# CHAPTER 6

# Screens and Meshes

The several very different types of filter media gathered together in this chapter, woven meshes, perforated sheets and structures of shaped wires, have one main common feature – an accuracy of aperture size. Another common feature is that they are all made from metal, largely because abrasion is a normal problem in their application, although many forms are now available in plastic as well.

All the dry screening (sieving, sifting) operations are covered by the media in this chapter, as are almost all of the straining and coarse filtration applications.

## 6.1 Introduction

The prime feature of media made from meshes or screens is that of aperture shape – the size and shape of the apertures in the medium is critical for the intended application. The material of construction is less critical, although its high tensile strength may be vital as well.

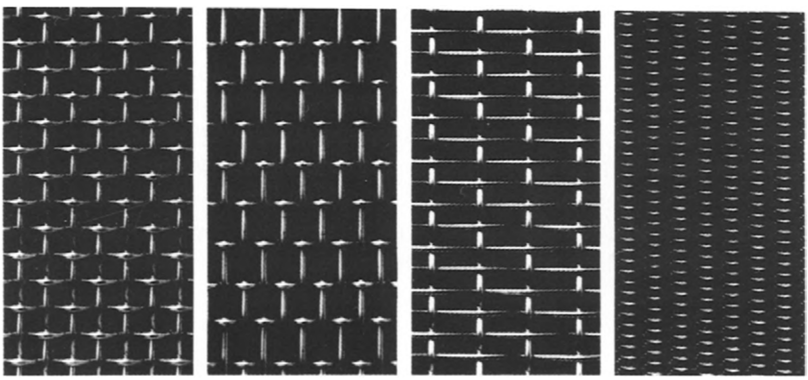
There are three broad classes of media covered under this heading: woven meshes, sheets perforated with a variety of holes, and elements made up from preformed materials. Some overlap exists between the woven meshes of this chapter and the woven monofilament materials of Chapter 2.

## 6.2 Woven Wire Mesh

The weaving of wire is no different, in principle, from the weaving of any other yarn – as described in Chapter 2. The product is a roll of woven material, which then is processed in a variety of ways, to produce the components of a filter medium. The term wirecloth is frequently used to refer to meshes woven from finer grades of wire, while the term *bolting cloth* refers to lightweight versions of square mesh cloths, comprising those based on the finest wires.

A wide variety of wire meshes is produced by weaving monofilaments of either ferrous or non-ferrous metals in widths of about 1 m up to 2 m. Two main categories can be distinguished, in terms of weave and of the shape of the apertures, as in Figure 6.1. One category utilizes plain weave with single wires of the same diameter for the warp and weft, to form rectangular apertures (the great majority being square); many of these are the screens typically used for sieving and sizing operations. The other category is 'zero aperture filter cloths', with the wires pressed closely together. These embrace a number of more complex weaves, such as dutch twills, which are commonly used in pressure and vacuum process filters.

Information on the metals used in wire mesh is given in Tables 6.1–6.7 (provided by Haver and Boecker). Each includes some guidance on resistance to corrosion, in terms of numerical values extending from 1 (= very good) to 5 (= poor); an added asterisk (*) indicates danger of localized corrosion.



Square Aperture | Rectangular "Oblong" | Rectangular "Broad" | Zero Aperture "Filter Cloth"

*Figure 6.1. Some types of apertures in woven wire.*

**Table 6.1 Metals for woven wire cloth: steel**

| Material | Material no. | Trade name | Max service temp. °C | Max service temp. °F | Finest weaving wire diameter mm | Finest weaving wire diameter inch | Resistance against: Atmosphere | Sea water | Lyes | Acids |
|---|---|---|---|---|---|---|---|---|---|---|
| Plain steel | 1.0010 | Carbon steel | 500 | 930 | 0.08 | 0.0030 | 5 | 5 | 2–4 | 4–5 |
| Galvanized steel | | | 200 | 390 | 0.16 | 0.0065 | 3 | 5 | 2–4 | 4–5 |
| Tinned steel | | | 150 | 300 | 0.10 | 0.0040 | 5 | 5 | 2–4 | 4–5 |
| Spring steel | 1.0500 | NIA-Steel High carbon steel | 500 | 930 | 0.125 | 0.0050 | 5 | 5 | 3–4 | 4–5 |

**Table 6.2 Metals for woven wire cloth: stainless steels**

| Material no. | AISI | Symbols | Composition | | | | Max service temp. | | Finest weaving wire dia. | | Resistance against: | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Cr | Ni | Mo | | °C | °F | mm | inch | Atmosphere | Sea water | Lyes | Acids |
| 1.4016 | 430 | X 6 Cr 17 | 17 | | | | 500 | 930 | 0.04 | 0.0016 | 2 | 4* | 2 | 3–4 |
| 1.4301 | 304 | X 5 CrNi 1810 | 18 | 10 | | | 600 | 1110 | 0.016 | 0.0006 | 1 | 3* | 1–2 | 2–4* |
| 1.4306 | 304L | X 2CrNi 1911 | 19 | 11 | | | 600 | 1110 | 0.016 | 0.0006 | 1 | 3* | 1–2 | 2–4* |
| 1.4310 | 301 | X 12 CrNi 177 | 17 | 7 | | | 600 | 1110 | 0.04 | 0.0016 | 1 | 3* | 2 | 2–4* |
| 1.4541 | 231 | X 6 CrNiTi 1810 | 18 | 10 | | Ti | 700 | 1290 | 0.05 | 0.0020 | 1 | 2* | 2* | 2–3* |
| 1.4401 | 316 | X 5 CrNiMo 17122 | 17 | 12 | 2 | | 600 | 1110 | 0.018 | 0.0007 | 1 | 2* | 2* | 2–3* |
| 1.4404 | 316L | X 2 CrNiMo 17132 | 17 | 13 | 2 | | 600 | 1110 | 0.018 | 0.0007 | 1 | 2* | 2* | 2–3 |
| 1.4435 | 317L | X 2 CrNiMo 18143 | 18 | 14 | 3 | | 600 | 1110 | 0.05 | 0.0020 | 1 | 2* | 2* | 2–3 |
| 1.4571 | 316Ti | X 6 CrNiMoTi 17122 | 17 | 12 | 2 | Ti | 700 | 1290 | 0.05 | 0.0020 | 1 | 2* | 2* | 2* |

### *6.2.1 Square mesh*

Listed in Table 6.9 is the range of square mesh wire meshes produced by one leading manufacturer, indicating which grades are available in specific metals. The tolerance of the aperture sizes specified varies according to the fineness of the cloth, as summarized in Table 6.8; a crucial factor in determining this is the tolerance of the diameter (including the extent to which it deviates from being truly round) of the wires from which the mesh is woven.

Crimping of the wires happens automatically as part of the weaving process, provided that the wires are sufficiently fine and ductile. With heavier and more rigid wires, however, such as those of high tensile steel for heavy-duty screens, a separate pre-crimping operation is necessary, both to form the desired apertures and to ensure appropriate stability during extended use. Various types of crimp are used, as outlined in Table 6.10.

**Table 6.3 Metals for woven wire cloth: special steels**

| Material no. | AISI | Symbols | Composition | | | Max service temp. | | Finest weaving wire dia. | | Resistance against: | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Cr | Ni | | °C | °F | mm | inch | Atmosphere | Sea water | Lyes | Acids |
| HB 253 | | HITHERM | 21 | 11 | | 1200 | 2190 | 0.025 | 0.0010 | 1 | 2* | 1–2 | 2–3* |
| HB 165 | | Corresist | 20 | 25 | | 900 | 1650 | 0.10 | 0.0040 | 1 | 2 | 2 | 2 |
| 1.4841 | 310 314 | X 15 CrNiSi 25 20 | 25 | 20 | Si 2 | 1200 | 2190 | 0.05 | 0.0020 | 1 | 3* | 2–3 | 2–4* |
| 1.4742 | | X 10 CrAl 18 | 18 | | Al 1 | 1050 | 1920 | 0.05 | 0.0020 | 1 | 4* | 2–3 | 2–4* |

**Table 6.4 Metals for woven wire cloth: copper and alloys**

| Material | | Material no. | Composition | | | Max. service temp. | | Finest weaving wire dia. | | Resistance against: | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Cu | Zn | | °C | °F | mm | inch | Atmosphere | Sea water | Lyes | Acids |
| Copper | E-Cu | 2.0060 | 99.9 | | | 150 | 300 | 0.050 | 0.0020 | 2 | 3 | 3 | 2–5 |
| Brass | CuZn 37 Ms 63 | 2.0321 | 63 | 37 | | 200 | 390 | 0.050 | 0.0020 | 5 | 5 | 3 | 4–5 |
| Low brass | CuZn 20 Ms 80 | 2.0250 | 80 | 20 | | 200 | 390 | 0.050 | 0.0020 | 4 | 4 | 2 | 2–5 |
| Common bronze | CuZn 10 Ms 90 | 2.0320 | 90 | 10 | | 200 | 390 | 0.050 | 0.0020 | 2 | 3 | 2 | 2–5 |
| Phosphor bronze | CuSn 6 | 2.1020 | 94 | | Sn 6 P | 200 | 390 | 0.025 | 0.0010 | 1 | 2 | 3 | 2–5 |

### *6.2.2 'Zero aperture' filter meshes*

The square mesh materials have a definite open area between successive warp or weft wires, however fine. The other main category of mesh has the wires as close

**Table 6.5 Metals for woven wire cloth: nickel and monel**

| Material | | Material no. | Composition | | Max service temp. | | Finest weaving wire dia. | | Resistance against: | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Ni | | °C | °F | mm | inch | Atmosphere | Sea water | Lyes | Acids |
| Nickel<br>NiMn 1 | | 2.4106 | ≥98 | Mn 0.3–1 | 250 | 480 | 0.036 | 0.0014 | 1 | 2 | 1–3 | 3–5 |
| Nickel<br>Ni 99.2 | Alloy 200 | 2.4066 | ≥99.2 | Mn <0.03 | 250 | 480 | 0.036 | 0.0014 | 1 | 2–3 | 1–2 | 3–5 |
| MONEL®<br>Metal<br>NiCu 30 Fe | Alloy 400<br>Niccoros<br>Silverin | 2.4360 | ≥63 | Cu 30<br>Fe | 400 | 750 | 0.04 | 0.0016 | 1 | 1 | 2–3 | 1–5 |

**Table 6.6 Metals for woven wire cloth: special metals**

| Material | | Material no. | Composition | | | Max service temp. | | Finest seaving wire dia. | |
|---|---|---|---|---|---|---|---|---|---|
| | | | Cr | Ni | | °C | °F | mm | inch |
| Inconel 600 | NiCr 15 Fe | 2.4816 | 15 | 72 | | 1050 | 1290 | 0.06 | 0.0023 |
| Incoloy 825 | NiCr 20 Mo | 2.4858 | 20 | 38–46 | Mo | 900 | 1650 | 0.08 | 0.0030 |
| Hastelloy C 4 | NiMo 16 Cr 16 Ti | 2.4610 | | | | 1100 | 2012 | 0.05 | 0.0020 |
| Titanium | 995 | 3.7025 | | | Ti 99.5 | 1000 | 1830 | 0.01 | 0.0020 |
| Silver | Ag 900 | | | | Ag 99 | 300 | 570 | 0.04 | 0.0016 |
| NiCr 80/20 | | 2.4869 | 20 | 80 | | 1250 | 2280 | 0.02 | 0.0008 |
| Carpenter 20<br>CB 3 | NiCr 20 CuMo | 2.4660 | 20 | 37 | Cu | 950 | 1740 | 0.06 | 0.0023 |

**Table 6.7 Metals for woven wire cloth: aluminium and alloys**

| Material | | Material no. | Composition | | Max. service temp. | | Finest weaving wire dia. | | Resistance against: | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Al | Mg | °C | °F | mm | inch | Atmosphere | Sea water | Lyes | Acids |
| AlmG 5 | Aluminoy | 3.3555 | 95 | 5 | 180 | 360 | 0.05 | 0.0020 | 3 | 4 | 4–5 | 3–5 |
| AlMg 3 | | 2.3535 | 97 | 3 | 180 | 360 | 0.08 | 0.0030 | 3 | 4 | 4–5 | 3–5 |
| Al 99 | | 3.0205 | 99 | | 180 | 360 | 0.16 | 0.0065 | 2 | 3 | 4–5 | 3–5 |

together as possible, thereby making the 'pore' diameter as small as possible. An illustration of the diversity of weaves embraced by this category, as typified by the 'Minimesh' range of Haver and Boecker, is provided by Figure 6.2. The diameters of the warp and weft wires are normally different.

For filtration purposes, the most widely used forms of woven wire are the dutch or hollander weaves, wherein the warp and weft are of different diameter, generally with a corresponding difference in the relative numbers of warp and weft wires. If the warp wires (i.e. those along the length of the loom) are thicker, the result is the 'plain dutch weave' of Figure 6.3; the alternative is for the weft wires (across the loom) to be the thicker, giving the 'reverse plain dutch weave' of Figure 6.4.

'Plain dutch weave' is also known as single plain dutch weave, basket weave, reps and corduroy. It forms a filter cloth that is easy to clean and has a low resistance to flow, but is of limited strength. 'Reverse plain dutch weave' is substantially stronger, and is in fact the strongest filter weave in commercial production; as a result, coupled with its good flow characteristics and high dirt-holding capacity, it is widely used industrially.

By a similar combination of warp and weft wires of different diameters, two basic forms of twilled dutch weave are produced. The use of heavy warp wires results in 'dutch twilled weave' (Figure 6.5), which permits the production of the very finest grades of woven wire cloths, while also having the advantage of a very smooth surface on both sides; its disadvantage is a relatively high resistance to flow. With heavy weft wires, 'twilled reverse dutch weave' is formed (Figure 6.6); this offers less resistance to flow but with a corresponding decrease in micron retention characteristics and with rough surfaces on both sides.

Numerous variations exist around these basic weaves. Thus the Haver and Boecker range of wire cloths includes not only the four dutch weaves described above, but also 'broad mesh twilled dutch weave' in which the weft wires are not arranged to give a 'light-tight' cloth but have a preset spacing between them; because of this, the weft mesh count and the retention vary somewhat at intervals. Their patented Zig-Zag weave uses the same weave but involves a special sequence, which guarantees the highest possible accuracy and regularity of spacing.

Another variation is to use twisted bundles of fine wires in place of a single wire. This is particularly favoured in the manufacture of the wire belts that form the heart of papermaking machines. One version is 'twisted plain weave', with

**Table 6.8 Tolerance of aperture sizes of Bopp square-mesh wire cloths**

| Aperture sizes (μm) | (mm) | Average tolerance of apertures (%) |
|---|---|---|
| 2–25 | 0.020–0.025 | ±7.5 |
| 32 | 0.032 | ±6.5 |
| 36–40 | 0.036–0.040 | ±5 |
| 55–67 | 0.056–0.067 | ±4.5 |
| 71–95 | 0.071–0.095 | ±4 |
| 100–170 | 0.100–0.170 | ±3.5 |
| 189–400 | 0.180–0.400 | ±3 |
| 425–1600 | 0.425–1.600 | ±2.5 |

**Table 6.9 Bopp standard range of mesh wire cloths**

| Aperture size w | Wire diameter (mm) ddelete Open area (%) Fo | Mesh[a] | Weight[b] | Stainless steel AISI 304/316 | Phosphor bronze | Brass | Tinned steel | Galvanized steel | Plain steel | |
|---|---|---|---|---|---|---|---|---|---|---|
| (mm) | | | | | | | | | | |
| **16** | 3.2 | 69.4 | 1.3 | 6.77 | x | | | | | |
| | 2.5 | 74.5 | 1.4 | 4.29 | x | | | | x | |
| | 2.0 | 79 | 1.4 | 2.82 | x | | | | | |
| *14* | 2.8 | 69.4 | 1.5 | 5.93 | x | | | | | |
| **12.5** | 2.5 | 69.4 | 1.7 | 5.29 | x | | | | | |
| | 2.0 | 74.5 | 1.8 | 3.50 | x | | | | x | |
| | 1.6 | 79 | 1.8 | 2.31 | x | | | | | |
| *11.2* | 2.5 | 67 | 1.9 | 5.79 | x | | | | | |
| | 1.6 | 77 | 2 | 2.54 | x | | | | | |
| **10** | 2.5 | 64 | 2 | 6.35 | x | | | | | |
| | 1.8 | 72 | 2.1 | 3.49 | x | | | | x | |
| | 1.5 | 77 | 2.2 | 2.18 | x | | | | | |
| 9 | 2.2 | 64 | 2.3 | 5.49 | x | | | | | |
| **8** | 2.0 | 64 | 2.5 | 5.08 | x | | | | | |
| | 1.6 | 69.4 | 2.6 | 3.39 | x | | | | x | |
| | 1.25 | 74.5 | 2.7 | 2.15 | x | | | | x | |
| *7.1* | 1.8 | 64 | 2.9 | 4.62 | x | | | | | |
| | 1.4 | 69.4 | 3 | 2.93 | x | | | | | |
| **6.3** | 1.8 | 60 | 3.1 | 5.08 | x | | | | | |
| | 1.4 | 67 | 3.3 | 3.23 | x | x | x | x | x | x |
| | 1.25 | 69.4 | 3.4 | 2.63 | | | | | x | |
| | 1.0 | 74.5 | 3.5 | 1.74 | x | | | | | |
| 5.6 | 1.6 | 60 | 3.5 | 4.52 | x | | | | | |
| | 1.25 | 67 | 3.7 | 2.90 | x | | | | | |
| | 1.12 | 69.4 | 3.8 | 2.38 | | | | | x | |
| **5.0** | 1.6 | 57.6 | 3.8 | 4.93 | x | | | | | |
| | 1.25 | 64 | 4.1 (4) | 3.18 | x | x | x | x | x | x |
| | 0.9 | 72 | 4.3 | 1.74 | x | | | | | |
| *4.5* | 1.4 | 57.6 | 4.3 | 4.22 | x | | | | | |
| | 0.8 | 72 | 4.8 | 1.53 | | | | | | x |
| **4** | 1.4 | 54 | 4.7 | 4.61 | x | | | | | |
| | 1.0 | 64 | 5.1(5) | 2.55 | x | x | x | x | x | x |
| | 0.71 | 72 | 5.4 | 1.36 | x | | | | | |
| *3.55* | 1.25 | 54 | 5.3 | 4.13 | x | | | | | |
| | 0.9 | 64 | 5.7 | 2.31 | | | | | x | |
| | 0.8 | 67 | 5.8 | 1.87 | x | | | | | |
| 3.35 | 0.9 | 62.1 | 6 | 2.43 | x | | | | | |
| **3.15** | 1.25 | 51 | 5.8 (6) | 4.51 | x | | | | | |
| | 0.8 | 64 | 6.4 | 2.06 | x | x | x | x | x | x |
| | 0.56 | 72 | 6.8 (7) | 1.07 | x | | | | | |
| *2.8* | 1.12 | 51 | 6.5 | 4.06 | x | | | | | |
| **2.5** | 1.0 | 51 | 7.3 | 3.65 | x | | | | | |
| | 0.71 | 60 | 7.9 (8) | 1.99 | x | x | x | x | x | x |
| | 0.5 | 69.4 | 8.5 | 1.06 | x | | | | | |
| *2.24* | 0.9 | 51 | 8.1 (8) | 3.28 | x | | | | | |
| | 0.63 | 60 | 8.9 (9) | 1.77 | x | | | | x | |
| | 0.36 | 74.5 | 9.8 (10) | 0.64 | x | | | x | | |
| **2** | 1.0 | 44.4 | 8.5 | 4.25 | x | | | | | |
| | 0.9 | 48 | 8.8 (9) | 3.56 | x | | | | | |
| | 0.63 | 57.6 | 9.7 (10) | 1.93 | x | | | | | |
| | 0.56 | 60 | 9.9 (10) | 1.56 | | x | x | x | x | x |
| | 0.32 | 74.5 | 10.9 (11) | 0.56 | x | | | x | | |

