	120–150
ECTFE	Polychlorotrifluoroethylene	150–160
Nomex	Polyaramid	190–205
Cotton	Cellulose	120–135
PVDF	Polyvinylidene fluoride	140–150
Felt	Wood	95–120

General notes

1. All of the chemicals listed in the tables are assumed to be in the pure state or in a concentrated or saturated aqueous solution unless otherwise indicated. Concentration percentages are weight percentages.
2. When a maximum temperature is shown it indicates the highest temperature for which data is available. Higher operating temperature may be possible but tests would have to be conducted.
3. Recommended operating temperatures relate only to the chemical compatibility at these temperatures. Mechanical considerations must also be taken into account.

application. Mixed yarns, as noted below, may provide the answer to the need for the optimum performance from the fabric.

Although the normal metric system is perfectly good enough for the measurement of fibre or filament diameters, the actual numbers are rather small. The textile industry has developed two independent, although similar systems, for the specification of thread and yarn sizes. Both involve weights of a length of the material, and so depend upon density as well as size.

The *denier* system was originally developed from a system used for specifying silk filaments (and which enumerated the size in terms of drams per thousand yards). The denier number is the weight in grams of 9000 m of filament or yarn, the smaller the denier number, the finer being the filament. So, 9000 m of 20-denier yarn weigh 20 g. (The 9000 m figure presumably comes from its near equivalence to 10 000 yards.) The denier is widely used to specify silk, and artificial filaments, but is not convenient for use with staple yarns, because of their much greater weight.

The *tex* system is more recent (late nineteenth century), and is a universal system for specifying the size of staple fibre yarns, although it can also be used for filament yarns. The tex figure is the weight in grams of 1000 m of the yarn, so that 1 tex = 9 denier. This simple definition is then complicated by the textile industry's use of the term *decitex* (written dtex) to be the weight in grams of 10 000 m of yarn, so that 1 dtex = 10 tex. Analogy with other uses of the deci-prefix suggests that this relationship is the wrong way round, but the usage is very well established. It follows that 1 dtex = 90 denier.

The diameter of a particular yarn may be calculated from its tex number as follows:

$$D = 0.036 \times [(\text{tex})/(\text{density})]^{0.5}$$

Table 2.5 Physical properties and natural and synthetic fibres

Fibre temperature	Maximum safe continuous temperature (°C)	Specific gravity	Absorbency for water (% wt)	Wet breaking tenacity (g/den)	Elongation at breaking (%)	Resistance to wear
Acetate	99	1.3	9–14	0.8–1.2	30–50	Poor
Acrylic	135–150	1.14–1.17	3–5	1.8–3	25–70	Good
Cotton	93	1.55	16–22	3.3–6.4	5–10	Fair
Glass	290–315	2.50–2.55	Up to 0.3	3–6	2–5	Poor
Modacrylic	70–82	1.31	0.04–4	2–4	14–34	Fair
Polyamide	105–120	1.14	6.5–8.3	3–8	30–70	Excellent
Polyaramid	205–230	1.38	0.1–3.3	4.1	14	Excellent
Polyester	150	1.138	0.04–0.08	3–8	10–50	Excellent
Polyimide	260	−41	3	4.2	30	Good
Polyfluoro carbon	260–280	2.3	Nil	0.9–3.3	10–25	Fair
Polyvinyl chloride	65–70	1.38	2	1–3	11–18	Fair
Polyvinylidene dichloride	82–85	1.7	0.1–1.0	1.2–2.3	15–30	Fair
Polyvinylidene difluoride	140–160	1.78	<0.04		80	Excellent
Polyethylene						
Low density	65–74	0.92	0.01	1–3	20–80	Good
High density	93–110	0.92	0.01	3.5–7	10–45	Good
Polypropylene	120	0.91	0.01–0.1	4–8	15–35	Good
Polyphenylene sulphide	180–200	1.37		3.5	35	Good
Rayon	100	1.50–1.54	20–27	0.7–4	6–40	Poor
Wood	82–83	1.3	16–18	0.76–1.6	20–35	Fair

Table 2.6 Fibres for high temperature dust filtration

Fibre	Acronym or example	Max. temperature (°C)		Resistance to attack by oxidizing			
		Continuous	Surge	Agents	Acids	Alkalis	Abrasion
Cotton		80	95	Fair	Poor	Good	Good
Wool		95	110	Fair	Good	Poor	Good
Polyamide	Nylon	95	120	Fair	Poor	Good	Fair
Polypropylene	PP	95	105	Good	Excellent	Excellent	Good
Polyacrylonitrile	Dralon	130	140	Excellent	Excellent	Fair	Fair
Polyester	Dacron	150	180	Good	Fair	Poor	Excellent
Polyphenylene sulphide	Ryton	190	230	Good	Excellent	Excellent	Good
Polyaramid	Nomex	200	240	Poor	Poor	Good	Excellent
Polyimide	P84	240	260	Excellent	Fair	Good	Good
Polytetra-fluoroethylene	Teflon	260	280	Excellent	Excellent	Excellent	Fair
Glass		280	300	Excellent	Poor	poor	poor
Inconel 601	Bekinox	550	600	Excellent	Excellent	excellent	good
Ceramic, metal oxides	Nextel	760	1200	Excellent	Good	good	good

Table 2.7 Effect of type of yarn on filter fabric performance (1 = best)

Performance characteristic	Order of preference		
	1	2	3
Maximum filtrate clarity	Staple	Multifil	Monofil
Minimum resistance to flow	Monofil	Multifil	Staple
Minimum moisture in cake	Monofil	Multifil	Staple
Easiest cake discharge	Monofil	Multifil	Staple
Maximum fabric life	Staple	Multifil	Monofil
Least tendency to blind	Monofil	Multifil	Staple

Table 2.8 Effect of yarn structure on filter fabric performance (1 = best)

Performance characteristic	Structure parameter[a]								
	Yarn diameter			Twists/cm			Fibres/yarn		
	1	2	3	1	2	3	1	2	3
Maximum filtrate clarity	L	M	S	Lo	M	H	H	M	Lo
Minimum resistance to flow	S	M	L	H	M	Lo	Lo	M	H
Minimum moisture in cake	S	M	L	H	M	Lo	Lo	M	H
Easiest cake discharge	S	M	L	H	M	Lo	H	M	Lo
Maximum fabric life	L	M	S	M	Lo	H	M	H	Lo
Least tendency to blind	S	M	L	H	M	Lo	Lo	M	H

[a] L = large, M = medium, S = small, Lo = low, H = high.

where D = diameter in mm. For example, a 16 tex polypropylene fibre (1.6 dtex or 144 denier), which has a density of 0.91 g/cm^3, has a diameter of 0.15 mm, or 150 μm.

2.2.2.1 Staple yarns

Staple yarns were, of course, the first yarns used in the manufacture of filter fabrics, made from natural fibres, long before any synthetic fibre was available. Even with synthetics, staple yarns were the first used in industrial filtration on a

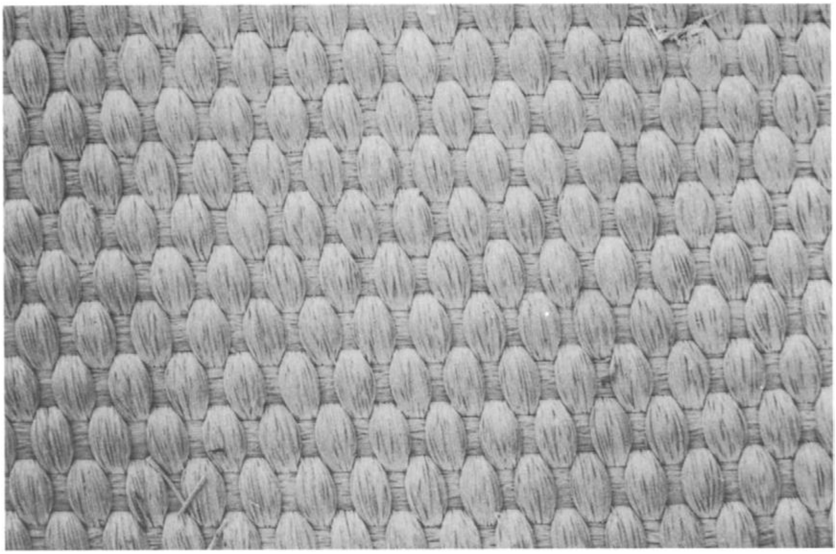


Figure 2.3. A plain weave multifilament fabric.

