Some aspects of the design of filter fabrics for use in solid/liquid separation processes

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Textile filter fabrics are an essential part of countless industrial processes, contributing to product purity, savings in energy/production costs and a cleaner environment. This paper describes, in general terms, the factors which are taken into account when designing a fabric for a solid-liquid separation process, touching on textile raw materials and, with particular reference to filtration and filtration equipment considerations, the elements of cloth constructions and finishing procedures.

Keywords: Filter fabrics, Filter media, Filtration, Solid-liquid separation

1 Introduction

In the last 20 years the European Community has introduced more than 100 legal regulations in the area of environmental protection, the majority of which are directed towards the control of environmental pollution. It is, therefore, not surprising that industry should look to filtration technologies to assist in meeting the increasingly stringent statutory requirements but, in addition, industry is also looking to the same technologies for both technical and economic reasons. The technical reasons include aspects such as improved product quality whereas economic aspects may be in respect of shorter process cycles or reduced manning levels or perhaps drier filter cakes and therefore the need for less thermal energy in subsequent processing.

This paper reviews some of the factors which are taken into account when selecting or designing a filter fabric for a particular application. The types of raw material available are described, together with some basic fabric constructions and finishing processes. Suggested procedures for fabric evaluation are also briefly examined.

2 Filter Media Types

It has been shown elsewhere that filter media may take many forms, these being summarized by Purchas in Table 1.

It is also well known that liquid filtration can be achieved by several mechanisms, principally gravity, vacuum, centrifuge and pressure. The

<table>
<thead>
<tr>
<th>Main type</th>
<th>Sub-division</th>
<th>Smallest particle retained μm</th>
</tr>
</thead>
<tbody>
<tr>
<td>Solid fabrications</td>
<td>(a) flat wedge-wire screens</td>
<td>100</td>
</tr>
<tr>
<td></td>
<td>(b) wire-bound tubes</td>
<td>100</td>
</tr>
<tr>
<td></td>
<td>(c) stacks of rings</td>
<td>5</td>
</tr>
<tr>
<td>Rigid porous media</td>
<td>(a) ceramics and stoneware</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>(b) carbon</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>(c) plastics</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>(d) sintered metals</td>
<td>2</td>
</tr>
<tr>
<td>Cartridges</td>
<td>(a) sheet fabrications</td>
<td>100</td>
</tr>
<tr>
<td></td>
<td>(b) yarn wound</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td>(c) bonded beds</td>
<td>2</td>
</tr>
<tr>
<td>Metal sheets</td>
<td>(a) perforated</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>(b) woven wire</td>
<td>2</td>
</tr>
<tr>
<td>Plastic sheets</td>
<td>(a) woven monofilaments</td>
<td>10</td>
</tr>
<tr>
<td></td>
<td>(b) fibrillated film</td>
<td>200</td>
</tr>
<tr>
<td></td>
<td>(c) porous sheets</td>
<td>0.1</td>
</tr>
<tr>
<td>Woven fabrics Link fabrics</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Nonwoven media</td>
<td>(a) filter sheets</td>
<td>0.5</td>
</tr>
<tr>
<td></td>
<td>(b) felts and media felts</td>
<td>10</td>
</tr>
<tr>
<td></td>
<td>(c) paper media—cellulose</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td>(d) bonded media</td>
<td>200</td>
</tr>
<tr>
<td>Loose media</td>
<td>(a) fibres</td>
<td>&lt;1</td>
</tr>
<tr>
<td></td>
<td>(b) powder</td>
<td>&lt;1</td>
</tr>
</tbody>
</table>
present paper is devoted to the separation of solids from liquids by textile filter media and focuses on the two mechanisms, viz. pressure and vacuum, which consume the largest volume of fabric.