**Table 6.9 (*continued*)**

| Aperture size w | Wire diameter (mm) ddelete Open area (%) Fo | Mesh[a] | Weight[b] | Stainless steel AISI 304/316 | Phosphor bronze | Brass | Tinned steel | Galvanized steel | Plain steel | |
|---|---|---|---|---|---|---|---|---|---|---|
| (mm) | | | | | | | | | | |
| 1.8 | 0.8 | 48 | 9.8 (10) | 3.13 | x | | | | | |
| | 0.32 | 72 | 12 | 0.61 | x | | | x | | |
| ***1.6*** | 1.0 | 38 | 9.8 (10) | 4.88 | x | | | | | |
| | 0.8 | 44.4 | 10.6 | 3.39 | x | | | | | |
| | 0.5 | 57.6 | 12.1 (12) | 1.51 | x | x | x | x | x | x |
| | 0.36 | 67 | 13 | 0.84 | x | | | | | |
| | 0.28 | 72 | 13.5 (14) | 0.53 | | | | x | | |
| | 0.22 | 77 | 14 | 0.34 | x | | | | | |
| 1.5 | 0.63 | 49.6 | 11.9 (12) | 2.37 | x | | | | | |
| 1.4 | 0.71 | 44.4 | 12 | 3.03 | x | | | | | |
| | 0.45 | 57.6 | 13.7 (14) | 1.39 | x | | | | | |
| | 0.25 | 72 | 15.4 (15) | 0.48 | | | | x | | |
| | 0.22 | 74.5 | 15.7 (16) | 0.38 | x | | | | | |
| 1.32 | 0.5 | 52.6 | 14 | 1.75 | x | | | | | |
| ***1.25*** | 0.8 | 38 | 12.4 | 3.97 | x | | | | | |
| | 0.63 | 44.4 | 13.5 | 2.68 | x | | | | | |
| | 0.4 | 57.6 | 15.4 | 1.23 | x | x | x | x | x | x |
| | 0.25 | 69.4 | 16.9 (17) | 0.53 | | | | x | | |
| | 0.22 | 72 | 17.3 (17) | 0.42 | x | | | | | |
| 1.18 | 0.63 | 42.5 | 14 | 2.78 | | x | | | | |
| | 0.22 | 71 | 18.1 (18) | 0.44 | x | | | | | |
| 1.12 | 0.56 | 44.4 | 15.1 (15) | 2.37 | x | | | | | |
| | 0.45 | 51 | 16.2 (16) | 1.64 | x | | | | | |
| | 0.36 | 57.6 | 17.2 | 1.11 | x | | | | x | |
| | 0.25 | 67 | 18.5 (19) | 0.58 | | | | x | | |
| | 0.22 | 69.4 | 19 | 0.46 | x | | | | | |
| 1.06 | 0.22 | 68.6 | 19.8 (20) | 0.48 | x | | | | | |
| ***1*** | 0.63 | 38 | 15.6 (16) | 3.10 | x | | | | | |
| | 0.56 | 41 | 16.3 (16) | 2.55 | | x | | | | |
| | 0.5 | 44.4 | 16.9 (17) | 2.12 | x | | | | | |
| | 0.4 | 51 | 18.1 (18) | 1.45 | x | | | | | |
| | 0.32 | 57.6 | 19.2 (19) | 0.98 | x | x | x | x | x | x |
| | 0.22 | 67 | 21 | 0.50 | x | | | x | | |
| (μm) | | | | | | | | | | |
| 950 | 0.2 | 68.2 | 22 | 0.44 | x | | | | | |
| 900 | 0.5 | 41 | 18. 1 (18) | 2.27 | x | | | | | |
| | 0.36 | 51 | 20 | 1.30 | x | x | | | | |
| | 0.2 | 67 | 23 | 0.46 | x | | | x | | |
| 850 | 0.5 | 39.6 | 18.8 | 2.35 | | | | | | |
| | 0.4 | 46.2 | 20 | 1.63 | x | | | | | |
| | 0.2 | 65.5 | 24 | 0.48 | x | | | | | |
| ***800*** | 0.5 | 38 | 19.5 | 2.44 | x | x | | | | |
| | 0.32 | 51 | 23 | 1.16 | x | x | x | x | x | x |
| | 0.2 | 64 | 25 | 0.51 | x | | | x | | |
| 750 | 0.18 | 65 | 27 | 0.44 | x | | | x | | |
| 710 | 0.45 | 38 | 22 | 2.22 | x | | | | | |
| | 0.36 | 44.4 | 24 | 1.55 | x | x | | | | |
| | 0.28 | 51 | 26 | 1.02 | x | | | | x | |
| | 0.18 | 64 | 29 | 0.46 | x | | | x | | |
| 670 | 0.16 | 65.2 | 31 | 0.40 | x | | | x | | |
| ***630*** | 0.4 | 38 | 25 | 1.97 | x | x | | | | |
| | 0.28 | 48 | 28 | 1.09 | x | | | | | |
| | 0.25 | 51 | 29 | 0.91 | x | x | x | x | x | x |
| | 0.16 | 64 | 32 | 0.41 | x | | | x | | |

**Table 6.9 (*continued*)**

| Aperture size w | Wire diameter (mm) ddelete Open area (%) Fo | Mesh[a] | Weight[b] | Stainless steel AISI 304/316 | Phosphor bronze | Brass | Tinned steel | Galvanized steel | Plain steel | |
|---|---|---|---|---|---|---|---|---|---|---|
| (μm) | | | | | | | | | | |
| 600 | 0.4 | 36 | 25 | 2.03 | | x | | | | |
| | 0.16 | 62.3 | 33 | 0.42 | x | | | x | | |
| 560 | 0.36 | 38 | 28 | 1.79 | x | | | | | |
| | 0.28 | 44.4 | 30 | 1.19 | x | | | | | |
| | 0.16 | 60 | 35 | 0.45 | x | | | x | | |
| 530 | 0.16 | 59 | 37 | 0.47 | x | | | x | | |
| ***500*** | 0.32 | 38 | 31 (30) | 1.59 | x | x | | | | |
| | 0.25 | 44.4 | 34 | 1.06 | x | x | x | x | x | x |
| | 0.16 | 57.6 | 38 | 0.49 | x | | | x | | |
| 475 | 0.16 | 56 | 40 | 0.51 | x | | | x | | |
| 450 | 0.28 | 38 | 35 | 1.37 | x | | | | | |
| | 0.2 | 48 | 39 (40) | 0.78 | x | | | | | |
| | 0.14 | 57.6 | 43 | 0.42 | x | | | x | | |
| 425 | 0.28 | 36 | 36 | 1.41 | | x | | | | |
| | 0.14 | 56.6 | 45 (44) | 0.44 | x | | | x | | |
| ***400*** | 0.25 | 38 | 39 (40) | 1.22 | x | | | | | |
| | 0.22 | 41 | 41 (40) | 0.99 | x | x | x | x | x | x |
| | 0.18 | 48 | 44 (45) | 0.71 | x | | | | | |
| | 0.14 | 54 | 47 | 0.46 | x | | | x | | |
| 375 | 0.14 | 53 | 49 (50) | 0.48 | x | | | | | |
| 355 | 0.22 | 38 | 44 | 1.07 | x | | | | | |
| | 0.18 | 44.4 | 47 | 0.77 | x | x | | x | x | |
| | 0.14 | 51 | 51 (50) | 0.50 | x | | | | | |
| 335 | 0.14 | 49.7 | 53 (54) | 0.52 | x | | | | | |
| ***315*** | 0.2 | 38 | 49 (50) | 0.99 | x | x | x | x | x | x |
| | 0.16 | 44.4 | 53 | 0.69 | x | | | | | |
| | 0.112 | 54 | 59 (60) | 0.37 | x | | | | | |
| 300 | 0.2 | 36 | 51 | 1.02 | | x | | | | |
| | 0.112 | 53 | 62 | 0.39 | x | | | | | |
| 280 | 0.22 | 31 | 51 (50) | 1.23 | x | | | | | |
| | 0.18 | 38 | 55 | 0.90 | x | x | | | | |
| | 0.112 | 51 | 65 (64) | 0.41 | x | | | | | |
| 265 | 0.1 | 52.7 | 70 | 0.35 | x | | | | | |
| ***250*** | 0.2 | 31 | 56 | 1.13 | x | | | | | |
| | 0.16 | 38 | 62 | 0.79 | x | x | x | x | x | x |
| | 0.1 | 51 | 73 (74) | 0.36 | x | | | | | |
| 236 | 0.1 | 49.3 | 76 | 0.38 | x | | | | | |
| 224 | 0.18 | 31 | 63 (64) | 1.02 | x | | | | | |
| | 0.16 | 34 | 66 | 0.85 | x | x | x | | | |
| | 0.1 | 48 | 78 (80) | 0.39 | x | | | | | |
| 212 | 0.14 | 36 | 72 | 0.71 | | x | | | | |
| | 0.09 | 49.3 | 84 | 0.34 | x | | | | | |
| ***200*** | 0.16 | 31 | 71 (70) | 0.90 | x | | | | | |
| | 0.14 | 34 | 75 | 0.73 | | x | | | | |
| | 0.125 | 38 | 78 (80) | 0.61 | x | x | x | | | |
| | 0.09 | 48 | 88 | 0.36 | x | | | | | |
| 190 | 0.09 | 46 | 91 (90) | 0.37 | x | | | | | |
| 180 | 0.14 | 31 | 79 (80) | 0.78 | x | | | | | |
| | 0.125 | 34 | 83 | 0.65 | x | x | x | | | |
| | 0.09 | 44.4 | 94 | 0.38 | x | | | | | |
| ***160*** | 0.125 | 31 | 89 (90) | 0.70 | x | | | | | |
| | 0.112 | 34 | 93 | 0.59 | x | x | | | | |
| | 0.1 | 38 | 98 (100) | 0.49 | x | x | x | | | |
| | 0.071 | 48 | 110 (105) | 0.28 | x | | | | | |

**Table 6.9 (*continued*)**

| Aperture size w | Wire diameter (mm) ddelete Open area (%) Fo | Mesh[a] | Weight[b] | Stainless steel AISI 304-316 | Phosphor bronze | Brass | Tinned steel | Galvanized steel | Plain steel |
|---|---|---|---|---|---|---|---|---|---|
| (μm) | | | | | | | | | |
| 150 | 0.1 | 36 | 102 (100) | 0.51 | x | | | | |
| 140 | 0.112 | 31 | 101 (100) | 0.63 | x | | | | |
| | 0.1 | 34 | 106 (105) | 0.53 | x | | | | |
| | 0.09 | 38 | 110 | 0.45 | x | x | x | | |
| | 0.063 | 48 | 125 (120) | 0.25 | x | | | | |
| ***125*** | 0.09 | 34 | 118 (120) | 0.48 | x | | | | |
| | 0.08 | 38 | 124 (125) | 0.40 | x | x | x | | |
| | 0.063 | 44.4 | 135 | 0.27 | x | | | | |
| 118 | 0.056 | 46 | 146 (145) | 0.23 | x | | | | |
| 112 | 0.08 | 34 | 132 (130) | 0.42 | x | | | | |
| | 0.071 | 38 | 139 (140) | 0.35 | x | x | x | | |
| 106 | 0.063 | 39.3 | 150 | 0.30 | x | | | | |
| | 0.05 | 46.2 | 163 (165) | 0.20 | x | | | | |
| ***100*** | 0.063 | 38 | 156 (150) | 0.31 | x | x | x | | |
| | 0.05 | 44.4 | 169 (165) | 0.21 | x | x | | | |
| 95 | 0.045 | 46 | 181 (180) | 0.18 | x | | | | |
| 90 | 0.063 | 34 | 166 (170) | 0.33 | x | x | | | |
| | 0.056 | 38 | 174 | 0.27 | x | | | | |
| | 0.04 | 48 | 195 (200) | 0.16 | x | | | | |
| 85 | 0.04 | 46.2 | 205 (200) | 0.16 | x | | | | |
| ***80*** | 0.056 | 34 | 187 (190) | 0.29 | x | | | | |
| | 0.05 | 38 | 195 (200) | 0.25 | x | x | | | |
| 75 | 0.05 | 36 | 205 (200) | 0.26 | x | | | | |
| | 0.036 | 45.7 | 230 | 0.15 | x | | | | |
| 71 | 0.05 | 34 | 210 | 0.26 | x | x | | | |
| ***63*** | 0.045 | 34 | 235 | 0.24 | x | x | | | |
| | 0.04 | 38 | 245 (250) | 0.20 | x | x | | | |
| | 0.036 | 41 | 255 | 0.17 | x | | | | |
| 56 | 0.04 | 34 | 265 (270) | 0.21 | x | | | | |
| | 0.036 | 38 | 275 (270) | 0.18 | x | x | | | |
| | 0.032 | 41 | 290 (300) | 0.15 | x | | | | |
| 53 | 0.04 | 32.5 | 275 (270) | 0.22 | x | | | | |
| | 0.036 | 35.5 | 285 | 0.19 | x | | | | |
| ***50*** | 0.04 | 31 | 280 | 0.23 | x | x | | | |
| | 0.036 | 34 | 295 (300) | 0.19 | x | x | | | |
| | 0.03 | 39 | 320 (325) | 0.14 | x | | | | |
| 45 | 0.036 | 31 | 315 | 0.20 | x | | | | |
| | 0.032 | 34 | 330 | 0.17 | x | x | | | |
| 42 | 0.036 | 29 | 325 | 0.21 | x | x | | | |
| ***40*** | 0.032 | 31 | 355 (350) | 0.18 | x | x | | | |
| | 0.025 | 38 | 390 (400) | 0.12 | x | | | | |
| 38 | 0.025 | 36.4 | 405 (400) | 0.13 | x | | | | |
| 36 | 0.028 | 31 | 395 (400) | 0.16 | x | x | | | |
| ***32*** | 0.025 | 31 | 445 (450) | 0.14 | x | | | | |
| ***25*** | 0.025 | 25 | 510 | 0.16 | x | | | | |
| ***20*** | 2.02 | 25 | 635 | 0.13 | x | | | | |

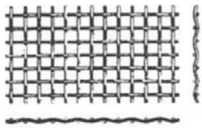
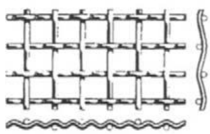
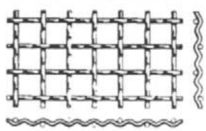
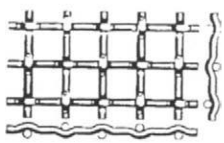
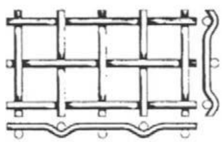
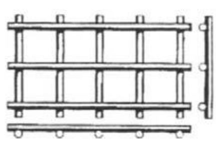
[a] True mesh count, in parentheses approximate mesh count.

[b] Calculated with a density of 7.85 for steel; please multiply by 1.01 for stainless steel, by 1.125 for phosphor bronze, by 1.083 for brass CuZn 37.

either the warp alone or both warp and weft composed of six strands of wire twisted around a core (known as a 'cable wire'). Another example is 'triple warp weave', with three wires twisted to form the warp of a plain weave: this is used for producing very thin papers.

The differences in weave affect the surface and depth structure of the resultant cloths and consequently also their performance characteristics in filtration, including their resistance to flow. For example, certain weaves favour surface filtration and facilitate cleaning by back washing, whilst others achieve higher particle retention efficiencies by utilizing depth filtration. Some of these factors are summarized in Table 6.11, while an overview of the relative retention characteristics of 'Minimesh' wire cloths is provided by Table 6.12. More detailed data in respect of the retention rating and permeability of the different weaves are given in Tables 6.13–6.17.

**Table 6.10 Types of crimp in weaving wire screens to DIN 4192 and ISO 4783/3[a]**

| Type | Destination | Comments | |
|---|---|---|---|
| A | Double crimp | The rough surface on both sides permits a very intensive screening of the material, thus resulting in high grain accuracy. |  |
| B | Single intermediate crimp | Plain warp wires, weft wires with intermediate crimps between wire intersections. |  |
| C | Double intermediate crimp | Warp and weft wires with intermediate crimps. This type of weave is used for relatively thin wires or for oblong or slot mesh screens. |  |
| D | Lock crimp | Warp and weft pre-crimped on both sides, thus locking the wires securely in place. This type offers a uniform aperture during the service life of the screen. |  |
| E | Flat top screen | Wires are pre-crimped on one side only, leaving the other side flat. This minimizes friction on delicate feed material. Wear is equal over the whole upper surface of the screen. |  |
| F | Pressure welded screen | Made from manganese steel wires and immovably locked together by pressure welding. The intersections remain in place until the wires are completely worn. |  |

[a] Haver & Boecker.

In Tables 6.13–6.17 air permeabilities are expressed as values of the factors $Y$ and $M$, for use with the following equation:

$$P = YV + MV^2$$

where $P$ = pressure difference across wire cloth ($10^{-3}$ mbar); $V$ = flow velocity of atmospheric air at 20°C (cm/s). This simple relationship may be adapted for the flow of other fluids (excluding non-Newtonian fluids such as polymer melts) by multiplying the calculated pressure difference $P$ by the ratio of the viscosities of the fluid and air:

$$P_{fluid} = P \times (\text{viscosity of fluid})/(\text{viscosity of air})$$

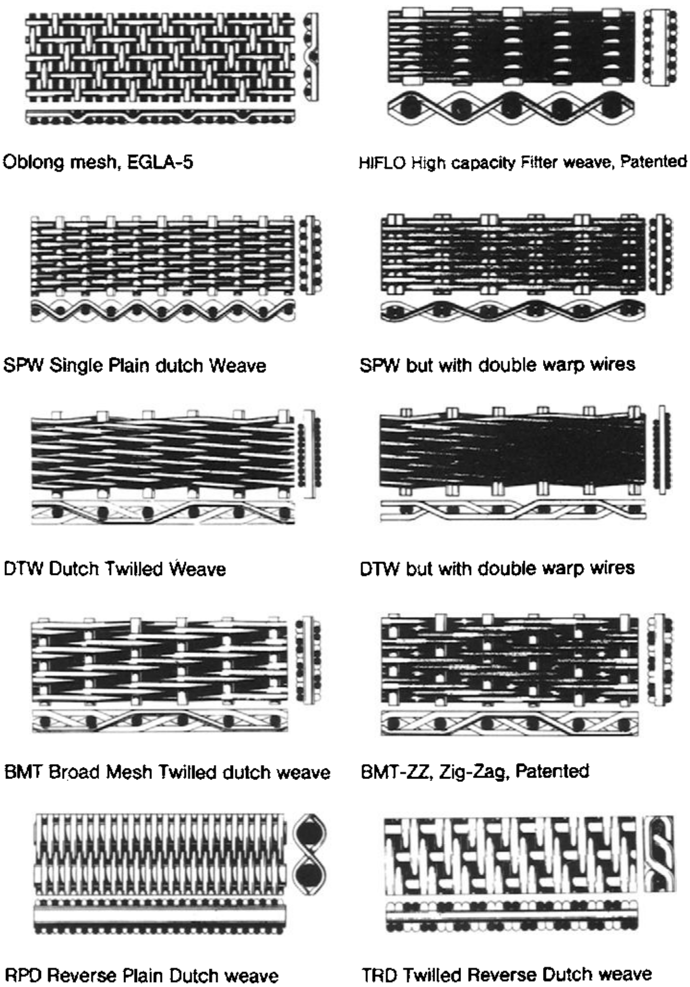



*Figure 6.2. Examples of weaves of 'Minimesh' metal filter cloths.*

### 6.2.3 Composite mesh-based media

The term 'composite' implies the combination of different types of material into one filter medium. The different types would be assembled to give different filtration characteristics or extra strength (or both). Woven wire mesh is an excellent material for use in composite media, because of its strength, especially with larger wire diameters. Thus it is used to support delicate screens in basket centrifuges, and cloth belts in belt presses.

When used in combination with other wire meshes and sintered, a very good filter medium is produced – discussed later in this chapter – while meshes are also used to support metal membrane media – discussed further in Chapter 8.

An interesting composite medium, recently developed by GKD, is the 'Ymax' mesh–fibre composite. This has the basic strength of a wire mesh surface filter combined with the depth filtration characteristics of bundles of fibres. The basic mesh is woven from single wires, 0.1–7.0 mm in diameter, and this is interwoven by bundles of non-twisted finer wires. These, in hundreds per bundle, are 5–30 μm in diameter.