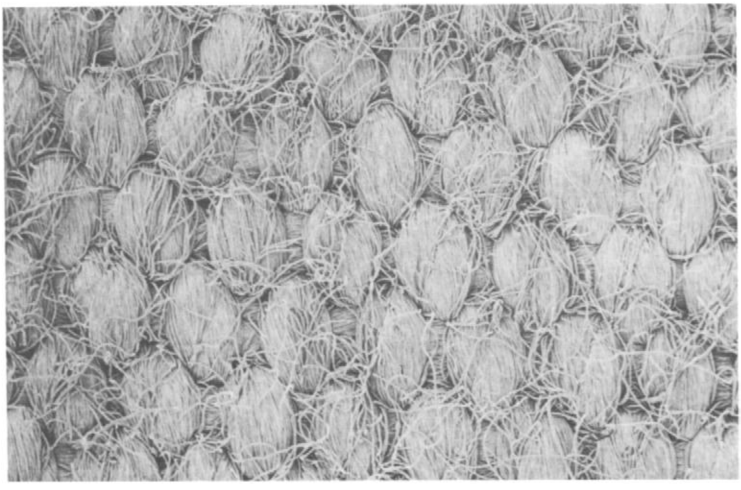


Figure 2.4. A plain weave staple yarn fabric.

large scale, since they made possible the production of the heavy-duty, durable fabrics needed for traditional filter presses and leaf filters.

Natural fibres, supplied in bulk, must first be cleaned to remove foreign matter (and grease, in the case of wool). Natural fibres, after cleaning, and artificial fibres, after cutting to the appropriate length, are *carded* by means of an array of spikes, which separates the individual fibres, and lays them parallel, as a thin sheet of uniform thickness. This sheet is then drawn together to produce a thick, continuous and untwisted *sliver* (if the sliver is given a loose twist, it becomes *roving*). Before the carding, the fibres may be mixed by blending in different lots of material, usually to ensure the production of a uniform yarn.

An additional process, called *combing*, may follow carding. This process removes short fibres, and produces a sliver made up of long fibres, lying parallel, which is smoother and more lustrous than uncombed sliver. At any given yarn diameter, a combed yarn is stronger than an uncombed one.

Slivers (or roving) are then processed in *spinning* machines, which stretch the strands and twist them to the required degree, both to hold the fibres together, and to give the necessary strength to the yarn. The direction of twist can result either in S-twist or Z-twist, with a slope increasing with the tightness of the twist; the opposite direction of twist is then normally used for converting the single yarn into a two- (or more) ply yarn. Within reason, the greater the degree of twist the stronger the yarn – but also the less useful it is in a filter fabric, when flow through the yarn is required.

A major difference between staple yarns and other types is the 'hairier' finish. This can readily be seen by comparing Figures 2.3 and 2.4. The impact of this difference is the greater difficulty in removing a filter cake from a fabric made with staple yarn than is the case with fabrics made up from silk or polymeric filaments.

The spinning processes used to make staple yarns are developed either from the spinning of cotton (with relatively short fibres, in the region of 40 or 50 mm), or the spinning of wool (with considerably longer fibres, perhaps 2–3 times the length of cotton, and much more crimped). Synthetic fibres are cut from the extruded filaments of polymer in lengths to suit whichever of these two spinning systems is to be used.

As a general guide, yarns from woollen spinning systems are bulkier than those from cotton systems, while the fibres within wool-spun yarns can move more easily within the yarn assembly. It is thus claimed that wool-spun yarns are better for filtration than either cotton-spun staple yarns or multifilament yarns, by permitting a higher throughput, and by being less prone to blinding.

2.2.2.2 Monofilament yarns

It is perhaps strange to call a monofilament a yarn in view of the latter's normal multifibrous connotation. Nevertheless, monofilaments are used in significant quantity in filtration fabrics, either as the only yarn or as a warp yarn with the weft of some different (and usually bulkier) yarn. A large proportion of fabrics made only with monofilament are better called meshes – and as such are covered in Chapter 6.

Monofilament yarns consist of a single continuous filament made by extruding molten polymer through a specially engineered die, or *spinneret*, to give the filament its required diameter and cross-sectional shape. After leaving the spinneret, the filament is drawn through a series of rollers, which improve the alignment of the polymer molecules, and so develop the desired tensile strength.

Although a whole variety of cross-sectional shapes is possible, as illustrated in Figure 2.5, woven monofilament fabrics nearly always employ filaments of cylindrical cross-section, and in diameters ranging from 0.1 to 0.3 mm, but occasionally up to 0.8 mm, or even greater. (Filaments of other shapes are used in non-woven fabrics.)

Madison's Filterlink is an interesting construction for monofilament fabrics, which was developed originally for papermaking machines. Preformed spirals of monofilaments, which run in the warp direction (MD or machine direction) are enmeshed and linked together by a series of straight monofilaments in the weft direction, across the machine (Figure 2.6). The spirals are pulled tightly into the straight filaments during a special heat-setting process, which imposes a heavy crimp, and effectively locks the structure, as is shown in the enlargement of Figure 2.6(b). The tight packing of the spirals results in exceptional width stability, and gives the fabric excellent resistance to bowing and distortion. The filaments are relatively large in diameter, being in the range 0.6–0.9 mm.

Netlon and similar meshes appear to be of monofilament construction. However, they are not woven, but made by a special, extrusion process, the products of which range from fine mesh to heavy-duty netting and robust perforated tubes. Such products are discussed in Chapter 6.

2.2.2.3 Multifilament yarns

Multifilament yarns begin in much the same way as a monofilament, except that the spinneret has a multiplicity of finer holes, so as to produce simultaneously a corresponding number of fine filaments, of about 0.03 mm in diameter. There is now little concern about the strength of the individual

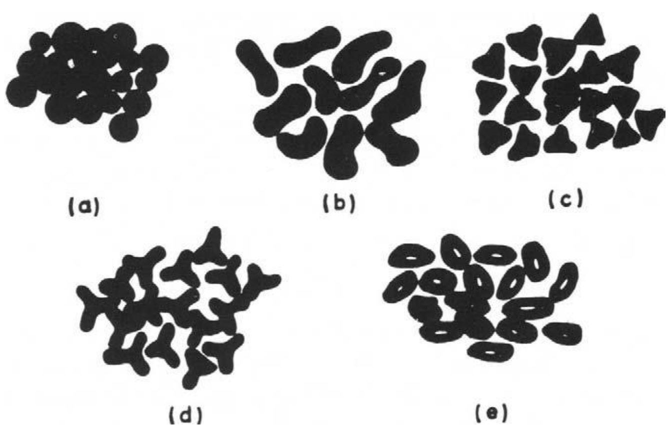


Figure 2.5 Variations in cross-sectional shape of synthetic fibres: (a) polyester – circular; (b) cellulose acetate; (c) polyester – triangular; (d) polyester – star like; (e) polyester – hollow.

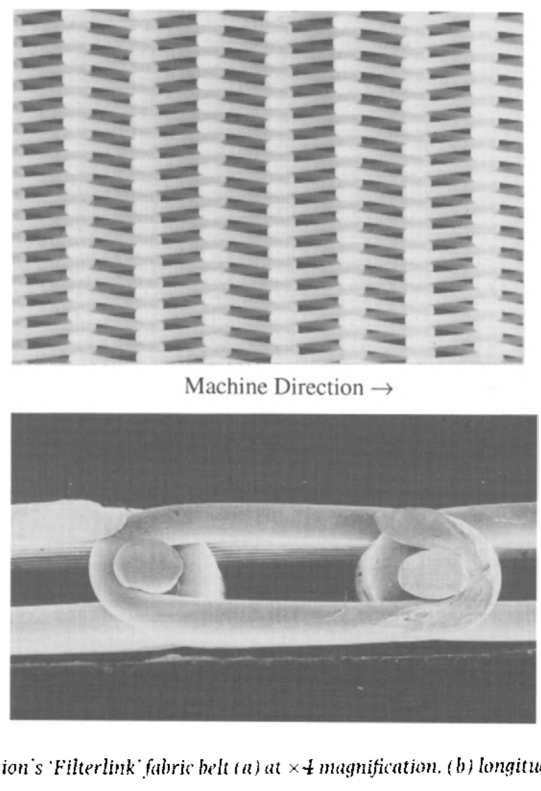
filament, so the bundle is immediately compacted, and then twisted to a preset amount (which is expressed in terms of twists/cm). The twisting not only strengthens the yarn, and makes it more rigid, but also helps to protect it from abrasion, both during weaving, and in subsequent use.

The amount of twist is also important in respect of the filtration characteristics of the final fabric, since it partly determines the proportion of the fluid flow that passes through the yarns, as compared with the flow between adjacent yarns. With a very tightly twisted yarn, little if any flow will go through it. Moreover, as the amount of flow though low-twist yarns increases, so also does the tendency for particles to become embedded within the yarn, and so trapped, thereby making cleaning more difficult, and increasing the tendency of the fabric to blind.

