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Application fields for nonwovens

Heinrich Jackob
Textilmaschinenfabrik, Austria

The applications of nonwoven fabrics in the field of geotextiles and filtration have been discussed, highlighting the market share, raw materials used, manufacturing process and various end uses of these products.

Keywords: Filters, Geotextiles, Microfibre, Spray bonding, Spun bonding, Technical textiles, Thermobonding, Wadding

1 Introduction

Technical textiles is a general term for products, woven or nonwoven, used in industrial processes. In fact, the technical textiles are tailor-made products where the properties of the woven or nonwoven are adapted to the requirements of the process. This paper gives some general information on designing the technical textiles and shows the possibilities of influencing the properties of nonwoven products.

The properties of a nonwoven fabric can be influenced by the fibre characteristics, processing conditions, nature of bonding, and finishing conditions. The way these parameters influence the properties of nonwoven fabrics has been discussed by taking the example of geotextiles and filters.

2 Geotextiles

The geotextile market is dominated by the nonwoven products with a share of 66% followed by the woven products with 26% (Fig. 1). Further, in nonwoven geotextiles, polypropylene fibre dominates with a share of 80%, followed by polyester with 16% (Fig. 2).

On the basis of the application and basic functions, geotextiles can be put into four main categories:

—Stabilization
—Reinforcement
—Separation
—Drainage/Filtration

It is, therefore, quite natural that a wide range of products is required to be produced by different ways of production. Fig. 3 shows the different possibilities of producing nonwoven geotextiles from web forming through bonding to finishing. In web forming, staple fibres or continuous filaments can be used. While using staple fibres, there is the possibility of applying either the conventional carding followed by cross folding or the airlay process.

In the airlay process (Fehrer V21/K12), a randomized product is manufactured which is then needled, CD-stretched and thermofixated. Fig. 4 shows Fehrer V21/K12 production line which produces geotextiles with an MD/CD ratio of 1:1. But in case of conventional carding followed by

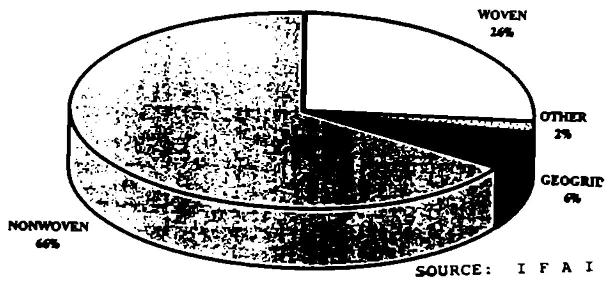

Fig. 1—Geotextile market

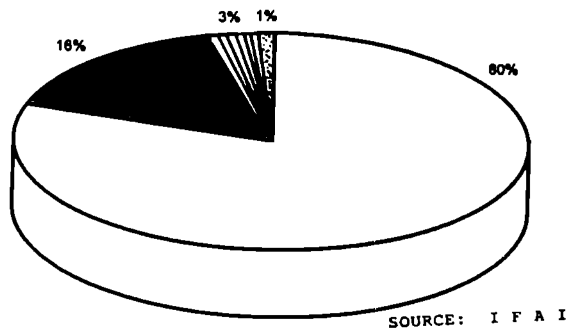

Fig. 2—Fibres used in geotextiles [□-polypropylene, ■-polyester, ▣-polyethylene, and ⊟-others]