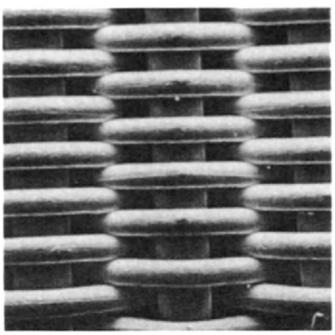


*Figure 6.3. Plain dutch weave.*

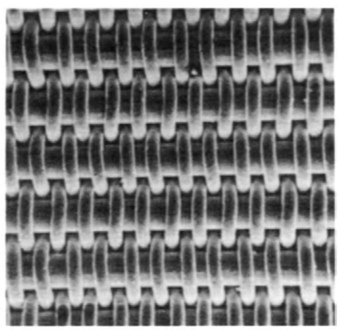


*Figure 6.4. Reverse plain dutch twill.*

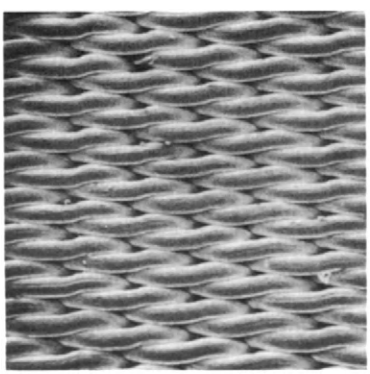


*Figure 6.5. Dutch twilled weave.*

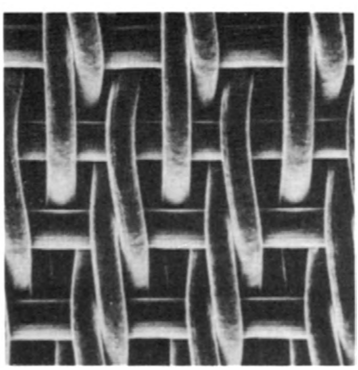


*Figure 6.6. Twilled reverse dutch weave.*

The material acts like a zero aperture mesh, in that there are no large pores between the basic wires. Larger particles are held on the surface, while smaller ones pass into the depth of the fibre bundles. The medium has porosities up to 60%, with retention figures from 3 to 100 μm. Ymax, available as single pieces up to 3.5 m wide, and 20 m long, is non-compressible, thus maintaining the integrity of pore size and filtration efficiency. Its cost is said to be comparable with that of metal fibre or powder media.

### *6.2.4 Sintered mesh*

Sintered wire mesh refers here to any material, made basically from woven wire mesh, that has been sintered at a temperature sufficient to cause localized melting at the contact points between warp and weft wires. The applied heat and pressure during the sintering process allows some localized molecular diffusion between the wires such that, when cooled, the structure has become much more rigid. This adds considerably to the value of the material as a filtration medium, and overcomes one of the main problems of wire mesh as a filter medium, its inability to withstand fatigue in operation.

Unsintered woven wire meshes suffer from instability, with relative movement or deformation of the wires, resulting from the stresses imposed by vibration, pulsating flow or high differential pressure. This can result in the deterioration of the rated filtration efficiency; abrasion of the wires and the consequent generation of metal particles that contaminate the material being filtered; the unloading of previously trapped particles into the filtrate; and structural failure.

These problems can be avoided by sintering the mesh, so greatly increasing the rigidity of the mesh, producing an extremely strong structure that is resistant to deformation. Sintering also enables the use of finer wires, leading to a higher open area, with a consequential decrease in resistance to flow, and an increase in dirt-holding capacity. Sintered media also have the great advantage that they can be cut and shaped without risk of local disintegration, in a way not possible with unsintered meshes.

The key feature of sintered wire mesh is that it involves one layer of woven mesh (and occasionally two) to act as the filtration medium, with others, where necessary, to give the whole medium adequate stiffness and mechanical support.

**Table 6.11 Influence of weave on cloth characteristics[a]**

| | SPW | HIFLO[R] | DTW | BMT | BMT ZZ | RPD | TRD |
|---|---|---|---|---|---|---|---|
| Surface filtration | ● | ● | ● | | | ● | |
| Depth filtration | | | ● | ● | ● | ● | ● |
| Surface smooth on both sides | | | ● | ● | ● | | |
| Macroscopic surface unevenness | ● | ● | | | | ● | ● |
| Higher tensile strength – wrap | | | | | | ● | ● |
| Higher tensile strength – weft | ● | ● | ● | ● | ● | | |
| Easy cleaning by backwashing | ● | ● | | | | ● | |

[a] Haver & Boecker.

**Table 6.12 Micron retention**[a] of 'Minimesh' metal filter cloths[b]

| 1<br>Micron retention[a] (μm) | 2<br>Square mesh ISO 565 DIN 4189 w (mm) | 3<br>Weave USA mesh | 4<br>DTW mesh | 5<br>BMT MBT ZZ mesh | 6<br>SPW mesh | 7<br>HIFLO® HB-code | 8<br>RPD TRD HB-code | 9<br>SPW+ DTW twin warp | 1<br>Micron retention (μm) |
|---|---|---|---|---|---|---|---|---|---|
| 2 | | | 510×3600 | | | | | | 2 |
| 3 | | | | | | | | | 3 |
| 4 | | | 400×2800 | | | | | | 4 |
| 5 | | | | | | | | | 5 |
| 6 | | | 375×2300 | | | | | | 6 |
| 8 | | | 325×2300 | 325×1900 ZZ | | | | | 8 |
| 10 | | | 250×1400 | | | | | 2/198× 1700 DTW 2W 10 | 10 |
| 11 | | | | | | | | | 11 |
| 12 | | | 200×1400 | 325×1600 ZZ | | | | | 12 |
| 14 | | | | | | | | | 14 |
| 15 | | | | 250×1250 ZZ | | | RPD 15 | | 15 |
| 16 | | | | | | | | | 16 |
| 17 | | | | | | | RPD 17 | | 17 |
| 18 | | | 165×1400 | | | | | | 18 |
| 20 | | 635 | 165×1100 | | | Hiflo 20 | | | 20 |
| 22 | | | | 200×1200 | | | | | 22 |
| 23 | | | | 200×900 ZZ | | | | | 23 |
| 25 | 0.025 | 500 | | | | Hiflo 25 | RPD 25 | | 25 |
| 28 | 0.028 | | | 165×800 ZZ | | | | | 28 |
| 30 | | | | | | Hiflo 30 | | | |
| 32 | 0.032 | 450 | | 200×600 ZZ | | | | | 32 |
| 34 | | | | | 80×300 | | | | 34 |
| 36 | 0.036 | | 80×700 | | | Hiflo 36 | | | 36 |
| 38 | | 400 | | | | | | | 38 |
| 40 | 0.040 | | | 120×600 | 80×400 | Hiflo 40 | RPD 40 | | 40 |
| 45 | 0.045 | 325 | | | | Hiflo 45 | | 2/50× 250 SPW 2W 45 | 45 |
| 50 | 0.050 | | | 120×400 | | Hiflo 50 | | | 50 |
| 53 | | 270 | | | | | | | 53 |
| 56 | 0.056 | | | | | | | | 56 |
| 60 | | | | | | | RPD 60 | | 60 |
| 63 | 0.063 | 230 | | | 50×250 | | | | 63 |
| 70 | | | | | | Hiflo 70 | | | 70 |
| 71 | 0.071 | | 40×560 | | 50×280 | | | | 71 |

**Table 6.12 (*continued*)**

| 1 Micron retention[a] (µm) | 2 Square mesh ISO 565 DIN 4189 w (mm) | 3 Weave USA mesh | 4 DTW mesh | 5 BMT MBT ZZ mesh | 6 SPW mesh | 7 HIFLO[b] HB-code | 8 RPD TRD HB-code | 9 SPW+ DTW twin warp | 1 Micron retention (µm) |
|---|---|---|---|---|---|---|---|---|---|
| 75 | | 200 | | | 40×200 | | TRD | 2/24× 128 | |
| | | | | | | | 75 | SPW 2W 75 | 75 |
| 80 | 0.080 | | | | | | RPD | 2/30× 150 | |
| | | | | | | | 80 | SPW 2W 80 | 80 |
| 85 | | | | | | | RPD 85 | | 85 |
| 90 | 0.090 | 170 | | | | | RPD | 3/12× 250 | 90 |
| | | | | | | | 90 | DTW 3W 90 | |
| 95 | | | 30×360 | | | | | | 95 |
| 100 | 0.10 | | | | 30×150 | | | 3/12× 200 DTW 3W 100 | 100 |
| 106 | | 140 | 20×260 | | | | | | 106 |
| 112 | 0.112 | | 28×500 | | | | | | 112 |
| 118 | | | 24×300 | | | | | | 118 |
| 125 | 0.125 | 120 | | | 24×110 | | TRD 125 | | 125 |
| 140 | 0.14 | | | | | | | | 140 |
| 150 | | 100 | | | | | | | 150 |
| 160 | 0.16 | | | | 20×160 | | | | 160 |
| 180 | 0.18 | 80 | | | | | | | 180 |
| 200 | 0.20 | | | | 16×120 | | | | 200 |
| 212 | | 70 | | | | | | | 212 |
| 224 | 0.224 | | | | | | | | 224 |
| 240 | | | | | 14×110 | | | | 240 |
| 250 | 0.25 | 60 | | | | | | | 250 |

[a] The (absolute) micron retention is the diameter of the largest round particle just passing through the cloth. It can be determined by Glass Bead Test or Bubble Point Test or calculated theoretically.
[b] Haver & Boecker.

It is not normally intended that a multi-layer sintered material should act as a depth filter – surface (and/or cake) filtration is the aim.

In its simplest form, a single layer of wirecloth, intended probably to be pleated for inclusion in a filter cartridge, will be sintered in order to guarantee that the spacings between the wires will not change during the pleating process. This is a very common use of sintering for wire mesh, with the pleated construction

**Table 6.13 SPW (single plain dutch weave) filter cloths[a]**

| HB-code | Nominal mesh count | Micron retention | | Equation factors for permeability performance | | Tensile strength[b] | | Weight[c] (kg/m$^2$) | Cloth thickness (mm) |
|---|---|---|---|---|---|---|---|---|---|
| | | Nominal (μm) | Absolute (μm) | $Y^d$ | $M^d$ | Warp wires $N$ | Weft wires $N$ | | |
| SPW 34 | 80×300 | 25 | 32–36 | 3.78 | 0.06796 | 330 | 460 | 0.98 | 0.25 |
| SPW 40 | 80×400 | 36 | 36–45 | 1.60 | 0.04908 | 310 | 430 | 0.82 | 0.23 |
| SPW 45 | 2/50×250 | 30 | 42–48 | 8.88 | 0.04369 | 310 | 670 | 1.15 | 0.31 |
| SPW 63 | 50×250 | 40 | 56–63 | 4.38 | 0.01851 | 310 | 640 | 1.00 | 0.32 |
| SPW 71 | 50×280 | 45 | 71–75 | 4.39 | 0.01530 | 310 | 680 | 1.00 | 0.32 |
| SPW 75 | 40×200 | 56 | 75–80 | 3.86 | 0.01297 | 320 | 730 | 1.30 | 0.40 |
| SPW 100 | 30×150 | 63 | 100–112 | 3.83 | 0.00905 | 420 | 870 | 1.60 | 0.50 |
| SPW 125 | 24×110 | 80 | 112–125 | 1.79 | 0.02748 | 930 | 1600 | 2.70 | 0.67 |
| SPW 140 | 22×140 | | 140–170 | 2.13 | 0.02561 | 570 | 980 | 2.10 | 0.66 |
| SPW 160 | 20×160 | | 160–180 | 3.57 | 0.00511 | 300 | 870 | 1.55 | 0.50 |
| SPW 180 | 20×150 | | 170–190 | 3.21 | 0.00621 | 260 | 1100 | 1.60 | 0.55 |
| SPW 200 | 16×120 | | 200–210 | 3.68 | 0.00019 | 280 | 1320 | 1.95 | 0.64 |
| SPW 240 | 14×110 | | 220–240 | 3.02 | 0.02103 | 390 | 1500 | 2.15 | 0.72 |
| SPW 250 | 12×95 | | 240–260 | 3.81 | 0.00053 | 330 | 1440 | 2.30 | 0.79 |
| SPW 260 | 14×88 | | 280–300 | 2.99 | 0.00300 | 640 | 1650 | 3.15 | 0.76 |
| SPW 280 | 10×90 | | 270–290 | 3.16 | 0.01701 | 510 | 1750 | 2.50 | 0.93 |
| SPW 300 | 12×64 | | 280–300 | 3.66 | 0.00026 | 750 | 2620 | 4.10 | 1.21 |
| SPW 360 | 8×85 | | 330–350 | 3.11 | 0.00174 | 400 | 2100 | 2.50 | 0.93 |

[a] Haver & Boecker.
[b] Tensile strength in Newtons for a 10 mm wide strip.
[c] Weight is for stainless steel, density 1.4301.
[d] Calculate permeability values from $Y$ and $M$ factors using equations in text.

**Table 6.14 Patented HIFLO high capacity filter cloth[a]**

| HB-code | Nominal mesh count | Micron retention | | Equation factors for permeability performance | | Tensile strength[b] | | Weight[c] (kg/m²) | Cloth thickness (mm) |
|---|---|---|---|---|---|---|---|---|---|
| | | Nominal (µm) | Absolute (µm) | $Y^{d}$ | $M^{d}$ | Warp wires N | Weft wires N | | |
| HIFLO® 20 | 165×1100 | n/a | 19–20 | 9.84 | 0.02925 | 88 | 137 | 0.29 | 0.093 |
| HIFLO® 25 | 80×1020 | n/a | 20–25 | 13.31 | 0.00733 | 160 | 251 | 0.49 | 0.165 |
| HIFLO® 30 | 80×820 | n/a | 28–30 | 7.99 | 0.00657 | 152 | 182 | 0.41 | 0.158 |
| HIFLO® 36 | 80×700 | n/a | 34–36 | 10.00 | 0.00090 | 251 | 204 | 0.60 | 0.210 |
| HIFLO® 40 | 80×525 | n/a | 38–40 | 5.27 | 0.01562 | 182 | 270 | 0.53 | 0.186 |
| HIFLO® 45 | 70×450 | n/a | 42–45 | 4.91 | 0.02323 | 329 | 345 | 0.80 | 0.240 |
| HIFLO® 50 | 53×480 | n/a | 48–50 | 3.14 | 0.02225 | 188 | 296 | 0.72 | 0.250 |
| HIFLO® 70 | 53×380 | n/a | 67–70 | 2.11 | 0.12525 | 200 | 335 | 0.82 | 0.260 |

[a] Haver & Boecker.
[b] Tensile strength in Newtons for a 10 mm wide strip.
[c] Weight is for stainless steel, density 1.4301.
[d] Calculate permeability values from *Y* and *M* factors using equations in text.

**Table 6.15 Dutch twill weave (DWT) metal filter cloth[a]**

| HB-code | Nominal mesh count | Micron retention | | Equation factors for permeability performance | | Tensile strength[b] | | Weight[c] ($kg/m^2$) | Cloth thickness (mm) |
|---|---|---|---|---|---|---|---|---|---|
| | | Nominal (µm) | Absolute (µm) | $Y^d$ | $M^d$ | Warp wires N | Weft wires N | | |
| DTW 2 | 510×3600 | <1 | 4–5 | 263.17 | 0.02525 | 92 | 250 | 0.30 | 0.06 |
| DTW 4 | 400×2800 | <1 | 5–6 | 231.47 | 0.22829 | 75 | 335 | 0.36 | 0.06 |
| DTW 6 | 375×2300 | 1 | 6–7 | 210.93 | 0.07449 | 150 | 320 | 0.39 | 0.08 |
| DTW 8 | 325×2300 | 2 | 7–8 | 172.55 | 0.15155 | 140 | 330 | 0.47 | 0.09 |
| DTW 9 | 260×1550 | 3 | 8–10 | 151.0 | 0.18407 | 200 | 420 | 0.68 | 0.12 |
| DTW 10 | 250×1400 | 4 | 11–12 | 126.93 | 0.15665 | 190 | 480 | 0.68 | 0.12 |
| DTW 12 | 200×1400 | 5 | 11–13 | 84.85 | 0.11646 | 220 | 480 | 0.75 | 0.14 |
| DTW 14 | 130×700 | 8 | 13–15 | 168.33 | 0.49690 | 390 | 640 | 1.60 | 0.28 |
| DTW 16 | 200×1120 | 9 | 15–17 | 127.17 | 0.21465 | 240 | 600 | 0.95 | 0.16 |
| DTW 18 | 165×1400 | 10 | 15–18 | 44.08 | 0.07645 | 200 | 510 | 0.70 | 0.15 |
| DTW 20 | 165×1100 | 12 | 20–21 | 68.19 | 0.11284 | 220 | 620 | 0.90 | 0.16 |
| DTW 36 | 80×700 | 25 | 34–36 | 25.81 | 0.10202 | 210 | 860 | 1.20 | 0.26 |
| DTW 71 | 40×560 | 50 | 71–80 | 13.91 | 0.06452 | 240 | 1300 | 1.70 | 0.39 |
| DTW 95 | 30×360 | 80 | 95–106 | 6.12 | 0.02134 | 560 | 1650 | 2.60 | 0.54 |
| DTW 100 | 30×250 | 53 | 100–112 | 1.60 | 0.17216 | 520 | 2340 | 3.20 | 0.65 |
| DTW 106 | 20×260 | 100 | 110–120 | 2.16 | 0.11361 | 290 | 2200 | 3.10 | 0.67 |
| DTW 112 | 28×500 | 85 | 106\426–112 | 1.06 | 0.01124 | 550 | 1420 | 1.95 | 0.46 |
| DTW 118 | 24×300 | 90 | 112\426–118 | 1.80 | 0.12094 | 390 | 2040 | 2.85 | 0.63 |

[a] Haver & Boecker.
[b] Tensile strength in Newtons for a 10 mm wide strip.
[c] Weight is for stainless steel, density 1.4301.
[d] Calculate permeability values from *Y* and *M* factors using equations in text.

**Table 6.16 Broad mesh twilled weave (BMT) and BMT Zig-Zag filter cloth[a]**

| HB-code | Nominal mesh count | Micron retention | | Equation factors for permeability performance | | Tensile strength[b] | | Weight[c] ($kg/m^2$) | Cloth thickness (mm) |
|---|---|---|---|---|---|---|---|---|---|
| | | Nominal (µm) | Absolute (µm) | $Y^d$ | $M^d$ | Warp wires N | Weft wires N | | |
| BMT 8 ZZ | 325×1900 | 6 | 6–8 | 85.63 | 0.09000 | 135 | 195 | 0.43 | 0.092 |
| BMT 12 ZZ | 325×1600 | 8 | 10–12 | 73.82 | 0.07341 | 120 | 245 | 0.45 | 0.094 |
| BMT 15 ZZ | 250×1250 | 12 | 13–15 | 42.72 | 0.07337 | 200 | 350 | 0.64 | 0.120 |
| BMT 22 | 200×1200 | 14 | 20–22 | 41.17 | 0.02134 | 240 | 420 | 0.71 | 0.140 |
| BMT 23 | 200×900 | 16 | 22–24 | 21.73 | 0.02699 | 160 | 460 | 0.64 | 0.140 |
| BMT 23 ZZ | 200×900 | 16 | 22–24 | 10.12 | 0.01762 | 195 | 440 | 0.64 | 0.148 |
| BMT 28 | 165×800 | 15 | 24–28 | 11.02 | 0.03468 | 200 | 430 | 0.71 | 0.160 |
| BMT 28 ZZ | 165×800 | 15 | 24–28 | 10.04 | 0.02116 | 205 | 350 | 0.71 | 0.170 |
| BMT 32 | 200×600 | 20 | 28–32 | 9.84 | 0.01816 | 170 | 290 | 0.50 | 0.150 |
| BMT 32 ZZ | 200×600 | 20 | 28–32 | 9.38 | 0.01721 | 105 | 180 | 0.50 | 0.144 |
| BMT 40 | 120×600 | 28 | 38–42 | 2.29 | 0.03504 | 270 | 450 | 0.90 | 0.230 |
| BMT 50 | 120×400 | 32 | 48–53 | 1.07 | 0.00048 | 290 | 400 | 0.75 | 0.240 |

[a] Haver & Boecker.
[b] Tensile strength in Newtons for a 10 mm wide strip.
[c] Weight is for stainless steel, density 1.4301.
[d] Calculate permeability values from *Y* and *M* factors using equations in text.