3 Fabric Design/Selection Considerations
The primary factors which influence the design or selection of filter media are thermal and chemical conditions, filtration requirements, equipment consideration and cost. These factors are discussed below:

3.1 Thermal and Chemical Conditions
The thermal and chemical conditions of the liquid being filtered effectively determine the type of polymer which is used in fibre/filament production. Historically, filter fabrics were produced by weaving yarns spun from natural fibres such as cotton which, on wetting, would swell to produce highly efficient media. However, on the debit side, in chemically aggressive conditions, their life expectancy is somewhat limited. By comparison, synthetic fibres are generally much more durable but even so, as can be seen from Table 2, it is still important to make the correct selection for the conditions which prevail in the filter.

Polyamide fibres, for example, will not tolerate continuous exposure to strong acids and, conversely, polyester fibres will degrade when exposed to strong bases and prolonged hydrolytic conditions. Whilst polypropylene is relatively inert to both acids and bases, and hence is the most widely used polymer in liquid filtration, it too has an "achilles heel" in its susceptibility to attack from oxidizing agents. The presence of chlorine or heavy metal salts are potential source of such attack.

PTFE fibres of course are resistant to most agents but carry a cost premium which in most cases is prohibitive.

3.2 Filtration Requirements
In order to satisfactorily fulfil filtration requirements, the ideal filter medium will provide:

Resistance to chemical/mechanical attrition: Reference has already been made to polymer selection in relation to chemical conditions; in similar vein, mechanical conditions such as the abrasive nature of the slurry and the tensile forces acting on the fabric will be items to consider when selecting the appropriate yarns and the density of the thread spacing in the fabric.

Resistance to blinding: This is a well-known term which relates to particulate matter becoming trapped, sometimes irretrievably, within the interstices of the fabric and ultimately leading to a serious reduction in throughput. Fabric blinding may be temporary or permanent. Temporary in that the cloth may be rejuvenated by washing, either externally or in-situ, and permanent in that such treatments are largely ineffective. The latter may be caused by several factors, one of the more common being crystal growth from the process itself. A good

<table>
<thead>
<tr>
<th>Fibre</th>
<th>Density</th>
<th>Max operating temp., °C</th>
<th>Acid</th>
<th>Alkali</th>
<th>Oxidising agent</th>
<th>Hydrolysis</th>
</tr>
</thead>
<tbody>
<tr>
<td>Polypropylene</td>
<td>0.91</td>
<td>95</td>
<td>VG</td>
<td>VG</td>
<td>P</td>
<td>G</td>
</tr>
<tr>
<td>Polyethylene</td>
<td>0.95</td>
<td>85</td>
<td>VG</td>
<td>VG</td>
<td>P</td>
<td>G</td>
</tr>
<tr>
<td>Polyester (PBT)</td>
<td>1.28</td>
<td>100</td>
<td>G</td>
<td>P</td>
<td>F</td>
<td>P</td>
</tr>
<tr>
<td>Polyester (PET)</td>
<td>1.38</td>
<td>100</td>
<td>G</td>
<td>P</td>
<td>F</td>
<td>P</td>
</tr>
<tr>
<td>Polyamide 66</td>
<td>1.14</td>
<td>110</td>
<td>P</td>
<td>G</td>
<td>P</td>
<td>F</td>
</tr>
<tr>
<td>Polyamide 11</td>
<td>1.04</td>
<td>100</td>
<td>P</td>
<td>G</td>
<td>P</td>
<td>F</td>
</tr>
<tr>
<td>Polyamide 12</td>
<td>1.02</td>
<td>100</td>
<td>P</td>
<td>G</td>
<td>P</td>
<td>F</td>
</tr>
<tr>
<td>PVDC</td>
<td>1.70</td>
<td>85</td>
<td>VG</td>
<td>G</td>
<td>VG</td>
<td>G</td>
</tr>
<tr>
<td>PVDF</td>
<td>1.78</td>
<td>100</td>
<td>VG</td>
<td>G</td>
<td>VG</td>
<td>G</td>
</tr>
<tr>
<td>PTFE</td>
<td>2.10</td>
<td>150+</td>
<td>VG</td>
<td>VG</td>
<td>VG</td>
<td>VG</td>
</tr>
<tr>
<td>PPS</td>
<td>1.37</td>
<td>150+</td>
<td>VG</td>
<td>VG</td>
<td>F</td>
<td>VG</td>
</tr>
<tr>
<td>PVC</td>
<td>1.37</td>
<td>80</td>
<td>VG</td>
<td>VG</td>
<td>F</td>
<td>VG</td>
</tr>
<tr>
<td>PEEK</td>
<td>1.30</td>
<td>150+</td>
<td>G</td>
<td>G</td>
<td>F</td>
<td>VG</td>
</tr>
</tbody>
</table>