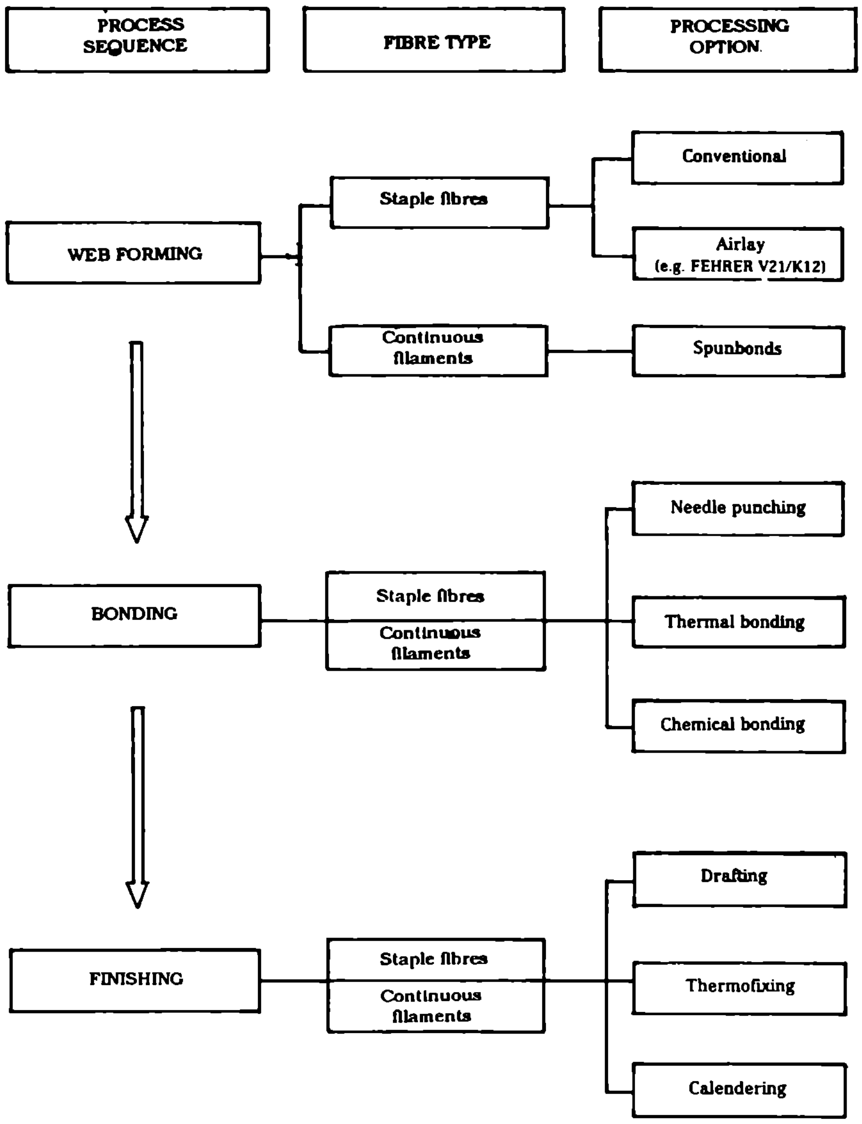

Fig. 3—Production methods for nonwoven geotextiles

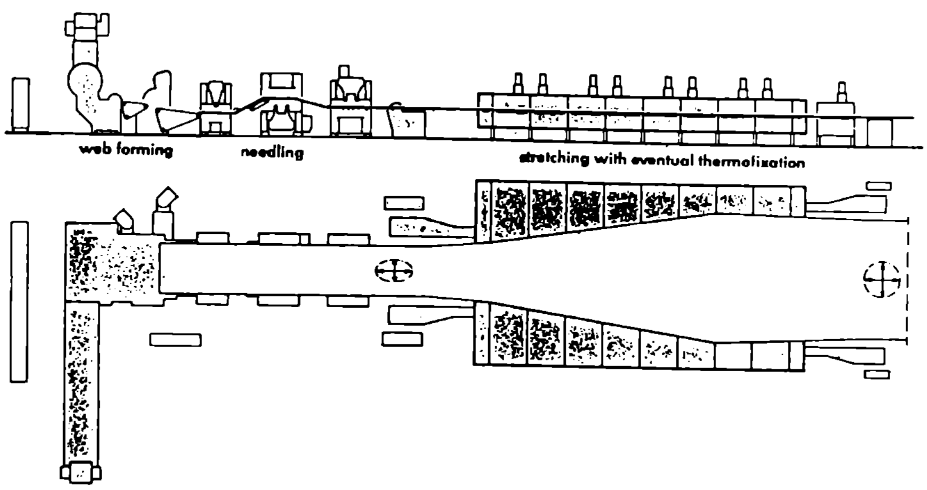

Fig. 4—V21/K12 production line for geotextiles

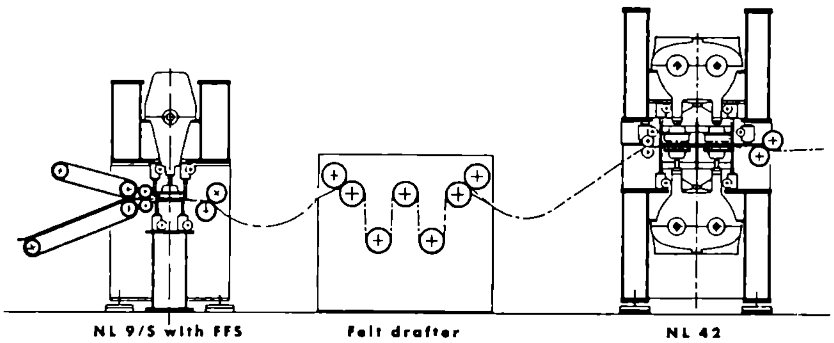

Fig. 5—Needle-punching line for cross-folded web

needle punching, MD-drafting is used in order to achieve MD/CD ratio of 1:1.