**Table 6.17 Reverse plain dutch weave (RPD) & twilled reverse dutch (TRD) cloths[a]**

| HB-code | Nominal mesh count | Micron retention | | Equation factors for permeability performance | | Tensile strength[b] | | Weight[c] ($kg/m^2$) | Cloth thickness (mm) |
|---|---|---|---|---|---|---|---|---|---|
| | | Nominal (µm) | Absolute (µm) | $Y^d$ | $M^d$ | Warp wires N | Weft wires N | | |
| RPD 15 | 720×150 | 15 | 16–20 | 35.63 | 0.01726 | 240 | 400 | 0.65 | 0.15 |
| RPD 17 | 630×130 | 17 | 20–24 | 30.95 | 0.02967 | 210 | 480 | 0.85 | 0.22 |
| RPD 25 | 600×100 | 25 | 34–38 | 10.14 | 0.01751 | 220 | 440 | 0.80 | 0.23 |
| RPD 40 | 290×75 | 40 | 53–58 | 12.94 | 0.03460 | 540 | 700 | 1.55 | 0.40 |
| RPD 60 | 175×50 | 60 | 67–75 | 8.29 | 0.03479 | 570 | 1200 | 2.40 | 0.57 |
| TRD 75 | 400×120 | 75 | 75–80 | 4.00 | 0.00520 | 360 | 230 | 0.73 | 0.24 |
| RPD 80 | 130×35 | 80 | 95–105 | 8.25 | 0.01614 | 860 | 1250 | 3.10 | 0.77 |
| RPD 85 | 175×37 | 85 | 100–106 | 3.81 | 0.00255 | 780 | 720 | 2.10 | 0.57 |
| RPD 90 | 170×40 | 90 | 106–118 | 4.03 | 0.01569 | 890 | 770 | 2.10 | 0.57 |
| TRD 125 | 260×40 | 125 | 112–125 | 1.12 | 0.16700 | 2220 | 580 | 2.25 | 0.62 |
| RPD 400 | 84×14 | | 450–530 | 0.33 | 0.01028 | 1630 | 1160 | 3.50 | 1.15 |
| TRD 400 | 132×17 | | 400–450 | 1.00 | 0.01686 | 6700 | 750 | 4.65 | 1.35 |
| RPD 500 | 80×14 | | 560–630 | 0.10 | 0.01123 | 1550 | 1160 | 3.40 | 1.18 |
| TRD 500 | 72×15 | | 500–600 | 0.02 | 0.01567 | 55 220 | 770 | 6.35 | 1.85 |

[a] Haver & Boecker.
[b] Tensile strength in Newtons for a 10 mm wide strip.
[c] Weight is for stainless steel, density 1.4301.
[d] Calculate permeability values from *Y* and *M* factors using equations in text.

allowing the packing of quite a large filtration area into a relatively small filter volume, as with papers or non-woven media.

A single-layer sintered mesh is essentially a surface filtration medium. However, depending on the gauge of the wires, and the weave, relatively high dirt-holding capacities may be achieved. Typical of these materials are Pall's range of Rigimesh media, the characteristics of which are summarized in Table 6.18. Higher dirt-holding capacities, and hence longer on-stream times, may be obtained by using laminates of several meshes with decreasing aperture sizes in the direction of filtrate flow, so that the resultant composite medium acts as a depth filter.

The best-known format for sintered wire mesh is the laminated form, which permits the construction of fine-pore surface filtration media of very high mechanical strength. A five-layer version is supplied by several companies, typically under a '. . .plate' brand name (indicative of its stiffness). However, laminated sintered wirecloth is available with any number of layers of material that the end-user cares to specify, from 2 to as many as 20, depending on whether the objective is give mechanical strength and rigidity to a very fine mesh, or to increase the dirt-holding capacity in depth filtration applications.

The standard five-layer format consists of a coarse top layer to protect the second layer, which is the actual filter medium. This will normally be a fine mesh, with apertures as small as a few micrometres. Below the filtering mesh will be a layer of coarser mesh to act as a flow distribution device, and below this will be two layers of much coarser mesh to act as support for the whole medium, as exemplified by Bopp's Poremet material, illustrated in cross-section in Figure 6.7. The supporting

**Table 6.18 Pall 'Rigimesh' and 'Supramesh' sintered metal media**

| Media grade | Micron removal rating | | | | Nominal standard thickness (mm) | Permeability[c] | |
|---|---|---|---|---|---|---|---|
| | Liquid service[a] | | Gas service[b] | | | to air | to water |
| | 98% | 100% | 98% removal by weight | 100% removal | | | |
| *Supramesh Z* | 1.5 | 15 | 0.5 | 2 | 0.28 | 147 | 1.8 |
| *Rigimesh* | | | | | | | |
| K | 5 | 18 | 3.5 | 13 | 0.15 | 520 | 84 |
| J | 10 | 25 | 6 | 18 | 0.15 | 1524 | 98 |
| M | 17 | 45 | 11 | 25 | 0.15 | 2456 | 118 |
| R | 40 | 70 | 30 | 55 | 0.28 | 4912 | 295 |
| S | 70 | 105 | 50 | 85 | 0.25 | 8038 | 393 |
| T | 145 | 225 | 120 | 175 | 0.3 | –[d] | –[d] |
| A | 300 | 450 | 250 | 350 | 0.48 | –[d] | –[d] |

[a] Using AC dusts in water, efficiency measured by particle count.
[b] Based on AC FineTest Dust in air. Absolute retention rating based on particle count data.
[c] $l/dm^2\ min^{-1}$ @ 10 mbar pressure drop.
[d] Properties not readable.

meshes enable the filtration to be carried out under a pressure differential across the medium that the filtering layer on its own would be unable to contain.

Poremet is available in a range of nominal filtration ratings from 2 to 60 µm, which correspond to absolute (i.e. glass bead challenge ratings) of 5–75 µm. Technical data for these media are given in Table 6.19, while air and water flow rates are given in Figures 6.8 and 6.9, against pressure drop (these figures include curves for Bopp's other, more open, medium Absolta).

Sintered wire mesh is normally produced from stainless steels (304L and 316L being the most popular forms), but other metals are also available, such as phosphor bronze, while more exotic alloys, such as Hastelloy, can be supplied.

The five-layer format is quite stiff, and capable of supporting itself in quite large dimensions. It can also be machined and shaped like solid metal plate, and is available as tubes and as cylindrical cartridges.

A different form of composite combines sintered woven mesh with a layer of powder or fibre sinter-bonded to the upstream surface. An example of this is Pall's Supramesh Z, data for which are included in Table 6.18.

A sophisticated variant of this last type of composite provides the basis of Pall's PMM range of metal membranes, which are discussed further in Chapter 8.

### 6.2.5 Knitted mesh

By contrast with the structural forms produced by the weaving of filaments, knitting results in a mesh structure of asymmetrical interlocking loops as illustrated schematically in Figure 6.10. The knitted mesh emerges continuously from the machine as a stocking or flattened tube, and is thus a double-layered strip typically in widths up to 635 mm (Figure 6.11). This may then be subjected to a series of subsequent operations to form it into thick rigid pads for use either in filtration, notably as demisters, or in coalescers.

Meshes are knitted from one of, or a combination of, a wide variety of materials, including metals such as galvanized steel, stainless steels, aluminium, copper, nickel and its alloys, as well as polypropylene and fluorocarbon polymers. Filaments are generally circular in section, with diameters in the range 0.1–0.3 mm; a flattened section is possible with synthetic filaments, which increases the surface area.

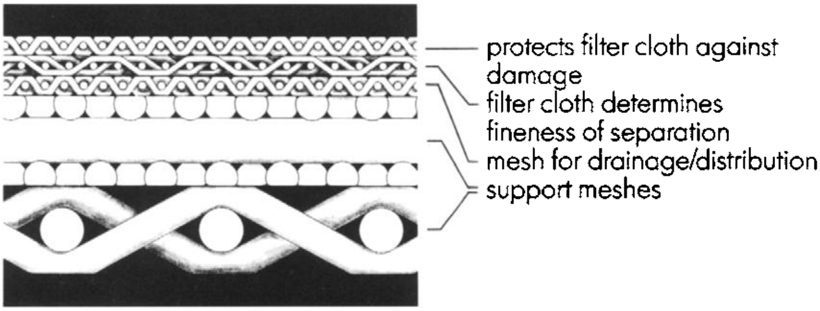



*Figure 6.7. Section through 'Poremet' multilayer media.*

Although much of the discussion in this section relates to mesh knitted from metal wire, the text can largely be taken to refer also to plastic filament meshes, especially in the comments about the need for plastic mesh in the coalescing of dispersed organic liquids.

Knitted mesh is generally specified by the number of stitches per centimetre in the two directions, along and across the machine (A and B in Table 6.20 – which includes plastic as well as metal meshes), with 1–6 being the most widely used. The stitch can be lengthened or shortened during knitting, while the mesh can be stretched lengthways to produce a narrower stocking with longer and thinner stitches, or opened out to form a wider stocking with a shorter and wider stitch. Crimping, which may be either diagonal or herringbone, increases both the thickness and the stiffness of the mesh; it also increases the free volume and reduces the resistance to airflow.

Filter elements are formed from multiple layers of crimped or uncrimped mesh by laying, folding, rolling and (where appropriate), compressing the layers. Exploitation of the variables outlined above permits the manufacture of a very wide range of different grades, with surface areas per $m^3$ extending from about 100 $m^2$ to more than 4000 $m^2$, with free volumes from 75 to 99.5%. Examples of rolls of uncrimped and crimped mesh and of some elements are shown in Figure 6.12.

#### *6.2.5.1 Demisters*

The particular use of knitted mesh in filtration is the removal of suspended liquid droplets in either a gas or a liquid stream. The structure of the mesh enables the captured droplets to coalesce into larger drops and then to drain out of the filter mass. The process is called demisting when done in the gas phase.

**Table 6.19 Technical data for Bopp 'Poremet' multilayer media**

| Poremet | Filter rating (μm) | | Thickness (mm) | $\tau_S$ [c] (N/mm²) | $\sigma_B$ [d] (%) | Elongation (N/mm²) | $\sigma_S$ [e] (%) | Space void (g/dm²) | Weight |
|---|---|---|---|---|---|---|---|---|---|
| | Nominal[a] | Absolute[b] | | | | | | | |
| 2 | <2 | 5 | | | | | | | |
| 5 | 5 | 10 | | | | | | | |
| 10 | 10 | 15 | 1.6–2.0 | 220–230 | | | | | |
| 15 | 15 | 20 | | | | | | | |
| 20 | 20 | 25 | | | 100–130 | 10–15 | 55–60 | 35 | 90–92 |
| 30 | 30 | 35 | | | | | | | |
| 40 | 40 | 50 | | | | | | | |
| 50 | 50 | 60 | 1.8–2.2 | 230–240 | | | | | |
| 60 | 60 | 75 | | | | | | | |

[a] Nominal filter rating: approximate value for cake filtration.
[b] Absolute filter rating, determined by the glass beard test.
[c] Shear strength $\tau_s$ determined by stamping related to the cross.
[d] Breaking strength $\sigma_B$ sections (thickness *X*).
[e] Yield point $\sigma_s$ at 0.2% elongation stressed length.

Table 6.21 summarizes the types of standard demisters recommended by KnitMesh for various typical industrial applications. Further information is provided in Section 5.4 of Chapter 5 in the discussion of media for air and gas filters.

*6.2.5.2 Coalescers*

Pads of mesh knitted from a single material are effective in removing dispersed droplets of an insoluble or immiscible liquid from a second liquid (e.g. oil droplets

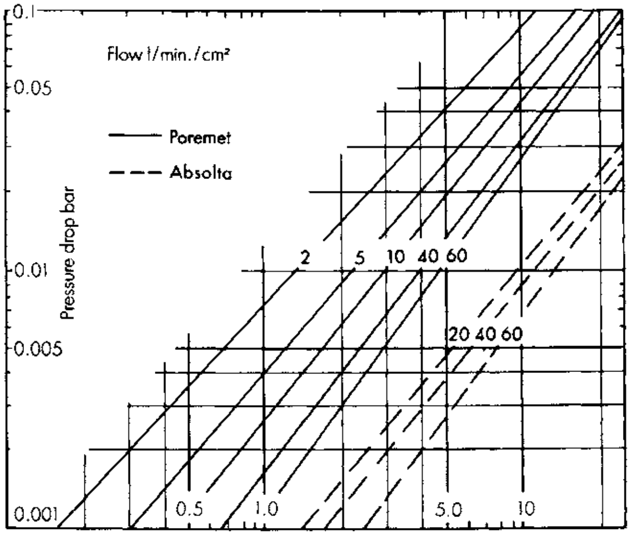



*Figure 6.8. Flow rates of air through 'Poremet' and 'Absolta' multilayer media.*

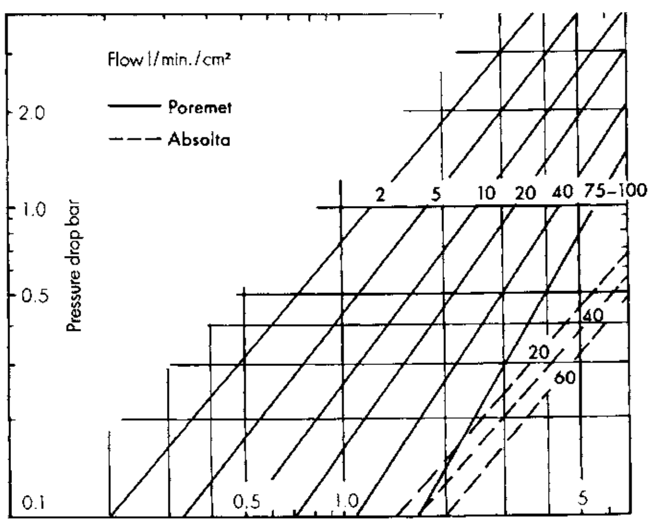



*Figure 6.9. Flow rates of water through 'Poremet' and 'Absolta' multilayer media.*

from water or water droplets from oil), provided the droplets are larger than about 30 μm. This corresponds to unstable *primary dispersions*, the two phases of which separate rapidly in the absence of agitation or shear.

The efficient functioning of a conventional coalescer of this type is dependent on the mesh filaments being preferentially wetted by the dispersed phase. This interaction between the liquid and the filament is related to the respective surface free energies, which vary considerably for different solids and liquids. Therefore, the material of the filaments must be selected to be compatible with the dispersed liquid; for example, aqueous liquids preferentially wet metals, which have high surface free energies, whereas organic liquids require filaments of low surface free energy, such as plastics.

By contrast, the KnitMesh DC coalescer combines both metal and plastic filaments in the one pad, to exploit the greatly enhanced coalescence observed to occur at 'junction points' where the two materials are in contact and produce a discontinuity of surface free energy. Variations of the filament type, filament diameter and stitch size provide a structure containing many such 'junction points'.

Advantages claimed for the KnitMesh DC coalescer include a higher separating efficiency due to the 'junction effect', as well as higher flow rates and lower pressure drops. Moreover, the coalescer can be used with either phase dispersed, so that there is no loss of performance even if phase inversion occurs. Examples of

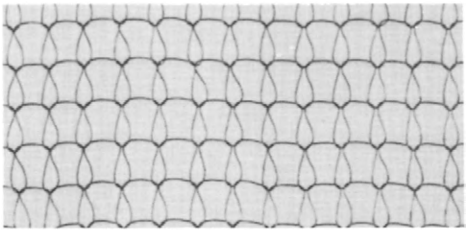


*Figure 6.10. Illustration of mesh patterns formed by knitting.*

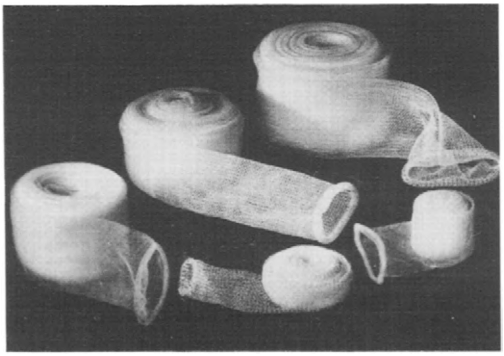


*Figure 6.11. Examples of stocking or double-layered knitted mesh.*

**Table 6.20 Examples of KnitMesh metal and plastic meshes**

| Reference no. | Diameter of wire (mm) | Width as knitted (cm) | Number of stitches/cm | |
|---|---|---|---|---|
| | | | A | B |
| *Fine mesh – metal* | | | | |
| 9002 | 0.11–0.15 | 1.6 | 3.5 | 4.4 |
| 9022 | 0.11–0.15 | 2.2 | 4.0 | 5.9 |
| 9028 | 0.11–0.15 | 6.4 | 3.5 | 3.1 |
| 9046 | 0.11–0.15 | 6.4 | 3.5 | 4.7 |
| 9035 | 0.11–0.15 | 8.3 | 4.0 | 3.4 |
| 9001 | 0.11–0.15 | 8.3 | 4.0 | 4.3 |
| 9029 | 0.11–0.15 | 13.0 | 4.0 | 5.5 |
| *Medium-fine mesh – metal* | | | | |
| 9037 | 0.15 | 3.8 | 2.8 | 3.7 |
| 9077 | 0.15 | 23.0 | 2.4 | 3.2 |
| 9059 | 0.15 | 32.0 | 2.4 | 3.1 |
| 9055 | 0.15 | 50.0 | 2.4 | 4.2 |
| *Standard mesh – metal* | | | | |
| 9017 | 0.25–0.28 | 5.4 | 1.6 | 1.9 |
| 9043 | 0.25–0.28 | 5.7 | 1.6 | 2.1 |
| 9041 | 0.25–0.28 | 13.7 | 1.6 | 1.5 |
| 9033 | 0.25–0.28 | 14.3 | 2.0 | 1.8 |
| 9056 | 0.25–0.28 | 23.0 | 2.0 | 1.8 |
| 9030 | 0.25–0.28 | 32.0 | 2.0 | 1.8 |
| 9063 | 0.25–0.28 | 40.0 | 2.0 | 1.7 |
| 9052 | 0.25–0.28 | 50.0 | 2.0 | 1.6 |
| *Coarse mesh – metal* | | | | |
| 9039 | 0.25–0.28 | 17.0 | 1.6 | 0.74 |
| 9057 | 0.25–0.28 | 23.0 | 1.6 | 0.90 |
| 9036 | 0.25–0.28 | 35.0 | 1.6 | 0.80 |
| 9066 | 0.25–0.28 | 40.0 | 1.6 | 0.85 |
| 9054 | 0.25–0.28 | 50.0 | 1.6 | 0.80 |
| *Fine mesh – plastic and fibre* | | | | |
| 9029 | 0.13 | 12.0 | 5.0 | 6.0 |
| 9062 | 0.13 | 14.0 | 6.7 | 4.3 |
| 9059 | 0.13 | 36.0 | 2.7 | 2.8 |
| *Standard mesh – plastic and fibre* | | | | |
| 9017 | 0.25 | 5.0 | 1.7 | 2.0 |
| 9040 | 0.25 | 12.0 | 1.7 | 1.7 |
| 9003 | 0.25 | 14.0 | 1.9 | 1.8 |
| 9030 | 0.25 | 36.0 | 1.9 | 1.6 |
| 9063 | 0.25 | 43.0 | 1.9 | 1.6 |
| 9052 | 0.25 | 55.0 | 1.9 | 1.5 |
| 9045 | 0.25 | 70.0 | 1.9 | 1.4 |
| *Coarse mesh – plastic and fibre* | | | | |
| 9039 | 0.25 | 13.0 | 1.6 | 1.0 |
| 9036 | 0.25 | 33.0 | 1.6 | 0.9 |
| 9049 | 0.25 | 64.0 | 1.6 | 0.8 |
| *Extra coarse mesh – plastic and fibre* | | | | |
| 9049 | 0.25 | 31.0 | 1.6 | 0.6 |