VG—Very good, G—Good, F—Fair; and P—Poor
example of this can be found in processes where gypsum is encountered, e.g. on either horizontal belt or tipping pan filters in the production of phosphoric acid.

**Good cake discharge at the end of the filtration cycle:** Filter cake which adheres to the fabric inevitably leads to a reduction in process efficiency, either by way of a reduction in effective filtration area or where the cakes require to be removed with manual assistance, a longer and hence more costly cycle time. This particular problem has been addressed in recent years by manufacturers with the provision of high pressure wash jets and in filter presses, brush cleaning facilities.

**Low cake moisture content:** This is particularly important with respect to processes where the cake has to be thermally dried. The high cost of thermal energy makes it imperative to express the maximum amount of moisture from the slurry by mechanical means. Similarly, where filter cakes are to be transported for landfill, the moisture content again has to be controlled to a low level to meet local statutory requirements. Both fabric and equipment have a part to play in this context.

**Throughput:** The maximum throughput in the minimum time and with minimum resistance is perhaps one of the process engineer's most important objectives, the operation frequently being crucial to the balance of the total production cycle. Once again, equipment parameters play a leading role in this subject.

**Filtrate clarity:** Whilst acknowledging that in most cases the role of the filter fabric is to achieve maximum separation of solids from liquids, absolute filtrate clarity may or may not be critical to the operation. The next destination of the filtrate and/or the ability of the process engineer to recirculate until satisfactory clarity is obtained need to be established and balanced against throughput requirements. Similarly, in certain screening operations, the fabric is designed to capture particles only of a specific size.

It is recognised that the filter fabric may not, in isolation, be the ideal medium for all process conditions and, in some cases, filtration has to be assisted. For example, with the aid of filter aids and/or body feeds, and perhaps even filter papers. Likewise, the nature, size and shape of the particles being filtered, the structure of the filter cake itself and the filtration pressures which can be generated by the equipment will, in most cases, have a larger bearing on throughput, cycle time and cake moisture content. Notwithstanding this, the principle requirements of the operation will exercise considerable influence not only on the choice of polymer but also on the design and construction of the filter fabric and the manner in which it is treated following its initial production.

### 3.3 Equipment Considerations

In respect of equipment considerations the ideal filter fabric will, in simplistic terms, provide a long trouble-free performance. In other words, it will provide resistance to stretch, structural deformation, flex fatigue and mechanical abrasive forces.

The tendency for fabric stretch may arise in several types of filter, e.g. in conventional filter presses and in both pressure and vacuum leaf filters it may occur due to the vertical pull of heavy filter cakes on the cloth during the discharge phase. On the other hand, on horizontal belt filters and in vertical automatic filter presses, it may occur as a result of filter belt tensioning forces, especially on start up.

In conventional filter presses such stretch may, in extreme cases, result in the port holes in the cloth being pulled out of alignment with the holes in the filter plate, thereby impeding filtrate escape. By comparison in vertical automatic presses, if the belt stretches to the limit of the filter's tensioning stroke, then the filter will have to be stopped with consequent losses in production whilst the belt is shortened and re-seamed.

In other vacuum filters, such as disc and certain rotary drum filters, stretch may result from the repeated injection of compressed air which, at the end of the filtration cycle, is used to assist discharge by inflating the cloth and thereby "easing" the cake away from it. In extreme cases, this could also result in mechanical damage to the fabric as the inflated cloth engages with the filter's scraper blade.

Mechanical attrition from abrasive forces, including flex abrasion, comes in many forms, e.g.