2.2.2.4 Fibrillated tape yarns

A fibrillated film or tape is one that has been processed so that its structure includes fine short fibres, or *fibrils*, and corresponding holes. Polymer film is fibrillated, either by special cutters and pins, or by more sophisticated methods involving the stretching of the film to cause it to split into multiple localized ruptures. It is then cut into tapes, which are rolled or bundled into yarns (also called split-film yarns).

(a)



(b)

Figure 2.6. P & S Filtration's 'Filterlink' fabric belt (a) at ×4 magnification, (b) longitudinal section at ×20 magnification.

These yarns are normally made from highly orientated polypropylene, since its non-polar nature and the low intermolecular forces between the long linear polymer chains lend themselves well to the fibrillation process. This involves embossing the film with a pattern by pressurized contact with rollers, which have surfaces that have been photo-etched (as in gravure printing). The embossed film is then heated and stretched in one or more directions, thus causing the indentations to rupture. Variations are possible in film thickness, embossed pattern, and stretching process, which enable the manufacture of a wide variety of products, either as yarns, or in sheet form, and as netting.

Fibrillated yarns are widely used in the textile industry, but mainly to make heavy-duty industrial fabrics, for applications such as bulk container bags, carpet backing, geotextiles, and agricultural uses. They have only a limited use in filtration, mainly to produce coarse open fabrics used as support or drainage cloths beneath finer grades of filter fabric. An example of a support cloth is shown in Figure 2.7.

Yarns of this kind are available in many different grades, the product range of the Fibrilon yarns, produced by Synthetic Industries Inc, extending from 250 up to 10 000 denier or more. An elegant illustration of their delicate structure is shown in Figure 2.2.

2.2.2.5 Mixed yarns

The above discussion of types of yarn has assumed that the yarn will be used as both warp and weft in any fabric woven from them. However, instead of using identical yarns, a combination of different yarns can be very beneficial.

One common combination is the use of multifilament yarn for the warp, with staple yarn for the weft, an example of which is shown in Figure 2.8. The higher tensile properties of the warp give strength to the fabric, while its filament

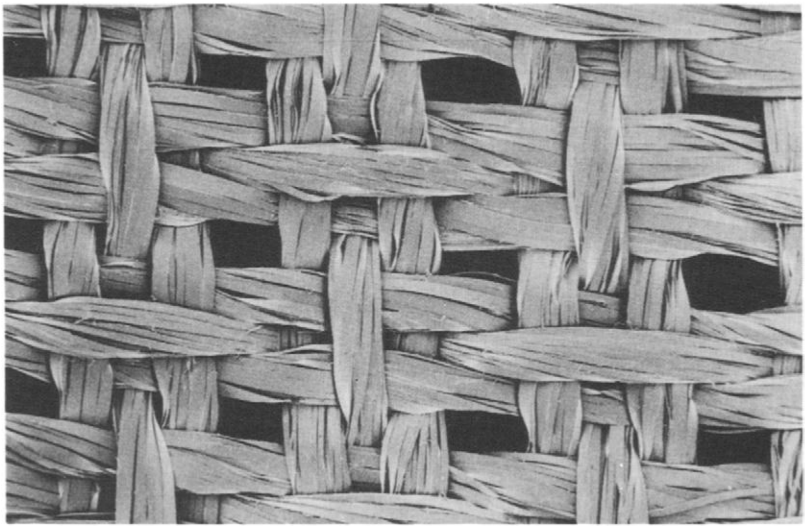


Figure 2.7. A support of backing cloth made from fibrillated yarn in mock-leno weave.

structure gives a reasonably smooth surface. The contribution from the weft is bulk, which improves the filtration efficiency and the durability of the fabric.

A different combination is to use a monofilament warp, which aids cake discharge, with a multifilament weft, with its better collection efficiency. Alternatively, the main weft yarn may be combined with a secondary one, to act as a filler, thereby increasing the bulk of the fabric.

2.3 Woven Fabric Media

The basic material of a woven fabric (filament or fibre) and the way that this material is formed into a yarn are major parameters in the choice of a fabric as a filter medium. The third such parameter is the way in which the yarns are laced together, i.e. the type of *weave*, together with any *finishing* process applied to the fabric. These are now considered, together with the properties of the resultant fabric.

2.3.1 Types of woven fabric

The variety of available woven fabrics is virtually unlimited even if only the materials from which the filaments or yarns, and the complexity of the yarn are considered. To these must then be added the structure of the woven fabric itself: the way in which the yarns are woven together, and the finishing process (if any) applied to the fabric after weaving.

In common with all industrial textiles, filter fabrics have to meet quite rigid specifications as to width, weight per unit area, weave and yarn structure, strength and elongation, thickness and chemical properties. Flexibility may be an important requirement, and the necessary porosity certainly is. There are, of

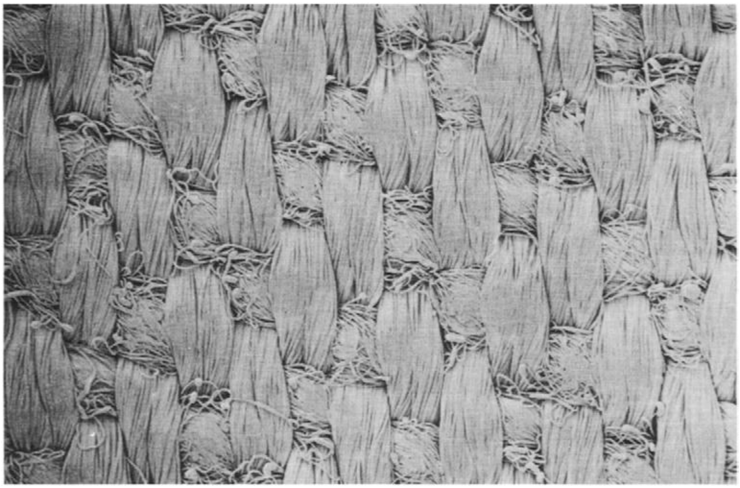


Figure 2.8. A mixed yarn reverse-satin weave fabric, with multifilament warp and staple weft.

course, many other properties of fabrics that are of no concern to their use as filter media.

Woven fabrics are made up from yarns that are interlaced in a particular and regular order called a *weave*. The component yarns, warp and weft, need not be parallel to each other nor cross at right angles, but this is the case in most fabrics, and certainly it is so in filter media. The key features of a woven fabric come from the geometrical regularity of its components, and because these components are held in place, not by any rigid bonding, but by friction at their points of contact.

2.3.1.1 Types of weave

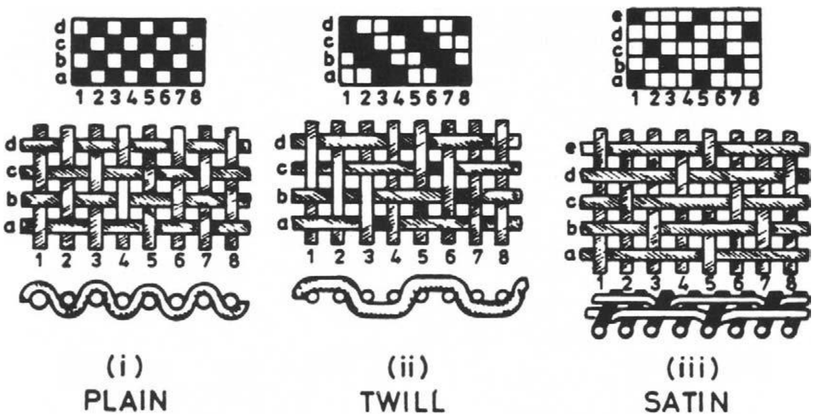
The binding system, or weave, is the basic factor that determines the character of the woven fabric. There are three main types of weave:

- plain,
- twill, and
- satin,

that are used in industrial textiles, as illustrated in Figure 2.9, although there are many other more complex systems, some deriving from hand manipulation, and others from mechanical changes in the loom. Examples of such complex patterns include the creation of a pile, or the formation of a gauze – the latter having some importance in filtration fabrics (as a *leno* weave).

The differences among the weaves depend upon the pattern formed as the weft yarns are woven over or under the longitudinal warp yarns. In the diagrams of Figure 2.9, the warps are numbered 1, 2, 3, etc., and the wefts are identified as a, b, c, etc. A white square, such as a2, corresponds to the passage of the weft over the warp.