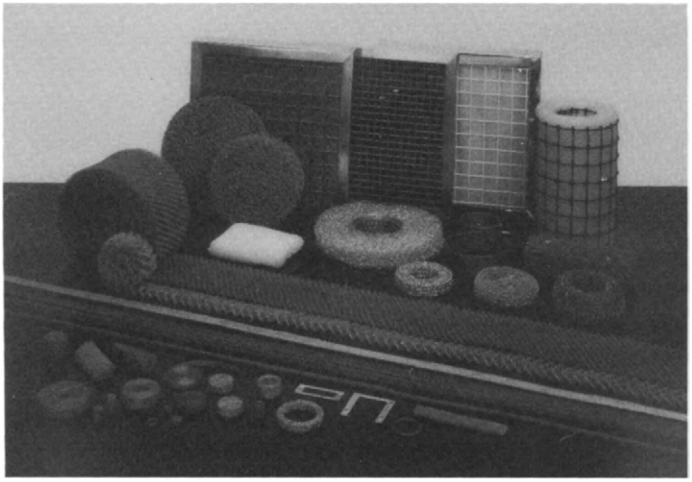


*Figure 6.12. Examples of crimped stocking and multi-layer elements. (Photograph: KnitMesh Ltd)*

Table 6.21 Applications of standard KnitMesh demisters

| Type no. | % free volume | Density[a] (kg/m³) | Surface area (m²/m³) | Special materials included | Applications |
|---|---|---|---|---|---|
| 9001 | 97.6 | 192 | 680 | None | Very high efficiency, very clean service |
| 9033 | 97.6 | 192 | 400 | None | Heavy duty |
| 9032 | 97.6 | 170 | 350 | None | For general use |
| 9030 | 92.2 | 144 | 300 | None | Standard, general purpose media |
| 9030L2 | 98.2 | 144 | 500 | None | High efficiency for fine entrainment |
| 9059 | 98.7 | 107 | 380 | None | Fine entrainment |
| 9036 | 98.8 | 96 | 200 | None | High velocity, dirty service |
| 4530 | 98.8 | 96 | 200 | None | High velocity, clean service |
| 4536 | 99.1 | 72 | 150 | None | Minimum pressure drop, dirty service |
| 9036 | 93.0 | 185 | 1500 | Glass wool | Coalescer – very fine mist |
| 9048 | 95.0 | 128 | 1000 | Glass wool | Coalescer – fine mist |
| 9008 | 95.7 | 45.5 | 1050 | Polypropylene | High performance – acid mist |
| 9030 | 93.2 | 72 | 820 | Polypropylene | |
| 9036 | 95.8 | 44 | 495 | Polypropylene | Acid mists and marine engine intakes with minimum pressure drop |
| 9048 | 97.0 | 32 | 360 | Polypropylene | |
| 9033 | 94.0 | 290 | 1115 | Glass wool/ss316 | |
| 9030 | 95.0 | 205 | 820 | Glass wool/ss316 | Fine mist where stainless steel is valid and minimum pressure drop is important |
| 9036 | 96.0 | 138 | 525 | Glass wool/ss316 | |
| 9048 | 94.0 | 128 | 820 | Teflon FEP | Highly corrosive conditions |
| 9048 | 95.1 | 85 | 725 | Hostaflon ET | Highly corrosive conditions |

[a] Density is for stainless steel. For nickel/copper alloys, add 13%.

**Table 6.22 Examples of applications of KnitMesh DC coalescer**

| System | Application | Coalescer type |
|---|---|---|
| Xylene–water | Condensation of vapour | DC 9201 SS/PPL |
| Ethylene dichloride–water | Condensation | DC 9201 Fibreglass PPL |
| Hydrocarbon–water | Steam stripping | DC 9201 SS/Hostaflon |
| Oil–water | Effluent oil separation | DC 9230 SS/PPL |
| Oil–water | Effluent oil separation | Composite DC 9201 SS/PPL/GW |
| Fatty acid–water | Contamination of wash water | DC 9201 SS/PPL |
| Diesel fuel–water | Washing operation | DC 9201 SS/PPL |
| Benzene–caustic solution | Entrainment | DC 9201 SS/PPL |
| Hexane–water | Extraction | DC 9201 SS/PPL |
| Propane–water | Extraction | DC9201 SS/Teflon |
| Vegetable fats–water | Fat sweetening, extraction process | DC 9201 SS/PPL |

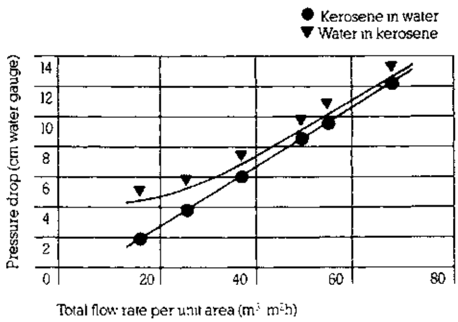



*Figure 6.13. Performance tests of KnitMesh DC9201 SS/PPL coalescer: flow rate versus pressure drop.*

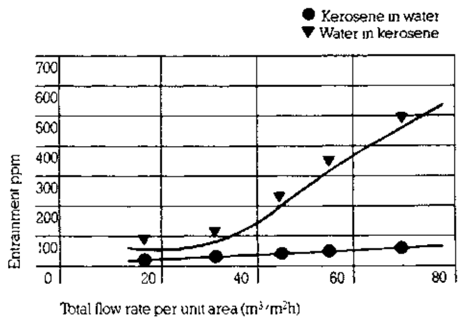



*Figure 6.14. Performance tests of KnitMesh DC9201 SS/PPL coalescer: flow rate versus entrainment.*

applications are given in Table 6.22. Figures 6.13 and 6.14 show the typical relationships between flow rate, pressure drop and entrainment for 1/1 kerosene-in-water and water-in-kerosene dispersions with mean drop size in the range 100–150 μm, filtered through a 300 mm thick DC9201 SS/PPL coalescer.

## 6.3 Woven Plastic Mesh

Everything that has been written above about metal wire meshes can apply in principle to the use of plastic monofilament as warp and weft – whether as square mesh or 'zero aperture' weaves. The use of multifilament yarns is more common in plastic materials than for wire mesh. Even sintering is possible, although much less commonly used, despite the less rigid nature of the meshes, and hence the lower degree of accuracy of aperture, especially after use.

Data on monofilament plastic meshes are to be found in Section 2.3.2 of Chapter 2.

### *6.3.1 Coated plastic mesh*

Interesting alternatives to conventional metal or plastic meshes are the 'Metalester' products of Saati, a manufacturer of an extensive range of precision woven monofilament meshes and fabrics. The Saatifil Metalester materials are hybrid materials, for which electrolytic techniques are used to deposit a coating of metal all over a polyester mesh substrate. The standard coating metal is nickel, but copper, silver, gold and platinum are also used.

The metal coating is stated to cover the plastic completely, and to result in a totally stable structure in which the individual filaments are bonded to each other at every intersection. Advantages claimed are freedom from the static problems common with plastic meshes, the ability to cut, bend and weld, as well as freedom from migration. Table 6.23 summarizes the standard grades, with apertures from 20 to 2000 μm.

## 6.4 Perforated Sheets and Plates

Perforated sheets are produced by high-pressure presses that punch groups of holes through a metal sheet as it is indexed through the press. This process may leave very slight burrs around the edges of the holes on the underside of the sheets; when applied as a support for a filter cloth, it may therefore be advisable to orientate a perforated sheet accordingly.

Despite the extreme simplicity of this structure, the multiplicity of variations in the geometrical parameters associated with holes in sheets, combined with the different metals available, potentially permit the production of an immense variety of perforated metal sheets. In addition to the thickness and type of metal, the variable parameters include the shape of the holes, their size, the pattern in which they are arranged, the number of holes per unit area, and the distance

**Table 6.23 Examples of 'Metalester' nickel coated polyester precision screens[a]**

| Reference no.[b] | 2000/65 | 1180/57 | 545/44 | 403/35 | 285/47 | 200/43 | 146/39 | 109/38 | 76/29 | 65/34 | 52/27 | 43/26 | 36/22 | 31/19 | 25/16 | 23/11 | 20/12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Aperture (μm) | 2000 | 1180 | 545 | 403 | 285 | 200 | 146 | 109 | 76 | 65 | 52 | 43 | 36 | 31 | 25 | 23 | 20 |
| Meshes/cm | 4.25 | 6.5 | 12 | 15 | 24 | 32 | 43 | 55 | 71 | 90 | 100 | 120 | 130 | 140 | 165 | 150 | 180 |
| Thread dia. (μm) | 500 | 385 | 260 | 260 | 120 | 100 | 80 | 64 | 55 | 40 | 40 | 34 | 34 | 34 | 31 | 34 | 31 |
| Thickness of fabric (μm) | 990 | 800 | 470 | 550 | 235 | 172 | 140 | 120 | 100 | 69 | 70 | 66 | 67 | 62 | 68 | 75 | 64 |
| Open area (%) | 65 | 57 | 44 | 35 | 47 | 43 | 39 | 38 | 29 | 34 | 27 | 26 | 22 | 19 | 16 | 11 | 12 |
| Weight ($g/m^2$) | 225 | 210 | 184 | 235 | 84 | 75 | 60 | 51 | 51 | 32 | 37 | 33 | 37 | 40 | 35 | 43 | 40 |

[a] SAATI SpA. and Sericol Ltd.

[b] All reference numbers should be prefixed MET.

between adjacent holes; various combinations of these parameters determine the percentage of open area.

Perforated sheets are used for some of the coarsest separation duties in industry – the grading of pebbles, for example – with hole diameters measured in centimetres, not millimetres, let alone micrometres.

At one time it was customary for suppliers to include literally hundreds or even thousands of items in their nominal list of standard products. By contrast, modern rationalization of manufacturing and stock control procedures has tended to result in a much shorter standard product range, tailored to careful analysis of the market, but to supplement this with producing special grades as required. For example, Table 6.24 lists the standard mild steel perforated sheets held in stock by one supplier and Table 6.25 is the same company's stock list of stainless steel and non-ferrous perforated sheets, all of these being based on round holes.

Plastic sheets can be perforated by the same pressing techniques as used to perforate metal, and more easily. Although limited ranges of plastic sheets were formerly available, they appear now only to be produced to special order partly because most perforated sheet applications are for dry screening of abrasive materials, to which plastic materials are not very resistant.

**Table 6.24 Standard perforated mild steel sheets (round holes)[a]**

| Pattern no. | Hole diameter (mm) | Pitch (mm) | Open area (%) | Thickness of sheet (mm) | |
|---|---|---|---|---|---|
| | | | | 2 m×1 m | 2.5 m×1.25 m |
| 3703A | 1.10 | 2.00 | 27 | 1 | |
| 613 | 1.60 | 2.84 | 28 | 1.2/1.5 | |
| 82 | 1.96 | 3.07 | 36 | 1.2 | |
| 127 | 2.84 | 3.80 | 50 | 1.2/1.5 | |
| 109 | 2.46 | 3.97 | 36 | 0.91/1.2/1.5 | |
| 1614A | 3.20 | 5.0 | 37 | 3.0 | |
| 1614 | 3.17 | 4.75 | 40 | 0.9/1.2/1.5 | |
| 694 | 4.75 | 7.14 | 40 | 0.9/1.2 | |
| 2136 | 3.17 | 6.35 | 23 | | 3.0 |
| 467 | 4.75 | 7.93 | 32 | 0.9/1.2/1.5/3.0 | 1.5/3.0/5.0 |
| 214 | 6.35 | 8.71 | 47 | 1.2/1.5 | 1.2/1.5 |
| 567 | 6.35 | 9.53 | 40 | 0.9/1.2/3.0 | 3.0/6.0 |
| 600 | 6.35 | 12.70 | 23 | 6.0 | 5.0/6.0 |
| 249 | 9.53 | 12.70 | 50 | 1.5 | |
| 252 | 9.53 | 14.27 | 40 | 3.0 | 3.0/5.0 |
| 273 | 12.70 | 17.46 | 47 | 1.5/2.0 | |
| 497 | 12.70 | 19.05 | 40 | 3.0/6.0 | 3.0 |
| 605 | 12.70 | 25.40 | 23 | 10.0 | |
| 285 | 22.20 | 27.00 | 61 | | 3.0 |
| 1024 | 25.40 | 34.90 | 48 | | 6.0 |

[a] Associated Perforators & Weavers Limited.

### *6.4.1 Expanded metal media*

Expanded metal is made from metal sheets by a repetitive process that involves first cutting it to form a series of short slits, and then stretching the sheet to open up these slits into the characteristic diamond apertures of Figure 6.15. This may be followed by calendering so as to flatten the resultant metal strands from the sloping profile imposed on them during stretching.

Measurement of the dimensions of the apertures and the strands is defined in Figure 6.16 for both uncalendered mesh ('conventional') and for calendered mesh ('flattened'). Typical data for the finer grades of both types in various metals are given in Tables 6.26 and 6.27.

Plastic sheets can be expanded by the same slitting and stretching techniques as used to expand metal. Although limited ranges of plastic sheets are available,

**Table 6.25 Standard stainless steel and non-ferrous perforated sheets (round holes)[a]**

| Pattern no. | Hole diameter (mm) | Pitch (mm) | Open area (%) | Metal | Thickness (mm) | Stocked size (mm) |
|---|---|---|---|---|---|---|
| 1533 | 0.55 | 1.02 | 26 | Brass | 0.45 | 1220×610 |
| 1762A | 0.80 | 1.50 | 26 | S/S 304 | 0.50 | 2000×1000 |
| 613A | 1.50 | 2.60 | 30 | S/S 304 | 1.0 | 2000×1000 |
| 441 | 2.16 | 3.00 | 46 | Zinc | 0.35 | 2440×915 |
| 668 | 2.46 | 4.75 | 24 | Pre-galvanized | 0.7 | 2500×1250 |
| 668 | 2.46 | 4.75 | 24 | Pre-galvanized | 1.2 | 2500×1250 |
| 951 | 3.17 | 5.33 | 32 | Pre-galvanized | 0.7 | 2500×1250 |
| 951 | 3.17 | 5.33 | 32 | S/S 304 | 1.2 | 200×1000 |
| 951 | 3.17 | 5.33 | 32 | S/S 304 | 0.9 | 2000×1000 |
| 1614 | 3.17 | 4.75 | 40 | Aluminium | 1.2 | 2000×1000 |
| 1614 | 3.17 | 4.75 | 40 | S/S 304 | 1.5 | 2000×1000 |
| 694 | 4.75 | 7.14 | 40 | Aluminium | 1.2 | 2000×1000 |
| 467 | 4.74 | 7.03 | 32 | S/S 304 | 1.2 | 2000×1000 |
| 567 | 6.35 | 9.53 | 40 | S/S 304 | 2.0 | 2000×1000 |
| 567 | 6.35 | 9.53 | 40 | S/S 304 | 1.2 | 2000×1000 |

[a] Associated Perforators & Weavers Limited.

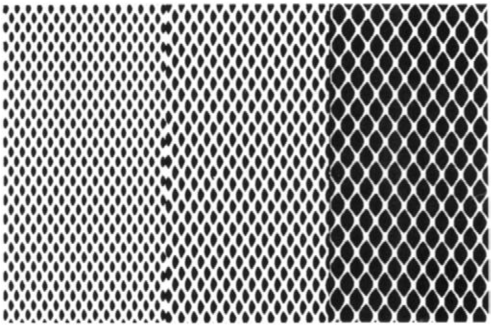


*Figure 6.15. Examples of expanded metal mesh. (Illustration: The Expanded Metal Co. Ltd)*

these products have largely been replaced by the extruded materials discussed below (Section 6.6).

### *6.4.2 Electrolytically formed sheets*

The processes of photo-etching and electroforming are used by Stork Veco to produce a substantial range of finely perforated metal sheets, 15–1500 μm in thickness, and a smaller range of screens for continuous basket centrifuges. Photo-etching involves the removal of metal from a continuous sheet, while electroforming creates the perforated sheet by building up a layer of metal by depositing it upon a substrate. These two processes (plus laser cutting) provide a wide range of delicately structured items for industrial use, covering electric shaver foils to ink-jet orifice plates.

Photo-etching is applicable to almost all metals and their alloys. It begins with the production of a photo-mask in the precise shape of the required product, which is superimposed on a metal sheet. This sheet, already coated with a photo-emulsion, will become the perforated plate. After exposure through the mask to suitable UV light, and subsequent development and washing of the coating, the unexposed parts of the photo-emulsion protect the metal during etching; if both

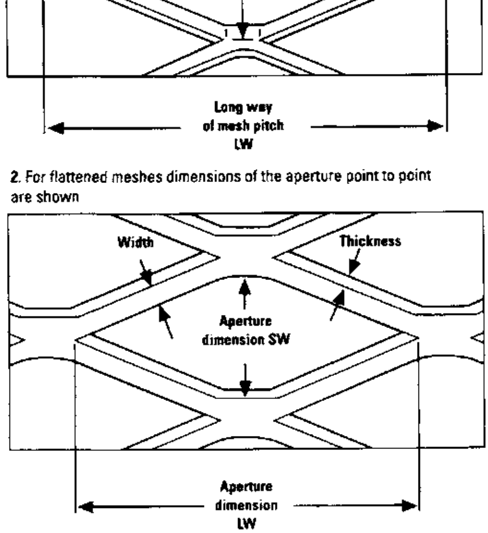



*Figure 6.16. Defining the dimensions of expanded metal meshes. (Illustration: The Expanded Metal Co. Ltd.)*

**Table 6.26 Conventional expanded metal mesh[a]**

| Mesh no. | Metal | Nominal aperture (mm) | | Size of strand (mm) | | Open area (%) | | Weight sheet (kg) | Sheet size (mm) | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | LW[b] | SW[c] | W[d] | T[e] | Normal | Max. | | LW[b] | SW[c] |
| 941MM | SS316/S11 | 1.00 | 0.67 | 0.20 | 0.15 | 32 | 36 | 0.170 | 212 | Coil |
| 957MM | SS316/S11 | 1.50 | 0.92 | 0.22 | 0.15 | 46 | 54 | 0.194 | 313 | Coil |
| 926S | SS304/S15 | 3.18 | 1.95 | 0.79 | 0.46 | 12 | 13 | 1.899 | 610 | 1070 |
| 927S | SS316/S31 | 3.175 | 1.81 | 0.254 | 0.152 | 60 | 66 | 1.088 | 420 | 7620 |
| 901A | Aluminium | 3.18 | 1.81 | 0.28 | 0.32 | 60 | 66 | 1.255 | 610 | 7620 |
| 707S | SS304/S15 | 4.75 | 2.38 | 0.56 | 0.46 | 43 | 51 | 1.258 | 1250 | 1250 |
| 220 | Steel | 5.84 | 3.50 | 0.79 | 0.60 | 42 | 54 | 1.570 | 1200 | 610 |
| 601A | Aluminium | 5.84 | 3.50 | 0.79 | 0.60 | 42 | 54 | 0.506 | 1200 | 610 |
| 602A | Aluminium | 5.84 | 3.39 | 1.17 | 0.56 | 25 | 33 | 0.774 | 1200 | 610 |
| 227S | SS304/S15 | 5.84 | 3.39 | 0.81 | 0.46 | 51 | 61 | 1.287 | 1250 | 1250 |
| 228S | SS304/S15 | 5.84 | 3.39 | 1.22 | 0.56 | 26 | 37 | 2.359 | 1250 | 1250 |
| 209 | Steel | 10.24 | 5.64 | 1.55 | 1.00 | 42 | 55 | 4.800 | 1220 | 915 |
| 351A | Aluminium | 10.24 | 5.64 | 1.55 | 0.90 | 42 | 57 | 1.496 | 1220 | 915 |
| 203 | Steel | 10.24 | 5.64 | 0.79 | 0.60 | 70 | 78 | 1.462 | 1220 | 915 |
| 199 | Steel | 14.29 | 5.64 | 1.17 | 1.00 | 57 | 68 | 3.628 | 1220 | 915 |
| 196S | SS304/S15 | 14.29 | 5.64 | 1.33 | 0.90 | 45 | 57 | 3.862 | 1250 | 915 |
| 197S | SS304/S15 | 14.29 | 5.64 | 1.33 | 0.70 | 56 | 74 | 3.003 | 1250 | 915 |
| 0798 | Steel | 19.05 | 7.43 | 1.70 | 1.00 | 52 | 65 | 10.687 | 2440 | 1220 |
| 0798A | Aluminium | 19.05 | 7.43 | 1.70 | 0.90 | 52 | 65 | 3.334 | 2440 | 1220 |
| 0798S | SS304/S15 | 19.05 | 7.26 | 1.71 | 0.90 | 52 | 66 | 7.613 | 2500 | 1250 |
| 1196 | Steel | 28.58 | 9.52 | 1.98 | 1.20 | 61 | 73 | 11.669 | 2440 | 1250 |
| 1196A | Aluminium | 28.58 | 9.52 | 1.98 | 1.20 | 61 | 73 | 4.019 | 2440 | 1250 |
| 1197S | SS304/S15 | 28.58 | 9.53 | 2.24 | 0.90 | 55 | 75 | 7.569 | 2500 | 1250 |
| 1296 | Steel | 30.48 | 11.72 | 2.36 | 1.20 | 62 | 76 | 11.282 | 2440 | 1220 |
| 1296A | Aluminium | 30.48 | 11.72 | 2.36 | 1.20 | 62 | 74 | 3.900 | 2440 | 1220 |

[a] The Expanded Metal Company Limited. [b] *LW* = long dimension of mesh. [c] *SW* = short dimension of mesh. [d] *W* = width of strand. [e] *T* = thickness of strand.