**Belt filters:** The moving edge of the belt may be subjected to abrasion through contact with stationary parts such as defective or poorly maintained cloth tracking mechanisms.

**Belt, disc and rotary drum filters:** Scraper blades may be set too closely to the face of the fabric. In
addition to general abrasion, local damage may also result if a large particle becomes trapped between the blade and the fabric.

*Filter presses:* Operators are often equipped with various types of scraper blades to assist in cake removal. Over zealous use may inflict serious mechanical damage to the cloth. This can be alleviated through the use of plastic scrapers.

*Abrasive slurries:* Under high filtration pressures such slurries can be extremely aggressive, seeking out or perhaps creating microscopic apertures in the fabric by severing the filaments, then enlarging the apertures to the extent that eventually the fabric allows the passage of an excessive amount of solids.

Closely related is the mechanical damage caused by rough surfaces or sharp edges on the filter plates themselves—either on the drainage pipes or in the sealing area. The latter has been largely eradicated in the case of polypropylene plates where the sealing area is clean and smooth i.e. unlike the traditional cast iron plates (of which a number are still in existence) where the surfaces can be quite rough through chemical corrosion. In such cases, cloth life can be enhanced by stitching fabric reinforcement strips to the sealing areas and, in addition, by applying special chemical compounds which penetrate into the cloth structure, edge leakage of filtrate through the fabric's interstices can also be prevented.

High internal pressures may also result in fabric deformation and possible filament damage around the drainage pipes. In such cases, especially where finely woven multifilament or monofilament cloths provide optimum filtration characteristics, the use of an additional support fabric or backing cloth may be necessary to extend cloth life. Examples of this can be found in the filtration of china clay.

### 3.4 Cost

Although considerable technology goes into the production of a filter cloth—both in production and fabrication—and although it may be of vital importance to the success of the operation or the quality of a product, it is often acknowledged that the cost contribution of the filter fabric to the final product cost is extremely low. However, the filters which are used in production are often used at extremely important process stages and "downtime" for cloth changing may result in considerable cost due to lost production. Filter fabrics are therefore expected to provide the longest possible life before failure due to blinding or mechanical/chemical damage.

### 4 Fabric Construction and Properties

#### 4.1 Yarn Types

In the production of woven filter fabrics and backing cloths, one of the four basic yarn types, viz. monofilaments, multifilaments, staple spun yarns and fibrillated tape yarns, is normally employed.

##### 4.1.1 Monofilaments

These are single filaments extruded from molten polymer through a specially engineered spinneret and then drawn through a series of rollers to orientate the molecules and thus provide the thread with the desired stress-strain characteristics. The monofilaments are usually round in cross-section although other profiles are possible. The diameter may be as large as 0.8 mm (perhaps larger in special cases) but for most filtration applications it is usually in the range 0.1-0.3 mm.

Fabrics produced from monofilaments are characterised by their resistance to blinding, their high throughput and their ability to discharge filter cakes cleanly and efficiently at the end of the filtration cycle. However, in critical filtration applications, where the particle size is extremely small and where maximum filtrate clarity is required, they do not always provide the necessary retention efficiency, even when crammed closely together into a tightly woven construction and subjected to an intensive calendering operation (see Section 4.3).

For filter presses, small horizontal belt, tipping pan, disc and rotary drum filters, monofilament fabrics are usually in the weight range 200-450 g. On the other hand, for heavy duty operations where greater throughput is required, e.g. horizontal belt and rotary drum (belt discharge) filters involving thicker diameters and hence more open constructions, the weight range may be up to 1500 g. They may also be woven in widths of up to 8 m for seamless operation on these filters.

##### 4.1.2 Multifilaments

These are also extruded and orientated in much the same way as monofilaments although on this occasion, the spinneret contains a large number of much smaller apertures. Although the diameter of
the individual filaments in this case is usually of the order 0.03 mm, the usual practice is to express the fineness, both of the individual filaments and the collective assembly of filaments, in terms of its linear density, typical units being denier, tex and denitex.