In *plain* weave, the weft yarn passes over and then under each succeeding warp yarn across the loom, as shown in Figure 2.3. The return weft then passes the opposite way, under then over succeeding warps, such that each weft is held securely in place by the interlocking of the warp yarns. If necessary, each



2.9. The three basic weaves generally used for filter cloths.

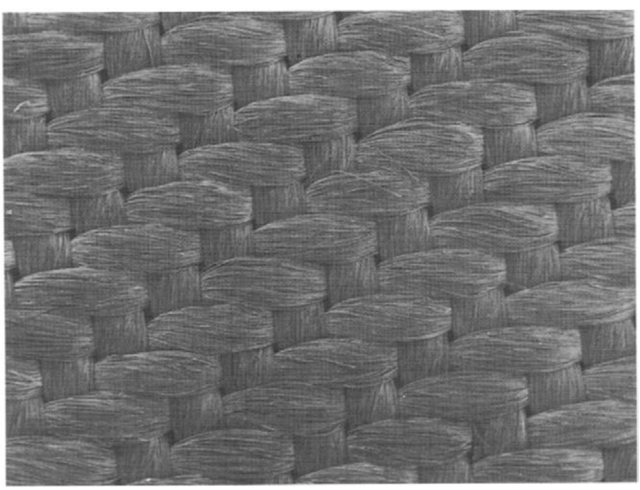
succeeding weft yarn is beaten into place, to reduce the distance between weft yarns along the fabric. Plain weaves can give the tightest fabric, with the highest filtration efficiency, as well as the most rigid.

Twill weaves are characterised by a strong diagonal pattern. They are formed by the passage of the weft yarn over two or more warps at a time, and then under one or more, in a regular pattern across the loom. The next weft thread follows the same pattern of over-and-under, but displaced by one warp yarn. The twill weave illustrated in Figure 2.9 is a '2/2' pattern showing two over followed by two under. The section of the weft yarn above a set of warps is called a *float*, and a fabric showing a predominance of warps floating on the face is called *warp faced*, and the one with weft floats dominating is *weft faced*.

The essential feature of a twill weave is its regularity, leading to its diagonal pattern. Most twill weaves are uneven in their split between warp and weft, which causes the float effect. Figure 2.10 shows a 2/1 twill weave, employing multifilament yarns. In a twill weave, more weft threads can be packed in to the fabric per unit length, which gives the fabric more bulk. Compared to a plain weave with the same yarns, twill fabrics are more flexible, and therefore easier to fit into a filter.

Satin weave extends further the concept of the twill weave, by having wider spacings between points of interlacing. Satin weave does not have the regular shift of weave pattern that twill has, and the result is an irregular appearance, smooth faced, with relatively long floating warp yarns. Most satin fabrics are made from smooth, lightly twisted yarns, thereby enhancing the visual effects.

Fabrics with a satin weave are still more flexible than the other two types of weave, because of the increased ease of yarn-to-yarn movement: this reduces the likelihood of particles becoming trapped in the structure. The longer floats allow insertion of proportionally more warp threads, thereby further improving the surface smoothness, resulting in easier cake discharge. However, unless the



2.10. A multifilament 2/1 twill cloth.

threads in both warp and weft directions are packed tightly together, satin weaves do not generally achieve high filtration efficiencies, while the long floats are more susceptible to abrasive wear.

The impact of weave on filtration performance of the resultant fabric is shown in Table 2.9, with the same layout as Tables 2.7 and 2.8, and also derived from Ehlers's work in 1961[1].

2.3.1.2 Fabric finishing processes

Fabrics of all kinds have to be treated after manufacture (non-woven as well as woven). The most common treatment will be some kind of cleaning process; bleaching may be needed to remove an unwanted natural colour. In the case mainly of woven fabrics, the material has to be inspected for imperfections, and any necessary repairs made.

Hardman[2] has identified three main reasons for carrying out finishing processes on fabrics that are to be used as filter media (there being several other such processes required for textiles for other end uses):

- to ensure stability of the fabric;
- to modify the surface characteristics; and
- to regulate the permeability of the fabric.

Stabilization may be necessary to counteract the tensions that are imposed on a fabric throughout the whole of the production process; as these tensions subsequently relax, movement and changes in the fabric dimensions may occur, so that, for example, eye holes in prepared filter press cloths may not align accurately with the ports of the press plates. To avoid such problems, it is common practice to subject a fabric to either a hot aqueous or dry setting process, at a temperature and for a duration suited to the particular polymer.

Another reason for stabilization is to anticipate the tensions that will be imposed on the fabrics in use, for example on belt filters and vertical automatic filter presses. In this case treatment involves stretching the fabric at a carefully controlled temperature; in addition to reducing the tendency of the fabric to stretch further during use, this prestretching process also ensures better tracking by equalizing any tension variations that may exist across the width of a belt.

Table 2.9 Effect of weave pattern on filter fabric performance

Performance characteristics	Order of preference		
	1	2	3
Maximum filtrate clarity	Plain	Twill	Satin
Minimum resistance to flow	Satin	Twill	Plain
Minimum moisture in cake	Satin	Twill	Plain
Easiest cake discharge	Satin	Twill	Plain
Maximum fabric life	Twill	Plain	Satin
Least tendancy to bind	Satin	Twill	Plain

Surface treatment is designed to adjust the characteristics of the surface of the fabric so that it is better suited to its particular purpose. Among the processes involved in treating a fabric surface are calendering, singeing, and napping.

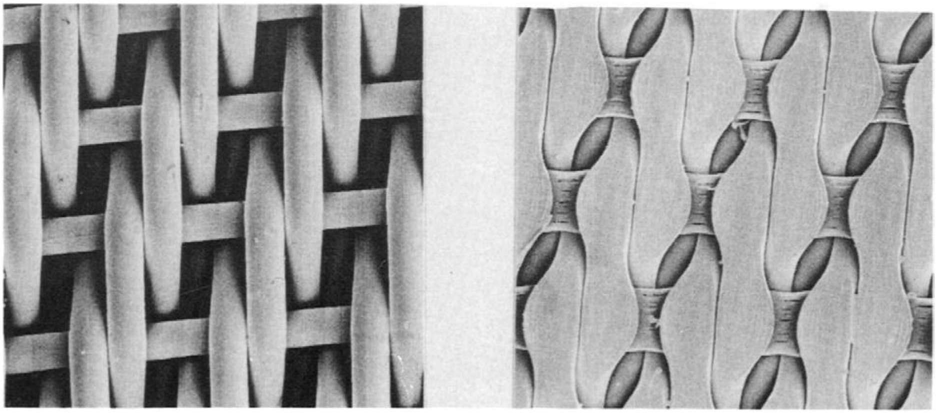
Calendering is the most frequently used of the surface treatment processes, and involves passing a fabric between heated pressurized rolls, with the temperature, pressure and speed through the rolls suited to the particular fabric. As illustrated in Figure 2.11, the effect is both to improve the surface smoothness (and hence cake discharge), and to regulate its permeability (and hence the filtration efficiency).

Singeing is a treatment process specific to the fibrous surface of fabrics made from staple yarns. The short protruding fibres, which can impede cake discharge, are removed by a rapid contact with either a gas flame or a very hot metal strip. This is usually followed by contact with a wet surface in order to stop any smouldering. The effects of singeing are illustrated in Figure 3.5 in Chapter 3, there applied to a non-woven felt.

Napping is the use of a fine steel comb to raise a soft fuzz on the face of a fabric (one or both sides), which may be followed by shearing to cut the raised fibres to a uniform length. This can improve the ability of the cloth to retain fine particles, and can also increase its dirt-holding capacity, but it will decrease the ability of cake removal from the material. It is a finish that is frequently used for dust filtration fabrics.

Permeability regulation is a vital process for the fabrics intended as filter media. It takes two basic forms: alteration of the surface, and adjustment of the relative positions of the integral yarns. Surface alteration includes calendering, as already mentioned, and the application of some kind of coating. Surface coatings are a special form of permeability regulation treatment, and are included below in the discussion of composite fabrics.

Mercerization is a process applied to cotton and some cotton blends, mainly to improve characteristics not of concern to filtration (such as lustre and affinity for dyes), but it does also improve strength. The process, which may be applied at the



(a) Before calendering (b) After calendering.

2.11. Effect of calendering on the surface of a 2/2 monofilament twill cloth.

yarn or fabric stage, involves immersion under tension in a caustic soda solution, followed by neutralization with acid. The treatment produces permanent swelling of the fibre, and hence changes the permeability of the fabric.

Tentering is a final process used to set the warp and weft of woven fabrics at right angles to each other, and to stretch and set the fabric to its final dimensions. Tentering stretches the fabric under tension by the use of a tenter frame, which travels on tracks through a heated chamber, to remove creases and wrinkles, to straighten the weave, and to dry the fabric to its final size. When the process is applied to synthetic fibres it is sometimes called *heat-setting*, a term also applied to the permanent setting of pleats, creases, and special surface effects.