**Table 6.27 Flattened expanded metal mesh**[a]

| Mesh no. | Metal | Nominal aperture (mm) | | Size of strand (mm) | | Open area (%) | | Weight sheet (kg) | Sheet size (mm) | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | *LW*[b] | *SW*[c] | *W*[d] | *T*[e] | Normal | Max. | | *LW*[b] | *SW*[c] |
| 706F | Steel | 2.79 | 0.81 | 0.76 | 0.58 | 26 | 26 | 3.360 | 1220 | 915 |
| 226F | Steel | 3.81 | 2.03 | 0.79 | 0.58 | 46 | 46 | 1.570 | 1220 | 915 |
| 228SF | SS304/S15 | 3.00 | 1.00 | 1.22 | 0.56 | 19 | 19 | 2.359 | 1250 | 1250 |
| 217F | Steel | 6.855 | 3.56 | 1.30 | 0.90 | 52 | 52 | 8.930 | 1220 | 2440 |
| 217AF | Aluminium | 6.86 | 3.56 | 1.27 | 0.89 | 52 | 52 | 2.585 | 1220 | 2240 |
| 0974F | Steel | 14.22 | 4.83 | 1.85 | 0.96 | 52 | 52 | 9.823 | 1220 | 2240 |
| 0974AF | Aluminium | 13.97 | 4.83 | 1.80 | 0.89 | 52 | 52 | 3.066 | 1220 | 2440 |
| 0792SF | SS304/S15 | 14.22 | 4.58 | 1.83 | 0.86 | 53 | 53 | 3.360 | 1250 | 1250 |
| 197SF | SS304/S15 | 10.50 | 3.50 | 1.33 | 0.70 | 52 | 52 | 3.003 | 1250 | 1250 |
| 1276SF | SS304/S15 | 25.00 | 8.00 | 1.98 | 1.09 | 57 | 57 | 6.542 | 2500 | 1250 |
| 1280F | Steel | 24.38 | 7.11 | 2.39 | 1.14 | 57 | 57 | 10.836 | 2440 | 1220 |
| 1280AF | Aluminium | 24.13 | 6.86 | 2.39 | 1.14 | 58 | 58 | 3.751 | 2440 | 1220 |
| 1282F | Steel | 24.38 | 7.62 | 2.08 | 1.14 | 63 | 63 | 9.436 | 2440 | 1220 |

[a] The Expanded Metal Company Limited. [b] *LW* = long dimension of mesh. [c] *SW* = short dimension of mesh. [d] *W* = width of strand.
[e] *T* = thickness of strand.

sides of the metal sheet are being etched simultaneously, the sheet is sandwiched between two precisely aligned photo-masks. After etching is complete, the photo-emulsion is stripped off prior to post-treatment operations such as protective plating and passivation.

Electroforming employs the same masking process, but now the unexposed parts of the photo-resist lacquer protect the surface of the substrate from deposition of the metal layer that will form the screen medium. The sheet of metal and unexposed resin form a matrix that serves as the cathode in an electrolytic bath, where metal from a pure metal anode deposits on the areas where the photo-resist was removed. A thick layer of photo-resist allows the deposition of a thick-film product, while a thin layer leads to the deposition of metal firstly within the spaces between the photo-resist, and then over its edges, to create an overgrow product. As with photo-etching, various post-deposition operations are possible, most commonly adding a hard protective layer of chromium.

The Stork range of screens for continuous centrifuges (as used mainly in the sugar industry) are deformable structures, and as such are supported in use on a coarse wire mesh backing screen. They are made in electroformed nickel, and are usually chrome plated. They range in thickness from 280 to 420 μm, and have slots, rather than round holes, with slot widths between 40 and 130 μm, as shown in Table 6.28.

The VecoStandard type of screen is for normal applications, with a mirror-smooth working surface. Its conical holes reduce binding and clogging, while the slots can be oriented in the screen to suit the travel direction of the sugar crystals (Figure 6.17(a)). The VecoFlux type is for higher filtrate rates, with an open area double that of the standard screens or more, for a given slot size (Figure 6.17(b)), while the VecoLife screens are significantly thicker to give a longer screen life by reducing the deformation into the support screen (Figure 6.17(c)).

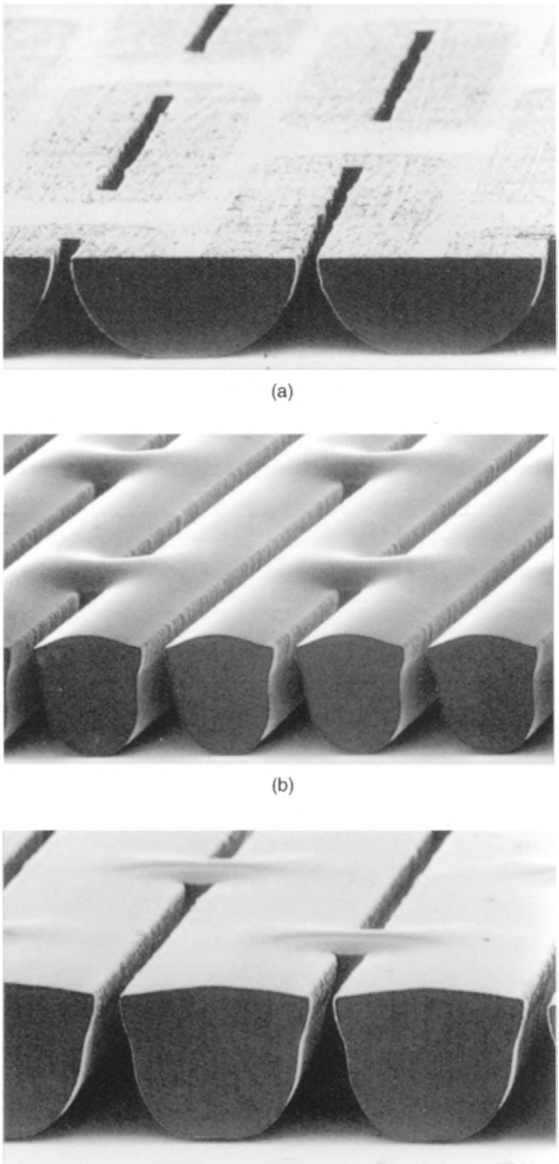
The other filtration media are rigid homogeneous structures, made mainly by electroforming. They have sharp separation characteristics, with perforations down to 10 μm, having a high throughput and being easily cleaned. The standard

**Table 6.28 Technical specifications for Veco centrifuge screens***

| Screen type | Slot size (mm) | Open area (%) | Thickness (mm) |
|---|---|---|---|
| VecoStandard A | 0.04 × 1.67 | 4.2 | 0.31 |
| | 0.06 × 1.69 | 6.4 | 0.29 |
| | 0.09 × 1.72 | 9.6 | 0.28 |
| | 0.13 × 1.76 | 14.2 | 0.25 |
| VecoStandard B | 0.06 × 2.11 | 6.4 | 0.34 |
| | 0.09 × 2.14 | 9.6 | 0.32 |
| VecoFlux | 0.04 × 2.18 | 9.6 | 0.33 |
| | 0.06 × 2.20 | 14.4 | 0.33 |
| | 0.09 × 2.23 | 21.8 | 0.33 |
| VecoLife | 0.06 × 2.65 | 9.0 | 0.42 |
| | 0.09 × 2.68 | 13.5 | 0.42 |

*Stock Veco BV

range, called Veconic, has a smooth working surface. It is electroformed in pure nickel, but can be chrome plated. The perforations are sharp-edged and conical in cross-section; they may be round or slot-shaped. Veconic screens are available in standard sheet dimensions of 1 m by 1 m. The range of sizes is shown in Table 6.29 for round holes, and in Table 6.30 for slotted holes. The wide range in open area is to be noted.



(a)

(b)

(c)

*Figure 6.17. Stork Veco centrifuge screens: (a) VecoStandard, (b) VecoFlux, (c) VecoLife.*

The Veconic *plus* range of screens is made by a special, patented electroforming process, also from pure nickel, which permits the variation in sheet thickness with the same perforation dimensions. As with the Veconic screens, Veconic *plus* is available with round or slotted holes, in sheets 1 m by 1 m. Veconic *plus* has a

**Table 6.29 Stork Veco Veconic filter screens with round holes[a]**

| Hole diameter (mm) | Mesh no.[b] | Open area (%) | Thickness (mm) |
|---|---|---|---|
| 0.02 | 125 | 1 | 0.09 |
| 0.04 | 125 | 4 | 0.08 |
| 0.06 | 125 | 8 | 0.07 |
| 0.10 | 40 | 2 | 0.25 |
| 0.13 | 40 | 4 | 0.23 |
| 0.15 | 50 | 8 | 0.18 |
| 0.20 | 40 | 9 | 0.20 |
| 0.25 | 50 | 23 | 0.12 |
| 0.30 | 20 | 5 | 0.45 |
| 0.35 | 30 | 16 | 0.25 |
| 0.40 | 30 | 21 | 0.18 |
| 0.45 | 30 | 27 | 0.16 |
| 0.50 | 25 | 23 | 0.20 |
| 0.75 | 20 | 33 | 0.20 |
| 1.00 | 15 | 33 | 0.20 |
| 1.50 | 12.5 | 52 | 0.20 |
| 2.00 | 9 | 48 | 0.28 |
| 2.50 | 7 | 45 | 0.42 |

[a] Stork Veco BV.
[b] Mesh number is the number of holes on a line 1 inch long, and on a line 1 inch long at 60° to the first.

**Table 6.30 Stork Veco Veconic filter screens with slotted holes[a]**

| Slot dimensions (mm) | Mesh no.[a] | Open area (%) | Thickness (mm) |
|---|---|---|---|
| 0.04 × 1.10 | 60/15 | 6 | 0.17 |
| 0.06 × 1.66 | 40/10 | 6 | 0.28 |
| 0.08 × 1.67 | 40/10 | 8 | 0.27 |
| 0.10 × 1.70 | 40/10 | 11 | 0.26 |
| 0.13 × 1.72 | 40/10 | 14 | 0.24 |
| 0.13 × 2.36 | 28/7 | 9 | 0.34 |
| 0.15 × 3.50 | 17/5 | 7 | 0.75 |
| 0.18 × 2.42 | 28/7 | 13 | 0.30 |
| 0.20 × 2.46 | 28/7 | 16 | 0.29 |
| 0.25 × 2.49 | 28/7 | 20 | 0.26 |
| 0.30 × 3.65 | 17/5 | 14 | 0.59 |
| 0.35 × 3.70 | 17/5 | 17 | 0.54 |
| 0.40 × 3.75 | 17/5 | 20 | 0.49 |
| 0.50 × 3.85 | 17/5 | 25 | 0.43 |
| 0.75 × 4.10 | 17/5 | 41 | 0.30 |

[a] Stork Veco BV.
[b] Mesh number gives, first, the number of slots on a line 1 inch long, and then the number on a line 1 inch long at 90° to the first.

**Table 6.31 Stork Veco Veconic *plus* filter screens with round holes[a]**

| Hole diameter (mm) | Mesh no.[b] | Open area (%) | Thickness (mm) |
|---|---|---|---|
| 0.03 | 125 | 2 | 0.15 |
| 0.03 | 125 | 2 | 0.30 |
| 0.03 | 125 | 2 | 0.50 |
| 0.04 | 125 | 4 | 0.15 |
| 0.04 | 125 | 4 | 0.30 |
| 0.04 | 125 | 4 | 0.50 |
| 0.06 | 125 | 8 | 0.15 |
| 0.06 | 125 | 8 | 0.30 |
| 0.06 | 125 | 8 | 0.50 |
| 0.08 | 125 | 14 | 0.15 |
| 0.08 | 125 | 14 | 0.30 |
| 0.08 | 125 | 14 | 0.50 |
| 0.10 | 80 | 23 | 0.20 |
| 0.10 | 80 | 23 | 0.35 |
| 0.10 | 80 | 23 | 0.50 |
| 0.15 | 80 | 20 | 0.20 |
| 0.15 | 80 | 20 | 0.35 |
| 0.15 | 80 | 20 | 0.50 |
| 0.20 | 50 | 14 | 0.20 |
| 0.20 | 50 | 14 | 0.35 |
| 0.20 | 50 | 14 | 0.50 |
| 0.25 | 50 | 22 | 0.20 |
| 0.25 | 50 | 22 | 0.35 |
| 0.25 | 50 | 22 | 0.50 |

[a] Stork Veco BV.
[b] Mesh number is the number of holes on a line 1 inch long, and on a line 1 inch long at 60° to the first.

**Table 6.32 Stork Veco Veconic *plus* filter screens with slotted holes[a]**

| Slot dimensions (mm) | Mesh no.[b] | Open area (%) | Thickness (mm) |
|---|---|---|---|
| 0.01 × 0.42 | 160/40 | 5 | 0.30 |
| 0.01 × 0.42 | 160/40 | 5 | 0.50 |
| 0.02 × 0.43 | 160/40 | 10 | 0.30 |
| 0.02 × 0.43 | 160/40 | 10 | 0.50 |
| 0.03 × 0.44 | 160/40 | 15 | 0.30 |
| 0.03 × 0.44 | 160/40 | 15 | 0.50 |
| 0.04 × 0.45 | 160/40 | 20 | 0.30 |
| 0.06 × 0.47 | 160/40 | 30 | 0.30 |
| 0.08 × 0.88 | 80/20 | 18 | 0.30 |
| 0.08 × 0.88 | 80/20 | 18 | 0.50 |
| 0.10 × 0.89 | 80/20 | 23 | 0.35 |
| 0.10 × 0.89 | 80/20 | 23 | 0.50 |

[a] Stork Veco BV.
[b] Mesh number gives, first, the number of slots on a line 1 inch long, and then the number on a line 1 inch long at 90° to the first.

greater thickness, and hence strength, and is supplied in the finer perforation sizes, as shown in Tables 6.31 and 6.32.

The Veronic range is made in the same way as the Veconic screens, but thicker, and hence stronger. It too is available in 1 $m^2$ sheets, with round and slotted perforations, but the range is much smaller, with 6 sizes of round hole (0.08–1.75 mm) and 7 slotted hole sheets (0.10–0.50 mm wide), but all have quite large open areas for the size of hole.

A small range of Vecopore screens, made from pure nickel by the same special electroforming process as Veconic *plus*, has fine holes (20–50 μm) with high mesh numbers, and consequently large open areas. These are available in sheets 500 mm by 600 mm.

The final member of the Stork Veco perforated sheet range is the Veconox range, made by photo-etching from AISI 316 stainless steel. These have quite large perforations – the slotted sheets having slot widths from 0.13 to 0.4 mm.

#### 6.4.2.1 *Track-etched sheets*

A very specialised case of etched pores in a sheet of material relates to the formation of minute pores by the bombardment of the material by rays of sub-atomic particles, followed by the chemical etching of the material, to form pores at the sites where it was bombarded. This is a technique used for making specialized membranes, exemplified by Whatman's Nuclepore range, and is further discussed in Chapter 8.

### 6.4.3 *Laser-cut sheets*

The application of laser techniques provides the unique benefit of forming precision-cut micro-slots in hard, wear-resisting metals such as stainless steel. In this way holes can be formed in the sheet with widths narrower than the thickness of the metal. Laser-cut screens are intended for applications needing a high proportion of open area, and a resistance to clogging of the medium. The holes are usually slots, but circular holes can also be formed in this way. The slots

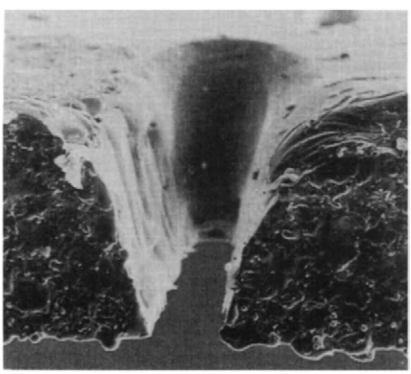


*Figure 6.18. Cross section of 60 μm SSL slot @ ×150 magnification, showing high relief angle and extremely sharp edges. (Photograph: Laser Action Pty Ltd)*

have sharp working edges, and the high relief angles act to prevent clogging. The smooth surface of the screen is an aid to fluid flow.

A typical format is available in the patented process developed in Australia by the Commonwealth Scientific and Industrial Organization, in cooperation with the Sugar Experimental Station Board. Commercialization of the resultant SSL (stainless steel laser-cut) screens and sieve products, and those of other metals such as titanium, is in the hands of LaserAction Pty; the products are available in the UK from Croft Engineering Services.

Figures 6.18 and 6.19 show the characteristic tapered form of the slots, with extremely sharp edges, a high relief angle and smooth working face, while Figure 6.20(a) reveals the narrowing of the slots at each end. Slot widths may be from 40 to 200 μm corresponding to the high open areas listed in Table 6.33; as compared with conventional slotted screens, SSL slots are shorter and thinner on average (because

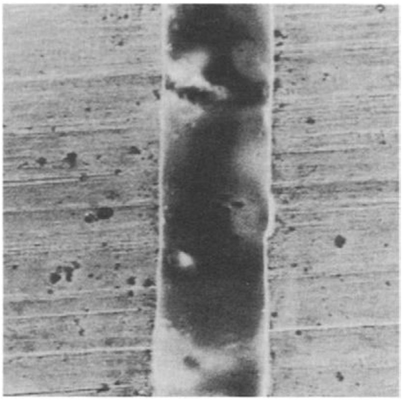
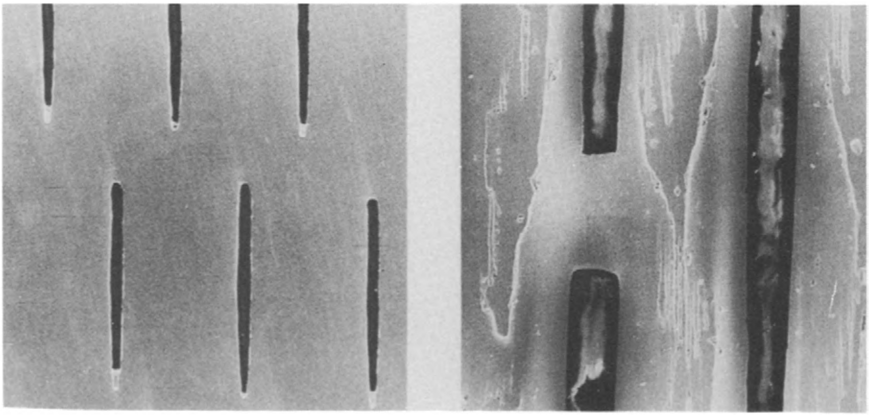


*Figure 6.19. Smooth working face of 60 μm SSL slot (a ×260), showing sharp slot edges. (Photograph: Laser Action Pty Ltd)*



(a) (b)

*Figure 6.20. Comparing, at the same magnification, the wear after 1350 h of operation of 60 μm slots in (a) laser-cut screen and (b) electroformed chrome nickel screen. (Photograph: Laser Action Pty Ltd)*

of their narrower ends), but are several times more numerous. The metal thickness is usually 20 μm; screens may be up to 0.9 m wide and as much as 2 m long.