Following extrusion, it is a common practice to bind the filaments together through a twisting operation. This helps to protect the yarn from abrasive forces both in weaving process and cloth use. The same twist also makes the filament assembly slightly stronger, more rigid and, if a high twist level is used, can alleviate the tendency of the yarn and hence the fabric to blind. Even so, multifilament fabrics whilst possessing greater collection efficiency, higher strength and greater flexibility than monofilament fabrics are nevertheless more prone to blinding than the latter, especially in processes where crystal growth can be expected.

The weight of fabrics woven from multifilaments can vary quite considerably from around 100 g/m² to as high as 1000 g/m², the heavier constructions (the actual weight perhaps being influenced by polymer density) being selected for more arduous duties such as vertical automatic filters. If, for special purposes, light weight fabrics are required on conventional horizontal filter presses, it is likely that they may require the additional support of a backing cloth to prevent premature mechanical damage.

4.1.3 Staple Spun Yarns

These were the first synthetic yarns to be employed on a large scale in industrial filtration, facilitating the production of heavy duty durable cloths, primarily for use on traditional cast iron plates and leaf filters.

Staple spun yarns are in fact produced from short fibres using spinning technologies which were developed for the processing of natural fibres such as cotton and wool. After extrusion, the fibre length is cut to 40-100 mm depending on which the staple spinning system is employed.

As a general guide, fibres processed on woollen spinning systems are more bulky than those processed on cotton systems. As a consequence of this bulk, coupled with the relative ease with which the fibres can move within the yarn assembly, it has been argued that for the separation of non-compressible particles, woollen spun yarns provide greater throughput, are more efficient and less prone to blinding than either multifilament yarns or yarns processed on the cotton spinning system. On the other hand, as with multifilament yarns, the blinding resistance of staple spun yarn is significantly inferior to that of monofilaments, especially where the separation process involves slimy material or where crystal growth may be expected.

Fabrics produced from staple spun yarns are mainly in the region 400-700 g/m², the major uses being in conventional filter presses, vacuum leaf, pressure leaf (esp. sugar industry) and rotary drum filters (wired on or caulked in).

4.1.4 Fibrillated Tape Yarns

These yarns are produced from narrow width polypropylene films which are converted into relatively coarse filaments by splitting the film either with special cutters or pins, hence the alternative term "split film yarns". These yarns find limited use in filtration and are used mainly in the form of coarse, open weave structures providing support and drainage for the primary filter cloth.

4.1.5 Combinations

By producing fabrics with different components in each direction, e.g. multifilament warp and staple weft, or monofilament warp and multifilament weft, it is possible to achieve the best of both worlds. In the first case, higher warp tensile properties and a reasonably smooth surface can be obtained from the multifilament component whereas bulk, improved filtration efficiency and durability can be obtained from the staple spun weft component. In the second case, excellent discharge can be obtained from the monofilament component whereas improved collection efficiency can be obtained through the multifilament weft insertion.

4.2 Fabric Constructions

4.2.1 Plain Weave

This is the most basic of fabric constructions. It is also the tightest, the most efficient and most rigid of elementary weave patterns and is particularly suited to multifilament or short staple yarns.

4.2.2 Twill Weave

There are numerous variations on the twill weave theme, though all of these feature a diagonal pattern running through the fabric. By virtue of this type of
construction it is possible to cram more weft threads per unit length into the fabric, thereby giving the material more bulk. Furthermore, as a result of the arrangements of threads, twill weave fabrics are essentially more flexible than those produced by the plain weave. This could be important where difficulties may be encountered in cloth manufacture or indeed in fitting the cloth on the filter.

4.2.3 Satin Weave

Again there are numerous styles of satin weave, the basic concept of which is to produce a smooth surface which, as far as possible, is devoid of the diagonal lines associated with twill weaves. The smooth surface is in fact achieved by interlacing the threads in an orderly manner but at wider intervals than either plain or twill weaves. As a result, a still more flexible fabric is achieved which, by virtue of the thread to thread movement which takes place, also helps in preventing the accumulation of particles within the structure. In addition, the longer threads "floats" in satin weaves also facilitate the insertion of more warp threads per unit of width, thereby creating the opportunity for still greater smoothness and hence better cake discharge at the end of the filtration cycle. From this, it will be appreciated that satin weaves are ideally suited to monofilament yarns.