2.3.1.3 Composite fabrics

When a second layer of fabric is joined to a first to make a *composite fabric*, then an element of confusion enters into the definition, as to whether the second material enhances the filtration performance of the first, or whether it completely changes the filtration regime of the resultant medium, with the second layer taking over the filtration function. The latter situation is exemplified by the laying down of a membrane layer over a woven substrate, such that the membrane does all of the filtration, and the woven material is only a support for the membrane. Composite fabrics of the second kind, which are effectively membrane media with woven fabric supports, are discussed in Chapter 8. The present section concentrates on coated woven fabrics, and multi-layer woven materials.

Surface coatings have become an important part of the woven fabric media business. The coating, which may be sprayed on as a liquid, or laid down as a thin sheet that is then bonded to the fabric, or even pushed into it, is primarily there to modify the surface permeability, but may also have other beneficial properties. (See also Section 3.3.1.2 for more information on coatings.)

Microporous polymer coatings can be applied to the face of woven and non-woven fabrics, both to achieve finer filtration, and to improve cake discharge. Examples of this format are provided by the various Ravlex coatings, supplied by Ravensworth; MP and HP grades are made from tetrafluoroethylene terpolymers, applied in liquid form, to provide a very robust coating with 5–8 µm pores. The scanning electron micrograph in Figure 3.6 in Chapter 3 shows a Ravlex coating on a non-woven fabric.

A polyurethane coating on a substrate of woven polyester is the basis of Madison's Primapor fabrics, introduced for use on process filters such as rotary drums and filter presses, shown in Figure 2.12. A development of this, the Azurtex coatings, again of polyurethane, on a polypropylene or polyester substrate, are impressed into the fabric. This gives a more durable finish, although the pore size is higher (6 µm, compared to 2.5–4 µm for Primapor). Madison also has a Tuf-Tex finish, of specially formulated resin, for woven (and non-woven) fabrics, although this is intended as an abrasion-resistant coating rather than permeability changing.

Laminated fabrics involve two or more layers of woven material, fixed together, either firmly or loosely. It is common practice in filtration to assemble several layers of different fabric on top of each other, with the finest on top as the main filtration medium, and those below of increasingly open and robust construction to provide mechanical strength and stability. It is much less common for the reverse system to be employed, where the coarsest material faces the feed, with the finest material last in the series – this might be used, for example, if the feed contains particles of widely differing particle sizes. The latter arrangement is an example of depth filtration, and is more widely used with non-woven media (as well as in loose media systems, such as sand beds).

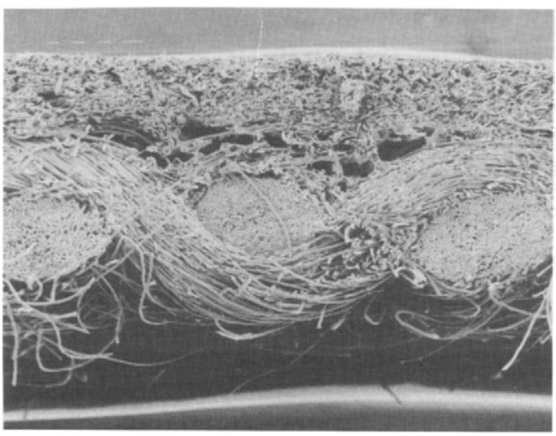
As has already been implied, a significant use for woven fabrics in filtration lies in their use as supports for membranes. Where a heterogeneous medium of this kind can be accepted, than woven fabrics can provide very strong support as membrane substrates.

Multi-layer weaving has been developed as a sophisticated weaving process by Sefar[4]. It enables the production of the Tetex multi-layer fabrics in one operation, the resultant media being very suitable for filter belts; an example is illustrated in Figure 2.13. Special looms are used that can handle several different warp and weft systems, involving around 10 000 filaments, simultaneously; this may include combining different warp and weft threads (e.g. monofilaments with ultrafine multifilaments). Equally specialized are the subsequent heat-setting/finishing processes, and the stretching and relaxing machines coupled with calendering. Belts may be 10–30 m long, and between 0.8 and 3 m wide; some belts are required to have different permeabilities in different regions, such as at the sides.

For the filtration of machine tool coolants on flat bed filters, traditionally done with disposable paper (or paper-like) media, the long life of double layer polyester belts, with nominal pore ratings of 40–120 μm, makes them an economic alternative.

2.3.2 Properties of woven fabric

The properties of woven fabrics that make them valuable as filtration media include their regular structure and their relative strength, both mechanical and



2.12. A section through a 'Primapor' coated fabric.

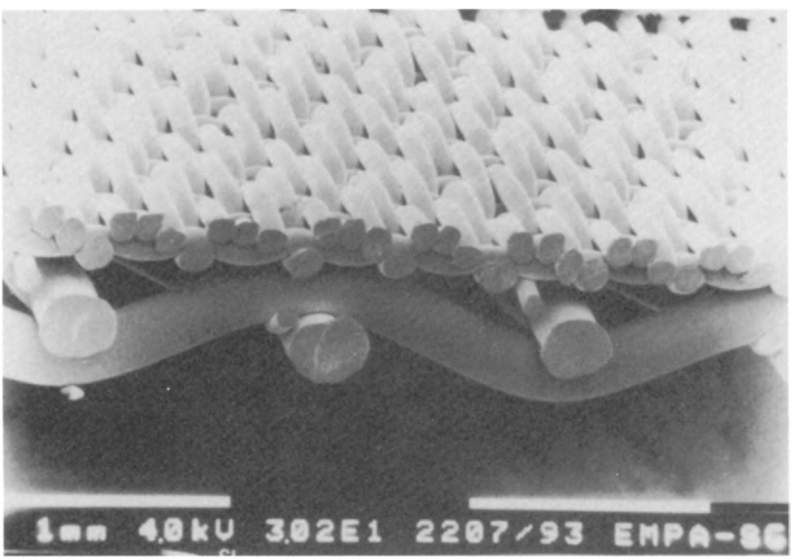
chemical. Fabrics from staple yarns are available in a wide range of materials. cotton and wool obviously, but also all thermoplastic polymers can be made into staple yarn, and used for fabrics.

A typical range of staple yarn filter fabrics is described in Table 2.10, which shows a preponderance of twill weaves. They are available with quite a wide range of permeabilities. Weights of fabrics based on staple spun yarns are generally in the range 400–700 g/m^2, the majority, in polyamide, polyester or polypropylene, are for liquids: those for dust filtration are in aramid, polyester or sulfar (PPS).

Plain weave monofilament fabrics range from lightweight cloths, with apertures of about 5 μm, up to heavy meshes with apertures as large as 5 mm: the corresponding fabric weights are typically in the range 40–400 g/m^2. The lighter grades are relatively flexible, but this gives way to stiffness and then rigidity as the filament size increases. The resultant format is more of a screen than a fabric, and they find a wide diversity of uses as sifters, sieves, strainers and screens. The media with precise, even if very fine, spacings between the woven filaments, are classified as screens and covered in more detail in Chapter 6.

A wide variety of grades of monofilament fabrics is available in each of the main synthetic polymers, as illustrated in Tables 2.11–2.14, which list representative selections from the Nytal (nylon), Estel (polyester), Propyltex (polypropylene), and Fluortex (PTFE) precision textiles of Sefar. The Fluortex fabrics can be supplied in various different commercial fluorocarbon polymers, the distinctive properties of which are listed in Table 2.15.

Rather than the plain weave used for screen-like monofilament fabrics, satin and, to a lesser extent, twill are the usual weaves of monofilament fabrics used for vacuum and pressure process filters for liquids. For smaller filter presses,



2.13. Section through a double layer woven 'Tetex' filter belt.

pressure leaf filters, horizontal belt filters, tipping pans, and both disc and drum vacuum filters, fabrics are usually in the weight range 200–450 g/m^2. For larger scale, heavy-duty operations, the weight range may extend to 1500 g/m^2. Examples of polyamide, polyester and polypropylene filter cloths in the lighter category, based on warp and weft yarns of various finenesses, are listed in Table 2.16, which are the principle qualities produced by one leading manufacturer.

The Madison Filterlink material, described above, has an exceptionally smooth surface, which has a far greater contact area than that of standard fabrics, thereby aiding filtration and extending fabric life by reducing mechanical wear. These fabrics have found particular use for the highly stressed operating conditions of multi-roll compression belt filters (belt presses), in the dewatering of flocculated sludges, for example; the absence of a mechanical seam in belts made from link fabric is of significant benefit, since this is often the weak link in conventional belts, and is frequently the first point of failure. These fabrics are typically well in excess of 1000 g/m^2 by weight, as indicated in the data of Table 2.17. Although they are effectively only available in polyester, it will be seen that a few grades contain some polypropylene, which is incorporated with the cross wires as a filler.