Extensive full-scale side-by-side comparative trials are reported to have demonstrated the benefits of using SSL screens in centrifuges separating sugar crystals from molasses. Although they cost some four times more than conventional centrifuge screens, this is claimed to be more than offset by process savings accruing from higher yields of sugar because of a much greater resistance to wear by the tough SSL screens. This is illustrated in Figure 6.20, which compares SSL and conventional electroformed chrome nickel 60 μm slot screens at the same magnification after 1350 hours of operation; the slots of the conventional screen are visibly much enlarged, whereas those of the SSL show little change in sharpness or width even at the high (×720) magnification in Figure 6.21.

## 6.5 Bar and Wire Structures

The remaining metal media in this chapter are fabricated from individual bars, or from rod or wire that has been processed to change its shape. The filter elements

**Table 6.33 SSL laser-cut screens**[a]

| Slot width (μm) | Maximum open area (%) |
|---|---|
| 40 | 7.5 |
| 50 | 10.0 |
| 60 | 12.0 |
| 70 | 14.0 |
| 80 | 16.0 |
| 90 | 18.0 |
| 100 | 20.0 |
| 120 | 24.0 |

[a] Laser Action Pty Ltd.

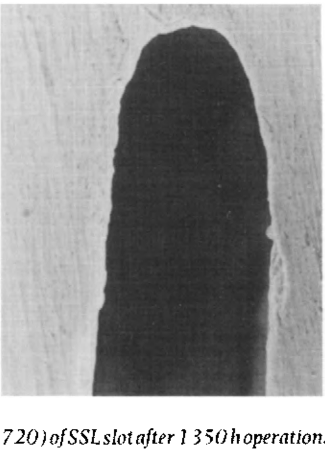


*Figure 6.21. High magnification (×720) of SSL slot after 1350 h operation. (Photograph: Laser Action Pty Ltd)*

made from these media are thus assembled rather than produced in sheets or rolls. As a result they are more expensive on a unit area basis than woven mesh or perforated sheet, and so are used where their particular combination of strength and accuracy of aperture size is necessary.

### 6.5.1 Looped wedge wire

Looped wedge wire (Figure 6.22) is made from round wire by a two-stage process. First it is looped at regular pitched intervals and then pressed so that the sections between consecutive loops are formed into deep wedge-shaped sections. The loops themselves are also pressed to flatten the sides into accurately sized spacing shoulders that butt together when the wires are assembled into panels using locking cross rods passed through the loops, as in Figure 6.23.

The width of the resultant slit apertures between adjacent wedge wires is determined by the extent to which the width across the spacing shoulders is greater than the width of the top face of the wedge profile. The strength of the assembled panels depends on the dimensions of the wedge sections, and on the diameter and pitching of the cross rods. All of these dimensional factors can be varied to suit the application.

Another important variable is the profile of the top surface of the wedge wires, the typical options being listed in Table 6.34, which includes comments on their applications. Table 6.35 summarizes the dimensions and profiles of wedge wires and the diameters and pitches of cross rods used by one manufacturer to produce the standard screens in Table 6.36 and the finer Mini-Wedge Wire screens in Table 6.37; whilst the latter are obviously less robust than standard wedge wire, they are many times stronger than equivalent fine woven meshes.

Looped wedge wire screens are available in a variety of different metals, as indicated by Table 6.38, which provides factors to convert the mild steel weights included in Table 6.36.

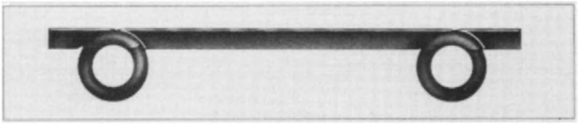


*Figure 6.22. A looped wedge wire. (Photograph: CAE Trislot N.V.)*

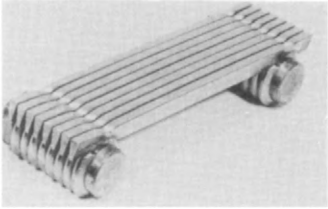


*Figure 6.23. Looped wedge wire screen. (Photograph: CAE Trislot N.V.)*

### 6.5.2 Welded wedge wire screens

Welded wedge wire, usually in 304 or 316 stainless steel but also in special metals such as Hastelloy, is produced by sophisticated automated welding techniques that permit preformed profiled wedge wires to be welded directly to

**Table 6.34 Typical profiles of wedge wire[a]**

| Section | Name | Code | Comment |
|---|---|---|---|
|  | Flat top wedge wire | F | The most commonly used profile, giving good screening efficiency over the whole range in most applications. It is excellent for dewatering slurries and is extensively used in coal washeries. |
|  | Conical top wedge wire | C | Designed particularly for fine mesh screens for dewatering slurries. |
|  | Square top wedge wire | S | Suitable for the larger aperture screens used with highly abrasive materials. |
|  | Riffle top wedge wire | R | Combines most of the dewatering qualities of both flat and conical top profiles, and is also widely used as an attractive non-slip finish for drainage grids and walkways. |

**Table 6.35 Profiles and dimensions of looped wedge wires[a]**

| Profile[b] | Section no. | Profile | | Cross rod | |
|---|---|---|---|---|---|
| | | Width (mm) | Depth (mm) | Diameter (mm) | Pitch (mm) |
| C | 12 | 1.02 | 1.64 | 3.2 | 25.4 |
| C | 16 | 1.37 | 2.20 | 4.8 | 38.1 |
| F | 20 | 1.70 | 2.74 | 7.9 | 70 |
| F | 23 | 1.93 | 3.07 | 7.9 | 70 |
| FCSR | 28 | 2.33 | 3.83 | 7.9 | 70 |
| FCSR | 32 | 2.66 | 4.32 | 7.9 | 70 |
| FCSR | 33 | 2.77 | 4.50 | 7.9 | 70 |
| FCSR | 35 | 2.90 | 4.70 | 7.9 | 70 |
| FCSR | 39 | 3.28 | 5.31 | 7.9 | 70 |
| FCSR | 42 | 3.50 | 5.72 | 7.9 | 70 |
| FCSR | 44 | 3.66 | 5.90 | 7.9 | 70 |
| F | 41 | 3.91 | 4.87 | 9.5 | 102 |
| FCSR | 49 | 4.08 | 6.63 | 12.7 | 102 |
| FCSR | 51 | 3.43 | 6.98 | 12.7 | 102 |
| FS | 54 | 4.52 | 7.34 | 12.7 | 102 |

[a] Screen Systems Limited.

[b] F = flat top; C= conical top; S = square top; R = riffled top.

deep section cross bars (Figure 6.24). As with looped wedge wire, considerable variation is possible in the profile and dimensions of the wedge wire, and also in the shape and dimensions of the cross bars. A representative list of the standard products of Screen Systems Ltd is reproduced in Table 6.39.

**Table 6.36 Standard looped wedge wire screens[a]**

| Apertures (mm) | Section no. | Open area (%) | Apertures per metre | Weight[b] ($kg/m^2$) |
|---|---|---|---|---|
| 0.125 | 20P[c] | 6.7 | 547 | 25.6 |
| | 23P | 6.0 | 486 | 29.4 |
| | 28P | 4.8 | 407 | 34.4 |
| | 32P | 4.3 | 358 | 38.6 |
| 0.25 | 20P | 12.5 | 511 | 24.3 |
| | 23P | 11.1 | 460 | 28.0 |
| | 28P | 9.2 | 387 | 32.8 |
| | 32P | 8.2 | 341 | 37.1 |
| 0.375 | 20 | 16.5 | 479 | 23.1 |
| | 23 | 15 | 433 | 26.7 |
| | 28P | 12.7 | 367 | 31.6 |
| | 32P | 11.3 | 328 | 35.9 |
| | 20 | 20.7 | 53 | 22.1 |
| 0.75 | 23 | 18.8 | 410 | 25.6 |
| | 28 | 16.1 | 351 | 30.4 |
| | 32P | 14.4 | 315 | 34.7 |
| 1.0 | 23 | 25.2 | 370 | 23.7 |
| | 28 | 21.9 | 325 | 28.6 |
| | 32 | 19.8 | 292 | 32.6 |
| | 23 | 30.9 | 341 | 22.2 |
| | 28 | 27.2 | 300 | 26.7 |
| | 32 | 24.8 | 273 | 30.7 |
| | 49 | 17.5 | 197 | 54.3 |
| 1.25 | 35 | 26.9 | 243 | 32.4 |
| 1.5 | 23 | 38.8 | 292 | 19.8 |
| 1.75 | 28 | 34.7 | 259 | 23.9 |
| | 35 | 30.2 | 226 | 30.6 |
| | 49 | 23.4 | 177 | 49.8 |
| | 28 | 37.0 | 246 | 22.9 |
| | 35 | 32.6 | 215 | 29.1 |
| 2.0 | 39 | 32.8 | 189 | 32.9 |
| | 49 | 27.4 | 164 | 46.9 |
| | 63 | 24.8 | 137 | 53.5 |
| 2.5 | 42 | 36.0 | 166 | 33.3 |
| | 49 | 32.1 | 151 | 43.9 |
| 3.0 | 44 | 38.5 | 151 | 32.9 |
| | 51 | 35.9 | 136 | 43.6 |
| | 54 | 34.9 | 133 | 46.8 |
| 4.0 | 51 | 42.0 | 120 | 40.0 |
| | 54 | 41.0 | 117 | 42.5 |

[a] Screen Systems Limited.
[b] Mild steel. For other metals, multiply by factor in Table 6.38.
[c] P: for severe side loading, spacing pips can be provided.

The Trislot screens developed by Bekaert (but now available from Trislot) include a configuration in which the slots can be as small as 10 μm. The total range of configurations comprises flat, curved, conical and tubular: it is a particular version of the last of these that makes the 10 μm slot possible, namely 'out-to-in' flow with tubes up to 70 mm in diameter. For all other versions and configurations, the smallest slot size is 50 μm (with an average tolerance of 10%).

A distinction is made between two versions of the spirally wound tubular configuration, depending on whether flow is intended to be out-to-in (Figure 6.25) or in-to-out (Figure 6.26). The 'slot tubes' of the former version were originally developed to serve as well screens, which required them to be large and heavy; subsequent developments have refined the construction and extended the applications, with Trislot tubes produced in standard nominal diameters from 30 to 620 mm. The minimum internal diameter of 'slotted cylinders' of the in-to-out configuration is 25 mm.

**Table 6.37 Looped 'Mini-Wedge Wire' screens[a]**

| Apertures (mm) | Section no. | Open area (%) | Apertures per metre | Weight[b] (kg/m$^2$) |
|---|---|---|---|---|
| 0.10 | 12 | 8.3 | 890 | 15.3 |
| | 16 | 6.4 | 685 | 20.9 |
| 0.125 | 12 | 10.1 | 870 | 15.0 |
| 0.25 | 12 | 18.2 | 785 | 13.8 |
| | 16 | 14.3 | 615 | 19.3 |
| 0.375 | 12 | 25.0 | 715 | 12.6 |
| | 16 | 20.2 | 575 | 18.2 |
| 0.50 | 12 | 30.5 | 655 | 11.9 |
| | 16 | 24.8 | 535 | 17.2 |
| 0.75 | 12 | 39.0 | 560 | 10.5 |
| | 16 | 32.8 | 470 | 15.1 |
| 1.0 | 16 | 39.0 | 425 | 14.4 |

[a] Screen Systems Limited.
[b] Mild steel. For other metals, multiply by factor in Table 6.38.

**Table 6.38 Weight conversion factors for various metals**

| Metal | Specific gravity | Conversion factor |
|---|---|---|
| Magnesium/aluminium alloy | 2.65 | 0.337 |
| 17% chrome steel | 7.70 | 0.980 |
| Mild steel | 7.85 | 1.000 |
| Galvanized steel | 7.85 | 1.000 |
| Stainless steel 18/8 | 7.90 | 1.006 |
| Brass | 8.50 | 1.083 |
| Silicon bronze | 8.54 | 1.088 |
| Phosphor bronze | 8.70 | 1.108 |
| Monel | 8.80 | 1.121 |
| Copper | 8.90 | 1.133 |

Johnson channel rod screens have a distinctive internal structure, as shown in Figure 6.27. These are available in a range of 10 standard sizes (internal diameters from 25 to 200 mm), with slot openings upwards from 75 μm. They are used in the underdrain systems of sand filters with the claimed advantage of eliminating the need for several layers of graded support gravel beneath the sand bed (Figure 6.28).

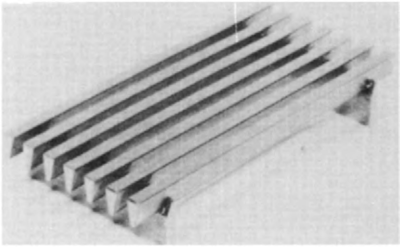


*Figure 6.24. Welded wedge wire screen. (Photograph: CAE Trislot N.V.)*

**Table 6.39 Welded wedge wire screens[a]**

| Aperture[b] (mm) | Profile no. | Profile width (mm) | Profile depth (mm) | Open area (%) |
|---|---|---|---|---|
| 0.25 | 28 | 2.2 | 4.5 | 10.2 |
| | 34 | 2.8 | 5.0 | 8.1 |
| | 42 | 3.4 | 6.5 | 6.8 |
| 0.53 | 28 | 2.2 | 4.5 | 18.5 |
| | 34 | 2.8 | 5.0 | 15.2 |
| | 42 | 3.4 | 6.5 | 12.8 |
| 0.75 | 28 | 2.2 | 4.5 | 25.4 |
| | 34 | 2.8 | 5.0 | 21.1 |
| | 42 | 3.4 | 6.5 | 18.1 |
| 1.0 | 28 | 2.2 | 4.5 | 31.1 |
| | 34 | 2.8 | 5.0 | 26.3 |
| | 42 | 3.4 | 6.5 | 22.7 |
| 1.25 | 28 | 2.2 | 4.5 | 36.2 |
| | 34 | 2.8 | 5.0 | 30.9 |
| | 42 | 3.4 | 6.5 | 26.9 |
| 1.5 | 28 | 2.2 | 4.5 | 40.5 |
| | 34 | 2.8 | 5.0 | 34.9 |
| | 42 | 3.4 | 6.5 | 30.6 |
| 1.75 | 28 | 2.2 | 4.5 | 44.3 |
| | 34 | 2.8 | 5.0 | 38.5 |
| | 42 | 3.4 | 6.5 | 34.0 |
| 2.0 | 28 | 2.2 | 4.5 | 47.6 |
| | 34 | 2.8 | 5.0 | 41.7 |
| | 42 | 3.4 | 6.5 | 37.0 |
| 2.5 | 28 | 2.2 | 4.5 | 53.2 |
| | 34 | 2.8 | 5.0 | 47.2 |
| | 42 | 3.4 | 6.5 | 42.4 |

[a] Screen Systems Limited.
[b] Apertures up to 10 mm are available.

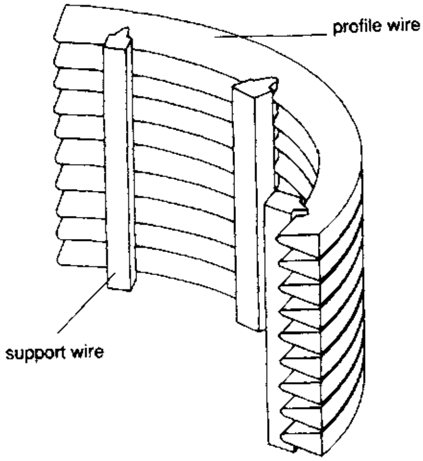



*Figure 6.25. 'Trislot' tubes for out-to-in flow. (Illustration: CAE Trislot N.V.)*

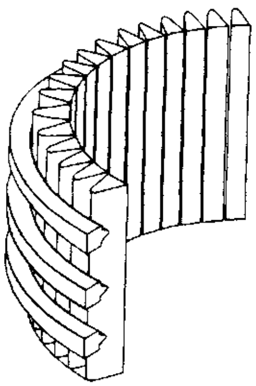


*Figure 6.26. 'Trislot' cylinders for in-to-out flow. (Illustration: CAE Trislot N.V.)*

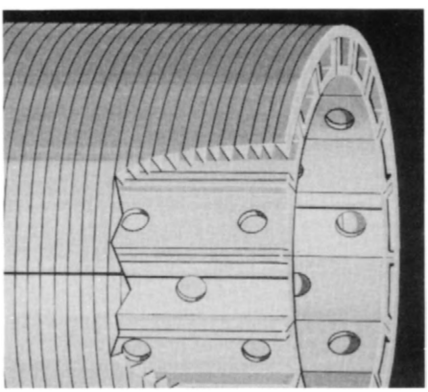


*Figure 6.27. Wedge wire channel rod screen. (Illustration: Johnson Filtration Systems)*

As an alternative to their stainless steel cylindrical screens for use in collector and distributor systems for sand filters (see Figure 6.27), Johnson Filtration Systems also produce a corresponding range of plastic screens (Figure 6.29). These are of sonic-welded PVC construction, tailored to integrate with standard PVC pipe fittings: the slot sizes extend from 150 μm to 3.175 mm.

### 6.5.3 Bar screens

A screen surface can be formed by assembling a number of separated flat bars. The huge flat or sloping screens used for separating crushed ores in mineral processing works are often made in this way. A more delicate example of this structure is incorporated in the high-pressure screw press for dewatering rubber crumb shown in Figure 6.30. As can be seen, this is of very robust construction so as to withstand operating pressures up to some 1300 bar. The drainage cage is therefore built up from 28 cm long stainless steel bars laid side by side, with spacers between them, to give a replaceable cartridge; several such cartridges placed end to end make up the full length of the cage.

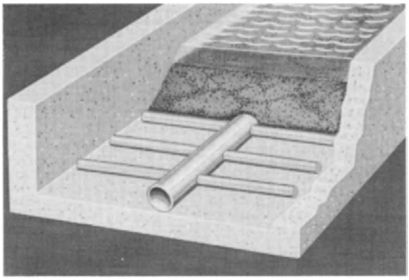


*Figure 6.28. Johnson channel rod underdrain for sand filter.*

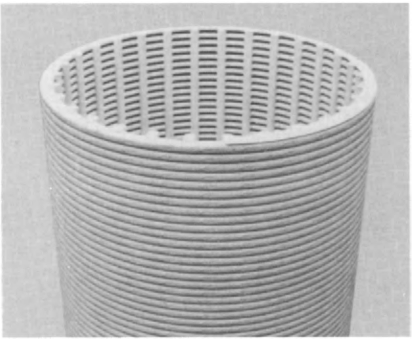


*Figure 6.29. PVC wedge wire cylindrical screen.*

A quite different form of bar screen is the *sieve bend* used in the wet classification of slurries. The screen is mounted vertically, with a surface that is flat across the screen, but concave downwards from a vertical portion at the top. The bars are arranged across the screen, with slurry flow downwards across the face of the screen, and almost tangential at the top. Also known as the DSM screen (as sold by Dorr-Oliver), this filter can be used as a classifying device, separating fine solids from coarse.

## 6.6 Extruded Plastic Meshes

Extensive ranges of mesh and sheet products are manufactured in plastics by the Netlon extrusion process, and by the embossing and stretching process similar to that described in Section 2.2.2.4 of Chapter 2, there referring to the production of fibrillated tapes. Products of both of these processes have very wide application in industry, far beyond their use in filtration, where they are most often used for components of filter media systems, other than the medium itself.