However, unless the threads in both warp and weft directions are packed tightly together, satin weaves are not normally associated with high particle collection efficiencies. They are, on the other hand, suited to cases where good cake discharge is essential, typical applications being filter presses in effluent treatment processes, cement and coal dewatering, and rotary vacuum or disc filters operating, e.g., in mining or hydro-metallurgical refining industries.

Summarizing, in general terms, the plain weave fabrics tend to be employed where maximum filtration efficiency is required, twill weave fabrics where greater bulk and mechanical durability are required and the satin weave fabrics where good discharge (especially with monofilaments) and blinding resistance are the primary requirements. And remember, it is possible to fine tune the fabric by mixing yarns of dissimilar type to suit specific applications.

4.2.4 Link Constructions

As the title implies these fabrics are produced by enmeshing preformed monofilament spirals, then linking them together with a series of standard (straight) monofilaments.

Although in filtration terms the very nature of these constructions precludes their use in more critical operations, their collection efficiency can be enhanced by filling the spirals with additional monofilaments, possibly with oval or rectangular profiles.

Whilst link fabrics were originally developed for paper making equipment, they have found use in a number of filtration applications, especially on multi-roll filters in the dewatering of polymer flocculated sludges, e.g., sewage and coal, which are relatively easy to filter but require good drainage. Another particular attribute of belts made from link fabrics is the absence of a mechanical seam, the latter being the weak point in conventional belts and frequently the first point of failure. Being made from fairly coarse monofilaments, these materials can be quite heavy, frequently in excess of 1000 g/m².

4.2.5 Needlefelts

These are produced by assembling several layers of carded fibre into a lofty formation, referred to as a "batt", then transforming this batt into a more dense structure by needle punching with special barbed needles. The usual practice is to needle the fibres to a woven scrim (one side or both) which provides the structure with the necessary tensile properties.

Compared with woven fabrics, needlefelts provide many more readily accessible pores and hence a greater filtration area than woven fabrics. Although they have, through changes in technology, largely replaced woven fabrics in dust collection operations, with specific exceptions they have so far found limited use in liquid filtration.

4.3 Fabric Finishing Processes

Fabric finishing procedures are carried out basically to ensure fabric stability, to modify the surface characteristics, and to regulate the fabric’s permeability.

4.3.1 Stabilization Treatments

Since the fibres or yarns are held under tension
throughout virtually the whole of the fabric production processes, there is a natural tendency for them to relax. This tendency may well give rise to problems in use. For example, in severe circumstances, it may result in:

- Cloth port holes moving out of alignment with holes in the filter plate, thereby impeding the flow of filtrate out of the press, or alternatively
- Unfiltered slurry completely bypassing the filtration area.

To avoid such occurrences, it is a common practice to subject the fabric to either hot aqueous or dry thermal treatment operations, the temperature and duration in each depending on the polymer type and the weight of fabric.

The dry process is frequently referred to as heat setting and involves (a) through the influence of heat, breaking the inter-molecular bonds in the fibre (or filament) and then (b) allowing them to cool and re-form in the new position. In theory, unless the new heat setting temperature is exceeded, or unless the fibre is stretched beyond its “yield point”, the fabric will retain the shape at which it has just been heat set.

On the other hand, for belt filters, including vertical automatic filter presses, it may be preferable to subject the fabric to a pre-stretching process. Such a treatment not only reduces the fabric's stretch propensity when under tension on the filter, but also ensures better tracking by equalizing any tension variations which may exist across its width. Pre-stretching under the influence of heat is normally carried out on equipment designed and used in the paper machine clothing industry.

4.3.2 Surface Treatments

Singeing: Fabrics produced from short staple fibres naturally possess a fibrous surface, which, in some cases, can impede cake discharge through mechanical adhesion of fibre to cake. This can simply be overcome by passing the fabric over either a gas flame or a metal strip heated to very high temperature.