Table 2.10 Woven staple yarn cloths[a]

Fibre	Quality code	Weave	Weight (g/m^2)	Permeability to air[b]	Tensile strength[c]	
					Warp	Weft
Cloths for filtering liquids						
PA	NX463-44	Twill	460	95	180	120
PA	NX563-44	Twill	560	100	200	140
PA	NX473-48	Twill	570	100	200	140
PA	NX713-45	Twill	710	40	350	130
PA	NX713-46	Twill	710	13	350	130
PE	AM543-07	Twill	540	10	270	110
PE	AM543-44	Twill	540	60	280	110
PE	AM543-49	Twill	540	10	280	110
PE	AM573-32	Plain	575	5	380	280
PP	PX243-41	Plain	240	70	140	100
PP	PX373-42	Twill	375	100	220	140
PP	PX413-45	Twill	410	35	220	140
Cloths for filtering gas/dust						
Aramid	AX319-51	Twill	315	95	200	90
PE	AM299-32	Twill	290	155	160	130
PE	AM439-75	Twill	435	360	160	90
PE	AM509-75	Twill	500	205	220	140
Sulfar	SU349-04	Twill	290	120	160	60

[a] Madison Filtration Ltd.

[b] Air permeability.

[c] Tensile strength, kgf/5 cm.

Table 2.11 Examples of 'Nytal' nylon precision monofilament textiles[a]

Reference no.	N4000	N2000	N1000	N800	N600	N500	N390	N300	N224	N100	N80	N56	N35	N20	N15HD	N10HD	N5HD
Aperture (μm)	4000	2000	1000	800	600	500	390	300	224	100	80	56	35	20	15	10	5
Warp meshes/cm	2.0	3.64	7.57	9.26	11.9	13.9	17.6	22.7	29.1	57.8	67.8	101	100.5	185	185	190	200
Weft mesh/cm	2.0	3.64	7.57	9.26	11.9	14.3	17.6	22.7	29.1	66.7	81.3	101	128.2	185	185	190	200
Thread dia. (μm)																	
Warp	1000	750	320	280	240	220	180	140	120	60+ 2×50	50+ 2×43	43	43	34	39	42	2×43
Weft	1000	750	320	280	240	200	180	140	120	50	43	43	2×43	34	39	42	2×43
Thickness of fabric (μm)	2440	1580	630	505	445	390	325	250	220	105	92	71	97	45	43	40	80
Open area (%)	64	53	58	55	51	50	47	47	43	38	35	32	16	14	8	4	1
Weight (g/m^2)	395	395	160	140	133	119	105	76	80	35	35	37	49	32	32	32	60
Permeability to air[b]	–	–	6000	5800	5760	5340	5370	5100	4710	3390	2200	2130	1500	510	320	180	30
Permeability to water[c]	–	–	–	–	–	–	–	–	–	492	460	420	334	130	60	48	5.4
Bursting pressure[d]	–	–	17.5	20.5	19.5	19.5	17.5	15.0	15.5	6.0	6.5	8.5	10.0	7.5	7.5	7.5	15.5

[a] Sefar.

[b] Air permeability, $l/dm^2/min$ @ 20 mm WG.

[c] Water permeability, $l/dm^2/min$ @ 500 mm WG.

[d] Bursting pressure, kg/cm^2.

Table 2.12 Examples of 'Estel' polyester precision monofilament textiles[a]

Reference no.	PE5100	PE4000	PE2000	PE1000	PE800	PE600	PE500	PE390	PE300	PE224	PE105	PE80	PE55	PE35	PE20	PE10
Aperture (μm)	5100	4000	2000	1000	800	600	500	390	300	224	105	80	55	35	20	10
Warp meshes/cm	1.6	2.0	3.6	7.6	9.3	11.9	13.9	17.5	22.2	29.1	56.2	76.9	95.2	105.3	95.0	95.0
Weft mesh/cm	1.6	2.0	3.6	7.6	9.3	11.9	13.9	17.5	22.2	29.1	56.2	76.9	95.2	133.3	166.7	166.7
Thread dia. (μm)																
Warp	1000	1000	80	320	280	240	220	180	150	120	73	50	50	2×40	2×40	2×40
Weft	1000	1000	80	320	280	240	220	180	150	120	73	50	50	40	40	40
Thickness of fabric (μm)	1800	1800	1450	615	500	440	410	337	258	195	120	80	82	84	85	65
Open area (%)	70	64	51	57	55	51	48	47	44	42	35	38	27	17	7	2
Weight (g/m^2)	355	430	520	175	165	160	155	120	109	103	66	42	51	49	85	65
Permeability to air[b]	–	–	–	–	10750	9050	8550	8600	8040	7150	5400	5825	3612	2722	550	50
Permeability to water[c]	–	–	–	–	–	–	–	–	–	–	857	–	737	542	50	10
Bursting pressure[d]	–	–	–	–	–	21.5	29.0	215	18.0	17.0	11.5	7.5	8.5	8.5	10.0	10.0

[a] Sefar.
[b] Air permeability, l/dm^2/min @ 20 mm WG.[c] Water permeability, l/dm^2/min @ 500 mm WG.
[c] Bursting pressure, kg/cm^2.

Table 2.13 Examples of 'Propyltex' polypropylene precision monofilament textiles[a]

Reference no.	PP5100	PP6-3660	PP3000-HD	PP10-2000	PP12-1680	PP18-1000	PP20-840	PP30-590	PP35-500	PP405	PP50-297	PP280	PP79-210	PP100-149	PP140-105	PP74
Aperture (μm)	5100	3360	3000	2000	1680	1000	840	590	500	405	297	280	210	149	105	74
Warp meshes/cm	1.6	2.3	2.5	3.5	4.0	6.7	8.0	10.5	12.0	15.7	19.7	22.7	27.6	39.0	47.4	59.5
Weft mesh/cm	1.6	2.3	2.5	3.5	4.0	6.7	8.0	10.5	12.0	15.7	19.7	22.7	27.6	39.8	47.4	59.5
Thread dia. (μm)																
Warp	1000	1000	1000	800	800	500	400	350	300	200	200	150	150	100	100	85
Weft	1000	1000	1000	800	800	500	400	350	300	200	200	150	150	100	100	85
Thickness of fabric (μm)	1800	1800	1800	1600	1600	920	765	700	610	350	420	275	320	230	230	220
Open area (%)	66.6	59.7	56.2	49.0	45.1	44.9	45.1	38.4	36.0	40.4	34.2	40.4	33.6	33.8	24.8	19.4
Weight (g/m^2)	235	340	380	335	380	335	380	240	200	170	100	130	85	100	78	70
Permeability to air[b]	–	–	–	–	> 12 000	9700	8270	8875	8660	7565	7670	8100	6835	7090	5000	5120
Permeability to water[c]	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Bursting pressure[d]	–	–	–	–	> 50.0	40.0	27.0	32.0	31.0	20.0	23.0	17.0	17.5	12.0	15.0	14.0

[a] Sefar.

[b] Air permeability, l/dm^2/min @ 20 mmWG.

[c] Water permeability, l/dm^2/min @ 500 mmWG.

[d] Bursting pressure, kg/cm^2.

Table 2.14 Examples of 'Fluortex' fluorocarbon precision monofilament textiles[a]

Reference no.[b]	PFK 2000	PFK 1000	PFK 850	PFK 590	FEP 590	FEP 500	PFK 500	PFK 420	PFK 300	COP 210	COP 180	COP 150	COP 120	COP 105	COP 70	COP 52
Aperture (μm)	2000	1000	850	590	590	500	500	420	300	210	180	150	120	105	70	52
Warp meshes/cm	3.8	6.7	8.9	11.6	11.5	12.8	13.0	14.9	20.0	32.3	35.7	40.0	50.0	54.0	63.0	85.0
Weft mesh/cm	3.8	6.7	8.9	11.6	11.5	12.8	13.0	14.9	20.0	32.3	35.7	40.0	50.0	54.0	63.0	85.0
Thread dia. (μm)																
Warp	600	500	270	270	280	280	270	250	200	100	100	100	80	80	80	60
Weft	600	500	270	270	280	280	270	250	200	100	100	100	80	80	80	60
Thickness of fabric μm	1130	1000	505	485	555	570	500	450	385	200	200	200	170	175	200	125
Open area (%)	59.3	44.5	57.6	47.0	46.0	41.0	42.3	39.3	36.0	46.0	41.3	36.0	36.0	32.2	19.5	19.5
Weight (g/m²)	375	480	180	240	330	370	270	260	230	88	100	110	113	115	135	96
Permeability to air[c]	–	–	–	–	–	–	–	–	–	8400	7350	6720	5000	5500	3300	3350
Bursting pressure[d]	20.0	26.0	14.0	16.5	6.5	7.0	17.0	18.0	14.5	6.5	6.5	7.5	8.0	8.0	8.0	8.5

[a] Sefar.