### 6.6.1 Stretched sheet media

Meshes can be made by stretching an extruded film of polymer that has been weakened in a regular pattern. The process involves embossing the pattern into the film by passing it over rollers, on whose surfaces the pattern has been photo-etched, as in gravure printing. The embossed film is then heated and stretched in one or more directions, thus causing the film to rupture in a structured way at

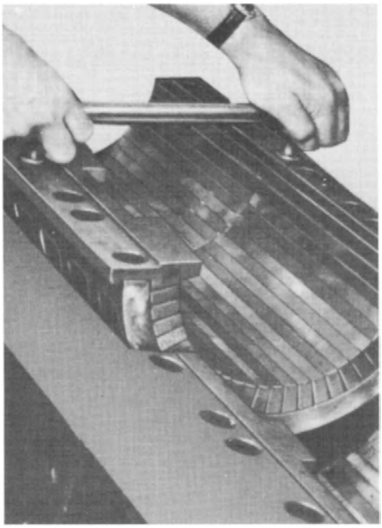


*Figure 6.30. Assembling the bar screen cage of a high pressure screw press. (Photograph: The French Oil Mill Machinery).*

the impressed indentations. Variation in type of polymer, film thickness, embossed pattern and stretching process all permit the manufacture of a wide range of products, from coarse net to fine membranes.

Examples of stretched film netting are provided by the Delnet products of Applied Extrusion Technologies Inc. Two different styles are available, respectively identified as the filament type and the boss type, illustrated in Figures 6.31 and 6.32. Typical data for the two types are included in Tables 6.40 and 6.41.

Stretched film membranes made in the same way are typified by the Goretex products described in Chapter 8.

### 6.6.2 Extruded mesh

Fully bonded plastic mesh and other netting can also be produced by the Netlon extrusion process. Although akin to melt spinning, this is a unique method for the production of a wide variety of integral meshes. It uses two concentric,

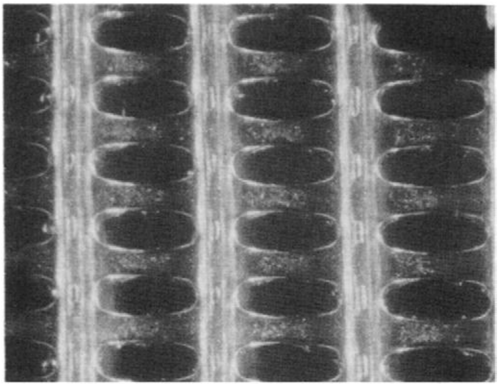


*Figure 6.31. 'Delnet' plastic netting: filament type RB0707-30P @ × 10 magnification.*

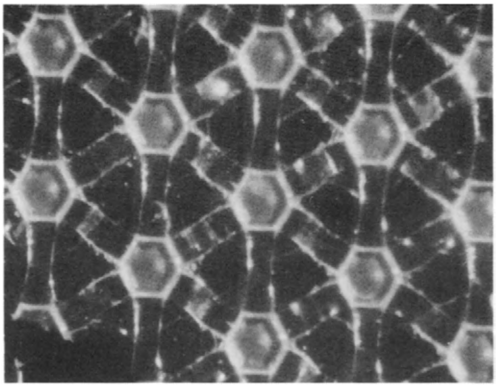


*Figure 6.32. 'Delnet' plastic netting: boss type AC530 @ × 30 magnification.*

**Table 6.40 Examples of filament type 'Delnet' polypropylene nonwoven fabrics[a]**

| Reference no. | RB0404-10P | RB0404-12P | RB0404-28P | RC0707-20P | RC0707-24P | RB0707-30P | R0412-10PR |
|---|---|---|---|---|---|---|---|
| Basis weight ($g/m^2$) | 33.8 | 27.0 | 18.6 | 18.6 | 30.4 | 30.4 | 43.9 |
| Filaments per cm | | | | | | | |
| Machine direction | 8.3 | 8.3 | 6.3 | 22.4 | 22.4 | 19.7 | 23.6 |
| Across machine | 5.1 | 5.1 | 6.3 | 9.1 | 9.1 | 9.8 | 5.5 |
| Thickness (μm) | 254 | 203 | 152 | 127 | 127 | 114 | 267 |
| Tensile strength (g/cm) | | | | | | | |
| Machine direction | 1430 | 1430 | 733 | 268 | 214 | 357 | 1787 |
| Across machine | 1430 | 1430 | 733 | 1251 | 965 | 1251 | 1787 |
| Permeability to air[b] | 4886 | 4886 | 6835 | 3158 | 4051 | 3763 | 4147 |

[a] Applied Extrusion Technologies Inc.

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

**Table 6.41 Examples of boss type 'Delnet' high density polyethylene nonwoven fabrics[a]**

| Reference no. | AC530 | D218 | D220 | EXP167 | KX215 | P520HF | P520 | P525 | P530 | P620 | PQ214 | PQ218 | X215 | X220 | X230 | X530 | X550 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Basis weight ($g/m^2$) | 17.9 | 33.8 | 29.1 | 24.3 | 37.2 | 22.6 | 27.0 | 21.6 | 21.0 | 28.4 | 54.1 | 30.4 | 33.8 | 27.0 | 21.0 | 18.3 | 12.2 |
| Filaments per cm | | | | | | | | | | | | | | | | | |
| Machine direction | 9.8 | 9.1 | 7.9 | 10.2 | 5.1 | 11.8 | 12.6 | 13.4 | 8.7 | 16.1 | 4.3 | 4.3 | 5.5 | 4.3 | 3.9 | 9.4 | 8.7 |
| Across machine | 11.8 | 4.3 | 4.7 | 11.8 | 5.5 | 11.0 | 13.8 | 11.0 | 14.2 | 15.7 | 4.7 | 4.3 | 4.7 | 4.3 | 4.7 | 9.8 | 9.4 |
| Thickness (μm) | 114 | 142 | 142 | 114 | 191 | 124 | 109 | 114 | 112 | 117 | 183 | 114 | 251 | 262 | 196 | 145 | 109 |
| Tensile strength (g/cm) | | | | | | | | | | | | | | | | | |
| Machine direction | 804 | 322 | 447 | 590 | 1215 | 894 | 894 | 590 | 876 | 822 | 1573 | 1055 | 733 | 715 | 447 | 536 | 518 |
| Across machine | 447 | 1948 | 1555 | 661 | 1305 | 804 | 804 | 1019 | 375 | 894 | 1072 | 929 | 1198 | 661 | 465 | 357 | 447 |
| Permeability to air[b] | 3638 | 2246 | 3177 | 1910 | 6077 | 1709 | 1574 | 2438 | 3418 | 1546 | 3331 | 2294 | 3100 | 5818 | 6106 | 4090 | 5376 |

[a] Applied Extrusion Technologies Inc.
[b] Air permeability, $l/dm^2/min$ @ 20 mm WG.

counter-rotating heads, each extruding a set of filaments around its perimeter: the two sets of filaments overlay each other to form a continuous tube of netting, which is slit as required to make flat strips. The net pattern, square, diamond, etc., depends upon the angle between the heads, while post-treatment, such as stretching, can produce other aperture shapes.

The Netlon process was invented in 1955 by the British textile technologist Brian Mercer and is now exploited in various forms by manufacturers in more than 40 countries throughout the world. The resultant diversity of products

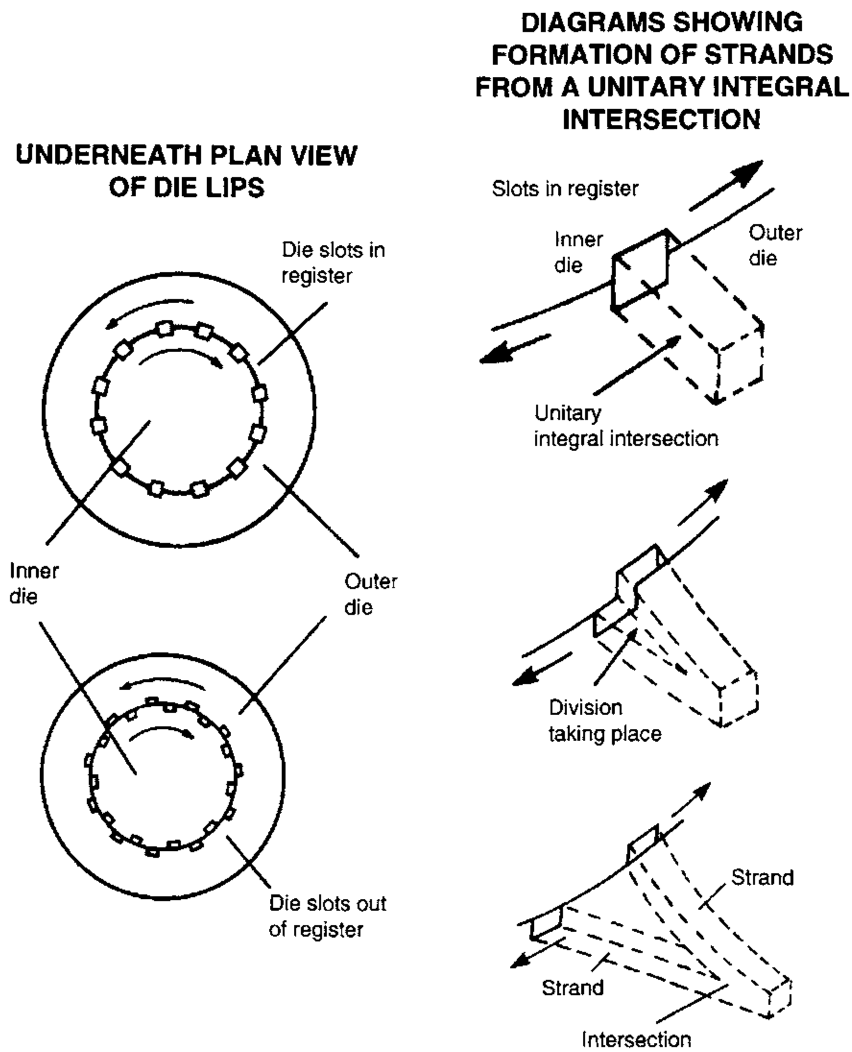



*Figure 6.33. Basic principles of the Netlon counter-rotating dies and the formation of strands of extruded polymer.*

have many applications, perhaps the most significant being as geotextiles in civil engineering, agriculture, horticulture and gardening, as well as in packaging.

The crucial component of the Netlon extrusion machine is the die head that, in the simplest version shown schematically in Figure 6.33, comprises two concentric counter-rotating dies, with a series of slots cut into the two edges or lips which are in contact with each other. When the slots are in register, the polymer melt is extruded as streams of double thickness; but rotation to bring them out of register causes each stream to be divided until they reunite as a slot in the inner die registers with the next one in the outer die. The result is the formation of a continuous mesh structure in tubular form, which is then drawn over a mandrel and subjected to stretching, slitting and quenching operations as required.

If the slots are regular and both dies are counter-rotated at the same speed, the mesh is of regular diamond pattern. Many variations are possible on this basic form, some of which are indicated in Figures 6.34. The characteristics of any particular mesh are largely determined by the profile and position of the slots (the precision of which is of crucial importance), the speed of rotation and the nature of the movement (which need not be constant).

A flat square mesh sheet is made as follows. One die is kept stationary, initially producing a diamond mesh with right-angled intersections. The tension of the sheet, as it is hauled off the extruder and passed under a roller set at 45° to the material path, causes the mesh to rotate as it is drawn down the mandrel. A cutter is set against this mandrel in such a position that it slits the material helically between a pair of adjacent strands, to form the desired flat square-meshed sheet.

The strands forming the mesh need not be of equal cross-section. Further variations, such as oscillation of one or both dies, permit a very wide range of figured pattern effects to be obtained. It is also possible to make a three-strand mesh by inserting a stationary die between the usual two rotating dies.

A highly important method of improving the strength, flexibility and lightness of Netlon mesh is by stretching the material, using rollers of varying speed and hot water as necessary; the stretching may be either longitudinally, transversely or both (i.e. biaxially), at production speeds up to 100 linear metres per minute.

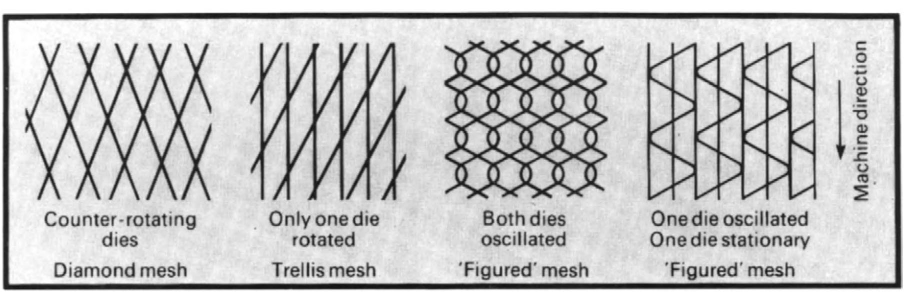



*Figure 6.34. Typical Netlon mesh patterns resulting from process variables.*

The effect is to increase the mesh area and also to strengthen the material very considerably by molecular orientation.

Simple methods of orientation stretch the mesh strands but leave the intersections unorientated. However, it is possible to make the intersections with a cross-section that ensures that they also orientate under suitable stress.

Although polyolefins are the most common materials used, the Netlon process is applicable to numerous other polymers, including nylon, vinyls, polystyrene and elastomers. An indication of the diversity of products possible is given in Figure 6.35. The range extends from very fine and flexible meshes containing as many as 1500 strands per linear metre and weighing only 10 g/m$^2$, to rigid tubular or sheet structures with 7 mm thick strands.

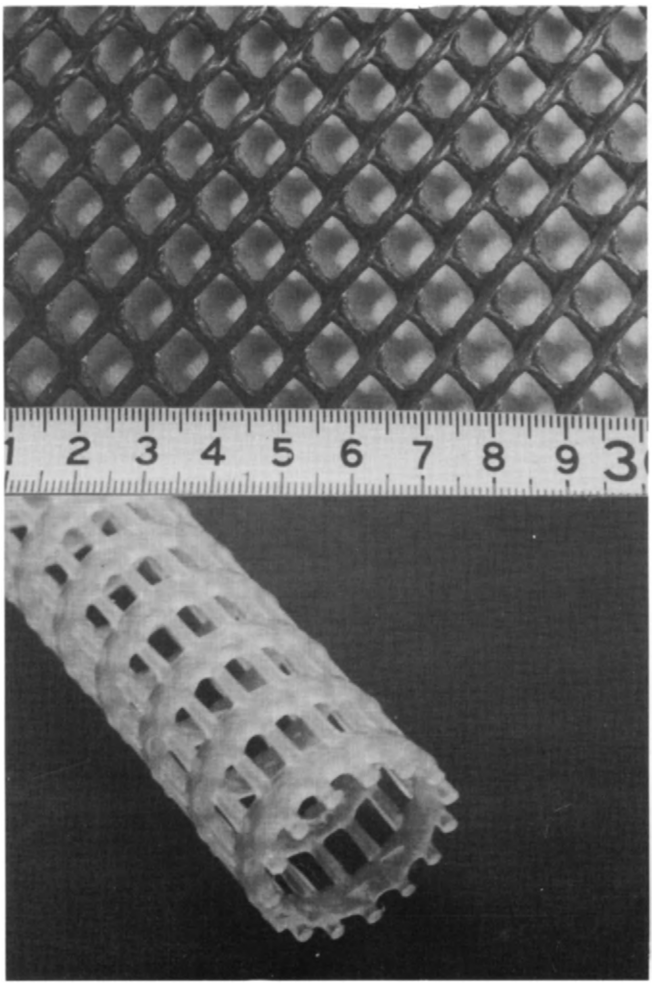



*Figure 6.35. Two examples of products of the Netlon process.*

Filtration applications range from simple heavy weight meshes, used as coarse strainers and separators and as backing cloths in filter presses, through to very fine meshes with apertures below 0.5 μm serving as separators between media layers in pleated cartridges. Rigid tubes are ideal as the cores of some styles of cartridge; examples of variations in the specifications of these tubes are given in Table 6.42.

Other examples of this process are the polypropylene and polyethylene Plastinet products from AET (Figure 6.36). Depending upon the thickness of the filaments, normally from 0.4 to 6 mm in diameter, the resultant netting may be soft and flexible, ranging up to fully rigid structures. Strand counts can vary from 1.2 to 6.8 per cm, giving products that can be flexible, 'lay flat' tubes, or rigid tubes, or flat sheets 5–245 cm in width.

**Table 6.42 Specifications of typical Netlon rigid tubes[a]**

| Structure number | Inside diameter (mm) | Outside (mm) (typical) | Aperture size diameter (mm) (typical) MX×TD | | Open area (typical) (%) | Polymer type | Weight |
|---|---|---|---|---|---|---|---|
| 10/87A | 22 (+0.5 – 0) | 27 | 3.0 | 4.5 | 28 | PP | 88 (±5) |
| 52/95M | 25 (+1 – 0) | 33 | 8.5 | 3.5 | 37 | PP | 130 (±5) |
| 7057 | 0 | 33 (+0 – 0.5) | 2.5 | 3.8 | 27 | HD | 120 (±5) |
| 7/96B | 26 (+0.5 – 0) | 34.5 | 3.5 | 4.5 | 27 | HD | 180 (±10) |
| 52/95D | 26.7 (+1 – 0) | 36 | 5.3 | 8.3 | 37 | PP | 150 (±5) |
| X125B | 27.6 (+0.9 – 0) | 35.5 | 5.3 | 3.7 | 28 | PP | 150 (±5) |
| X125A | 27.7 (+0.5 – 0) | 34.8 | 4.2 | 3.7 | 37 | PP | 135 (±5) |
| X197A | 30.5 (+0.5 – 0) | 36.4 | 5.6 | 5.0 | 29 | PP | 130 (±5) |
| 52/95L | 33 (+1 – 0) | 40.4 | 8.0 | 5.0 | 34 | PP | 150 (±5) |
| X193 | 38.2 (+0.6 – 0) | 43 | 6.4 | 6.2 | 44 | PP | 140 (±5) |
| 4/88A | 61 (+0 – 0.5) | 66 | 5.5 | 4.3 | 33 | PP | 170 (±10) |

[a] Netlon Ltd.

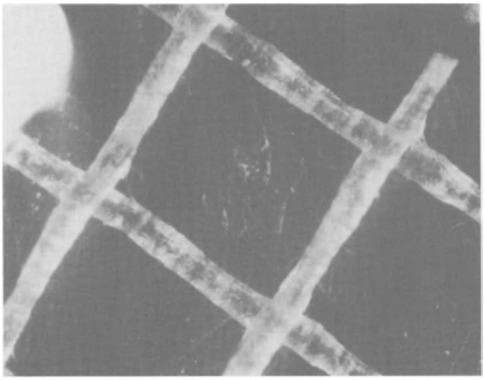


*Figure 6.36. 'Plastinet' netting @ ×24 magnification. 0.34 mm strands/cm. (Photograph: Applied Extrusion Technologies, Inc.)*

## 6.7 Selecting Screens and Meshes

The prime characteristics of screens and meshes from the point of view of filtration lie in their accuracy of separation, and in their operating features of resistance to high temperatures, corrosion and abrasion – these latter features referring essentially to metal media, although polymeric media can now operate at quite high temperatures. Thus they should be chosen where accuracy of size separation is an important requirement – the most obvious example being their use in sets of test sieves, used for analysing the particle size composition of a mixture of solids.

The presence in the feed slurry of chemically corrosive liquids or abrasive solids indicates that the first place to look for a suitable medium is among the materials covered in this chapter.

A high proportion of coarse filtration is done by woven mesh screens – in such devices as in-line strainers and inlet screens. There is a strong element of unattended operation in many of these applications, especially where the screens are automatically cleaned.

By virtue of the fact that these media largely operate by surface filtration, they are prone to the risk of plugging, where a particle lodges in a pore, thereby blocking it. This means that prolonged operation requires some form of backflushing to clear the plugged holes. However, the nature of these materials means that this cleaning operation is relatively easy – by shaking or rapping, by brushing, by pressurized water or by chemical cleaning.

The heaviest duties in separation in terms of abrasion, such as mineral dressing operations, are satisfied with bar screens and punched or milled perforated sheets, while, at the other extreme, in, say, the sifting of flour, fine wire or plastic meshes are required.

Apart from the finest levels of separation, which might require membranes, and situations where very high degrees of solid removal are required, then woven meshes and screens now offer a good choice to the filter designer. They include some of the strongest constructions, such as bar screens or laminated sintered wire mesh, and are, of course, widely used also as supports for other media.