Calendering: This process serves both to improve the fabric's surface smoothness (for better cake discharge) and also to regulate its permeability and hence improve its collection efficiency. This is achieved by a combination of heat and pressure, the temperature being decided partly by the polymer type and partly by the permeability requirements, working hand in hand with pressure and the speed at which the fabric is processed through the machine.

Special treatments: It will be recalled from comments made earlier in the paper that the ideal filter fabric will provide, amongst other things, acceptable clarity, resistance to blinding and good cake discharge. Special treatments therefore tend to focus on these areas, particularly the last mentioned, where superior discharge can make a significant impact on production costs. Most companies have their own proprietary treatments or coatings, the latest of which to appear on the market is one by Scapa Filtration called PRIMAPOR which provides both good discharge and outstanding clarity, even with fine particles such as are found, for example, in dyestuffs and pigments, e.g. titanium dioxide and iron oxide.

5 Fabric Evaluation Procedures

In many cases, fabric recommendations are based on previous experience in similar applications. However, where no experience exists, it may be appropriate to carry out laboratory or pilot scale filtration tests.

Filter press, rotary drum, horizontal belt and many more types of equipment are available in laboratory scale form and with such equipment it is possible to carry out comparative tests with fairly reliable results. However, even small-scale equipment may require such large volumes of slurry as to make laboratory work impractical and on such occasions it is usually easier to transport equipment to site. Where this is equally impractical e.g. for geographic reasons and, for logistical reasons, only a small amount of slurry can be made available for test, it will be necessary to revert to more basic bench equipment. Examples of this include the standard Buchner apparatus, or vacuum leaf equipment of the Dorr Oliver type, or for pressure filter tests, a simple pressure cylinder (air or piston pressure).

It will be appreciated that, in view of the small scale of the operation, these tests are essentially for comparative purposes. It would be impractical, for example, to assess long-term blinding characteristics. It should also be ensured that the nature and character of the slurry to be tested will be similar, if not identical to its condition when first
produced, even if it has to be reheated and/or re-slurried. Ideally of course, it will also be representative of standard production (should this ever exist!).

In the case of the vacuum leaf filter it is possible to carry out useful tests with as little as five litres of slurry operating at vacuum levels up to around 600 mm Hg. Using approximately 100 cm\(^2\) of fabric, information on solids in filtrate, ease of cake formation, cake thickness, cake moisture content and cake discharge properties can be assessed with this equipment.

For pressure tests, the pressure cylinder is ideally suited, requiring an even smaller volume of slurry (approximately 200 ml) and also a smaller area of fabric (e.g. 25 cm\(^2\)). Filter pressure may be applied by compressed air up to a maximum of around 7 bar. Filtration rate, ideally over a number of cycles (thus allowing the fabric to condition), solids in filtrate, cake discharge and cake moisture can all be gauged with this equipment.

In carrying out these tests, most manufacturers have a wide range of fabrics to choose from, these being characterized principally by yarn type, threads/cm, weight and permeability. Again, experience plays a large part in the selection of fabrics, taking cognisance of the factors listed earlier in this paper, but in addition to the above parameters, and in an attempt to characterise fabrics more specifically in terms of their filtration efficiency, a procedure was developed by Barlow and Haczycki in which:

- A dilute suspension of flyash in glycerol is prepared (flyash has a convenient particle size distribution).
- The said suspension is passed at constant velocity through the filter fabric.
- The particle size distribution is measured before and after filtration using a Coulter counter.

An important feature of this test is that particle size measurements are taken on the filtrate before pressurisation and the formation of a filter cake takes place, thereby getting a more valid indication of the fabric’s collection efficiency.

6 Remarks

It is hoped that the foregoing will have provided some insight into the thought processes which determine how fabrics are selected or designed to meet the end user’s requirements.

Inevitably, advances will be made in filtration equipment or chemical process technology or, as stated at the outset, tighter environmental pollution controls will be enforced. The onus, as always, will be on the filter fabric producer to respond accordingly to these changes.

Reference