[b] Reference Nos. identify the source of the PTFE (PFK=Hostaflon; FEP=Teflon; COP=Aflon). See Table 2.15 for their distinctive properties.

[c] Air permeability, $l/dm^2/min$ @ 20 mm WG.

[d] Bursting pressure, kg/cm^2.

Table 2.15 Properties of alternative PFTE polymers used in SST 'Fluortex' textiles

Fibre (monofilament)	FEP (Teflon)	PFK (Hostaflon)	LX (ETFE) (Tefzel) (Luxel)	LX (E-CTFE) (Luxilar) (Halar)	COP (Aflon)	PVDF
Properties						
Specific gravity	2.12	1.75–1.77	1.70	1.69	1.73–1.76	1.78
Tensile strength (kg/mm^2) (dry)	11–23	35–60	45–60	45–60	40–47	40–45
Rel. tenacity (wet %)	100	100	100	100	100	100
Elongation at break (%) (dry)	20–70	20–45	25–45	25–45	25–35	30–60
Elongation at break (%) (wet)	20–70	20–45	25–45	25–45	25–35	30–60
Moisture absorption (%) at 65% rel. hum and 20°C (68°F)	0	0	0	0	0	0.04
Melting point (°C)	285	270	270	245	265–270	170–180
Softening point (°C)	275	265	260	235	260	155
Temperature resistance or approx. limiting temp. in dry condition (permanent temperature)	−190°C to +232°C short-termed to 260°C, permanent temperature to 205°C	−200°C to +150°C evt. to +180°C	−200°C to +155°C	−60°C to +150°C	−180°C to +150°C	−50°C to +100°C
Resistance to light	Excellent	Excellent	Excellent	Excellent	Excellent	Very good
Abrasion resistance	Average to good	Average to good	Average to good	Average to good	Average to good	Average to good
Resistance and reactions to acids	Very resistant	Very resistant	Very resistant	Very resistant	Very resistant	Very good
Resistance to alkalis and reaction with caustics	Very resistant	Very resistant	Very resistant	Very resistant	Very resistant	Very good
Reaction to organic solvents (as used for instance for dry cleaning)	Insoluble	Insoluble	Insoluble	Insoluble	Insoluble	Partly resistant
Special feature	Anti-adhesive	Anti-adhesive	Anti-adhesive	Anti-adhesive	Anti-adhesive	Anti-adhesive

Table 2.16 Monofilament cloths for liquid filtration[a]

Fibre	Quality code	Weave	Weight (g/m²)	Permeability to air[b]	Tensile strength[c]	
					Warp	Weft
PA	NX281-01	Satin	280	1900	100	160
PA	NX281-07	Satin	280	500	90	160
PA	NX281-21	Satin	280	400	90	160
PA	NX281-22	Satin	280	1600	90	160
PA	NX371-01	c/twill[d]	375	710	360	130
PA	NX371-07	c/twill	375	400	360	130
PA	NX371-21	c/twill	375	125	360	130
PA	NX381-07	c/twill	380	85	360	130
PE	AM441-01	Satin	440	1650	180	230
PE	AM441-07	Satin	440	400	180	230
PP	PX201-01	Twill	200	3000	280	90
PP	PX201-07	Twill	200	190	260	80
PP	PX291-01	Satin	295	1400	350	140
PP	PX291-07	Satin	295	550	350	140
PP	PX291-21	Satin	295	1650	350	140
PP	PX321-01	Satin	320	950	400	120
PP	PX331-07	Satin	335	120	340	120
PP	PX341-07	Satin	340	24	340	120
PP	PX351-07	c/twill	350	400	340	120
PP	PX351-21	c/twill	350	20	340	120
PP	PX361-07	Twill	365	1260	350	160

[a] Sefar.
[b] Air permeability, l/dm²/min @ 200 mm WG.
[c] Tensile strength, kgf/5 cm.
[d] c/twill=compound twill.

Table 2.17 P & S 'Filterlink' woven fabrics[a]

Specification weight (g/m²)	Grade: SE0770 1350	SE780 11340	SE790 1650	SE795 1660	SE870 1120
Filament diameter, µm					
MD (i.e. warp)	0.60	0.70	0.6	0.7	0.58×0.88[b]
Cross (i.e. weft)	0.90	0.90	0.9+F[c]	0.9+F	0.9
Filaments per 10 cm					
MD	160	136	160	136	104
Cross	27	18	27	18	19
Material					
MD	PES	PES	PES	PES	PES
Cross	PES	PES	PES+F	PES+F	PES
Permeability to air[d]	›2350	›2350			

[a] Sefar.
[b] Air permeability, l/dm²/min @ 200 mm WG.
[c] F=polypropylene filler.
[d] Profiled filament.

As has already been mentioned, an additional filtration parameter exists for multifilament (as well as staple) yarn fabrics, in that there is now a choice of path of the fluid being filtered either between the yarns or through them, a division dependent both upon the tightness of the weave and upon the degree of twist of the yarns. The weight of multifilament fabrics can vary quite widely, from below 100 g/m^2 to more than 1000 g/m^2. Table 2.18 summarizes the characteristics of a typical range of multifilament filter fabrics. Most of those listed are intended for filtering liquids, with grades available in polyamide, polyester and polypropylene, and with the weaves variously plain, twill, or a variant of satin (reverse satin); the grades for gas filtration are all twill weaves, the yarns ranging from glass, to polyester and PTFE. An example of a multifilament plain weave is shown in Figure 2.3, while a twill weave fabric is shown in Figure 2.10.

Fabrics made from fibrillated yarns have only a limited use in filtration, mainly as support fabrics. Two such fabrics are described in Table 2.19. Nevertheless, yarns made from Gore-Tex expanded PTFE are particularly attractive, since they combine the exceptional chemical resistance of conventional PTFE, with significantly better mechanical properties in respect of tensile strength (2 to 3 times greater at all temperatures up to 300°C) and

Table 2.18 Multifilament cloths[a]

Fibre	Quality code	Weave	Weight (g/m^2)	Permeability to air[b]	Tensile strength[c]	
					Warp	Weft
Cloths for filtering liquids						
PE	AM992-81	Twill	1100	30	1100	400
PE	AM992-82	Twill	1100	15	1100	400
PP	PX312-32	Twill	310	95	280	120
PP	PX322-01	Plain	325	10	280	250
PP	PX412-70	Plain	410	3	500	120
PP	PX412-77	Plain	410	<3	450	120
PP	PX582-01	Twill	580	70	700	280
PP	PX592-07	Twill	590	6	700	280
PP	PX662-32	r/satin[d]	660	5	500	520
PP	PX662-33	r/satin	660	<3	500	520
PP	PX682-32	r/satin	680	10	500	520
PP	PX682-33	r/satin	680	<3	500	520
Cloths for filtering gas/dust						
Glass	GL299-00	Twill	290	250	150	150
Glass	GL469-00	Twill	460	235	280	75
Glass	GL749-00	Twill	745	230	400	180
PE	AM179-00	Twill	170	95	220	135
PTFE	TF299-00	Twill	290	140	75	60

[a] Madison Filtration Ltd.
[b] Air permeability, $l/dm^2/min$ @ 20 mmWG.
[c] Tensile strength, daN/5 cm.
[d] r/satin=reversible satin.

abrasion resistance (8 times greater). The expanded PTFE yarns have a very low elongation at break, excellent creep characteristics, extremely low shrinkage characteristics, and better flex life. These yarns are available in 100, 200, 400, 1200, and 2400 denier, with the 400 denier yarn being that most commonly made up into a woven fabric. The extra strength of these materials enables the

Table 2.19 Woven cloths of fibrillated tape yarn for liquid filtration[a]

Fibre	Quality code	Weave	Weight (g/m^2)	Permeability to air[b]	Tensile strength	
					Warp	Weft
PP	PX314	Mock leno	310	1575	300	200
PP	PX454	Mock leno	450	395	400	240

[a] Madison Filtration Ltd.
[b] Air permeability, $l/dm^2/min$ @ 20 mmWG.
[c] Tensile strength, daN/5 cm (10 Newtons = 1 daN = 0.981 kg. The P & S standard text uses daN).

Table 2.20 Woven cloths with mixed yarn[a]

Fibre	Quality code	Yarn type		Weave	Weight (g/m^2)	Permeability to air[b]	Tensile strength[c]	
		Warp	Weft				Warp	Weft
PE	AM673-09	Multi	Staple	r/satin[c]	630	20	600	200
PE	AM673-10	Multi	Stable	r/satin	630	8	600	200
PP	PX235-01	Mono	Multi	Twill	235	800	280	150
PP	PX235-07	Mono	Multi	Twill	235	270	280	150
PP	PX235-21	Mono	Multi	Twill	235	80	280	150
PP	PX305-01	Mono	Multi	Tatin	300	500	350	120
PP	PX305-07	Mono	Multi	Satin	300	24	350	120
PP	PX345-07	Mono	Multi	Satin	340	24	350	180
PP	PX575-01	Mono	Multi	Satin	570	315	450	550
PP	PX575-08	Mono	Multi	Satin	570	11	450	550
PP	PX467-42	Multi	Staple	r/satin	460	95	500	120
PP	PX467-43	Multi	Staple	r/satin	460	10	500	120
PP	PX547-03	Multi	Staple	r/satin	545	11	500	220
PP	PX547-04	Multi	Staple	r/satin	545	<3	500	220
PP	PX587-09	Multi	Staple	r/satin	585	8	500	220
PP	PX587-10	Multi	Staple	r/satin	585	<3	500	220
PP	OX587-11	Multi	Staple	r/satin	585	<2	500	220
PP	PX617-09	Multi	Staple	r/satin	610	13	500	220
PP	PX617-10	Multi	Staple	r/satin	610	<3	500	220
PP	PX817-82	Multi	Staple	Twill	815	40	900	240
PP	PX817-83	Multi	Staple	Twill	815	<3	900	240
PP	PX858-82	Multi	Tape	Twill	850	40	900	540
PP	PX858-83	Multi	Tape	Twill	850	8	900	540
PP	PX858-86	Multi	Tape	Twill	850	40	900	540
PP	PX858-87	Multi	Tape	Twill	850	8	900	540

[a] Madison Filtration Ltd.
[b] Air permeability, $l/dm^2/min$ @ WG.
[c] Tensile strength, daN/5 cm.
[d] r/satin = reversible satin.

use of a much lighter woven scrim for non-woven media (for example, 135 g/m^2 instead of 304 g/m^2).

The use of mixed yarns (a different type of yarn for warp and weft) can give considerable benefit to a filter fabric, by comparison with a single yarn material. Surface smoothness, and with it cake discharge, fabric strength, durability and filtration efficiency can all be improved by the use of mixed yarns, as compared with a single yarn. Some examples of mixed yarn woven fabrics are given in Table 2.20, showing a wide range of permeabilities.

The coated fabrics exemplified by Madison's Primapor and Azurtex materials are used for the fine filtration of liquid slurries containing titanium dioxide, china clay and dyestuffs. They are available in maximum widths up to 1.65 m, and in nominal weights between 620 and 750 g/m^2. The average pore sizes are 2.5 and 4 μm for the two grades of Primapor and 6 μm for both grades of Azurtex, while the corresponding values of liquid permeability for Primapor are 40 and 80 l/m^2/min and 110 l/m^2/min for Azurtex (all measured at 20 kPa Hg).

Finally, among the types of woven fabric are those made by multi-layer weaving. A range of these is illustrated in Table 2.21, covering a standard range of vacuum filter belts. Table 2.21 shows mostly polypropylene belts (with nominal pore sizes of 12–160 μm), with two examples in fluorocarbon (20 and 40 μm).

2.3.3 Special-purpose fabrics

There are two types of filter fabric, intended for special-purpose filtration, that have appeared in several new forms since the first edition of this Handbook was written. These cover anti-electrostatic media and combination media.

Table 2.21 Double layer weave fabrics for vacuum filter belts[a]

Belt style[b]	Pore size (μ)	Maximum temperature (°C)	Filtrate permeability			Belt stability	
			Very high	High	Normal	High[c]	Normal
PP-12/MM/DLW/C	12	90			x		x
PP-20/MM/DLW/C[d]	20	90			x		x
PP-21/MM/DLW/C	20	90			x	x	
PP-30/DLW/C	30	90			x		x
PP-41/MM/DLW/C	40	90			x	x	
PP-50/DLW/C[d]	50	90			x		x
PP-81/DLW/C	80	90			x	x	
PP-85/DLW/C	85	90		x			x
PP-120/DLW	120	90	x				x
PP-161/DLW	160	90	x			x	
FK46-20/MM/DLW/C	20	120			x		x
FK6-40/DLW/C	40	120		x			x

[a] Sefar.
[b] PP=polypropylene; FK=fluorocarbon.
[c] Excellent mechanical properties, suitable for filters with press belt device.
[d] Available as permanent antistatic version for application in hazardous locations.

Of growing importance in industrial applications are the combination filters, mainly for air cleaning, that undertake two duties at once: the removal of solid particles (or liquid droplets), and the removal of odours or other gaseous impurities. This can be done by the complete carbonization of the material, to give an activated carbon surface to the entire medium, or the inclusion within the medium of particles of activated carbon. domnick hunter[5] supplies compressed air filters using ACC (activated charcoal cloth), which has been made by the carbonizing of polyester or polypropylene fabrics. Such material usually needs supporting on a lightweight carrier, such as a spun bonded polymer. The lack of robustness is more than made up for by the very high adsorptive capacity and the low pressure drop of these materials.

Such included particles can also be of other chemicals, such as potassium permanganate and catalysts. As particle inclusion is more easily done in non-woven matrices, such uses are discussed in Chapter 3.

The use of materials that are intrinsically charged electrostatically to aid in filtration, mainly of dusts from air, has been known for a long time. Of much more recent development are those materials intended to conduct away any charge that might build up on the medium, and any trapped cake, so minimizing the hazard from the explosion of dry dusts or flammable solvents. Typical of these media are those made by Arville Textiles (and sold as filter media components by the Multiple Fabric Company), which incorporate fine steel or carbon threads in the weave, or use carbon fibres within the yarns.

2.4 Knitted Fabrics

Knitted fabrics are constructed by the interlocking of a series of loops made from one or more yarns, with each row of loops caught into the preceding row. Starting with the frame knitting machine, which first allowed production of a complete row of loops at one time, the modern knitting industry has grown into one with highly sophisticated machinery. Knitted fabrics can be made flat or cylindrical (as well as fully fashioned, for the garment industry).

From the point of view of filtration, knitted fabrics are a lot more open than are woven fabrics. Accordingly they are rarely used as a medium in a single layer, but rather as a packed bed of many layers, in which format they work well as demisters and coalescers.

Knitted fabrics can be made from yarns of quite wide variety, but for industrial use they normally employ single filaments as the yarn. By far the greatest proportion of knitted fabric is made from single wire or single polymeric filament, and, as such, is covered later in this Handbook (in Chapter 5 to some extent, and in Chapter 6 in more detail).

2.5 Selection of Woven Fabrics

The selection of any filter medium is dictated by the wish to achieve the optimum combination that it offers of all of the factors listed in Chapter 1: machine related,

Table 2.22 Relative cost of construction details of woven textiles[a]

Maximum ←		Proportion of cost ←			Minimum
Fibre[b] Material	Type of fibre	No. of threads	No. of twists	Yarn diameter[c] (mm)	Weave[d]
↑ Cost increases: Fluorocarbon	Monofilament	High	High	High	Satin
Aramid	Multifilament	Medium	Medium	Medium	Twill
large difference in cost	Mtaple	Low	Low	Low	Plain
Wool					
Polyamide					
Acrylic					
Modacrylic					
Polyester					
Cotton					
Rayon					
Saran					
Acetate					
Polypropylene					
Vinyon					
Glass					

[a] Based on comments by Madison Filtration Ltd on Sperry Ehler's original table.

[b] There is a vast difference between the top two and the others. It is only in deciding whether to use flurocarbon or aramid that the relative fibre costs become a consideration. Note also that the order ignores the influence of quality; thus, a low quality wool would appear much lower on the table.

[c] The relative cost order for yarn diameters is correct for monofilaments and multifilaments, but should be reversed for staple yarns.

[d] The choice of weave order has negligible effect upon the total cost.

application related and filtration specific. In addition to all of these, there is the question of cost. Another table originally published by Ehlers[1] sought to provide an overview of the relative impact of its constructional variables on the total cost of a woven fabric. This table was revised by one of the present authors[3], and is reproduced here as Table 2.22, still largely relevant after 20 years.

Ehlers's earlier tables (Tables 2.7–2.9) form a sound basis from which to choose a woven fabric. Perhaps the key features are the regular structure and the relative strength of woven fabrics by comparison, say, with many non-wovens. This is particularly the case where the medium is subject to variable mechanical strains during use – such as in a tower press, or in Heinkel's inverting basket centrifuge. Typical of the special needs of tower presses is the Albany International Primaflo series of belts, made from polyester or polypropylene, with weave patterns specially developed to maximize strength and structural integrity, giving lifetimes approaching 10 000 cycles.

A major set of data on fabric choice is included at the end of Chapter 3, offering application guidance for both woven and non-woven fabrics in a variety of applications.

2.6 References

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