Fig. 5 shows a geotextile line with pre-needling, felt drafting unit and a NL42 Quadro punch needle-punching machine. Instead of NL42 Quadro punch machine, the NL9/SRS Tandem (Fig. 6), which has several advantages over the NL42, can be used. The NL9/SRS has less draft compared to the NL42 by giving more free transport time for the felt during needling (Fig. 7).

The processing of continuous filaments usually requires needling lines for spunbonds. Fig. 8 shows a typical needling line for spunbonds. This line, consisting of NL2000/S, is used for producing geotextiles as well as base fabrics for roofing felts which are bitumen-coated afterwards. In this field, mainly polypropylene and polyester are used. These production lines are characterized by a very high capacity and do require high-speed needle looms for round-the-clock operation.

Fehrer AG supplies its NL2000/S and, as the latest development, the NL3000 with a maximum stroke frequency of 3000 rpm for speeds of up to 50 m/min.

By using the different processes shown in Fig 3, different products can be manufactured in adaptation to the requirements of the product's application.

3 Filters

Filtration has become a very important field of application for nonwovens, especially with the background of protecting our environments. Table 1 shows different fibres which can be used in filtration and their characteristics.

Filters should have not only the strength—a main factor for geotextiles—but also the resistance to acids, heat and bacteria/mildew. The fibre denier is of special importance in filtration and is to be adapted to the size of the particles

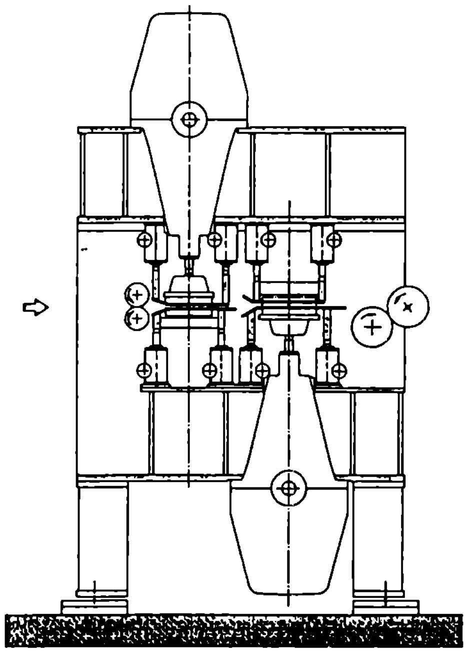

Fig. 6—Fehrer NL9/SRS Tandem

which have to be filtered. So, in filtration products, there is also the tendency to use micro-denier fibres.

Micro-denier fibres can be produced out of the multifilament fibres, developed from bicomponent fibres (Fig. 9). These fibre systems, which are coarse denier consisting of several micro-denier fibres, are first carded and then separated into micro-denier fibres by either mechanical or chemical treatment, whereby the carrier substance of the micro-fibres is solved out of the finished product.

A typical needle-punching line, consisting of pre-needling, up-stroke needling and finish needling in a double-board needle-punching loom is shown in Fig. 10.

In most cases, the manufacture of filtration products requires needling from both sides. For this,

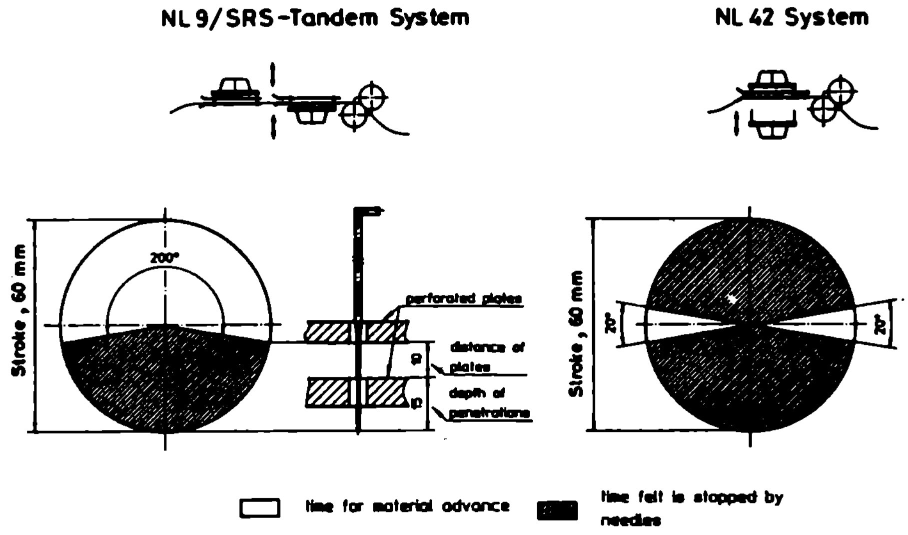

Fig. 7—Comparison of free transport time

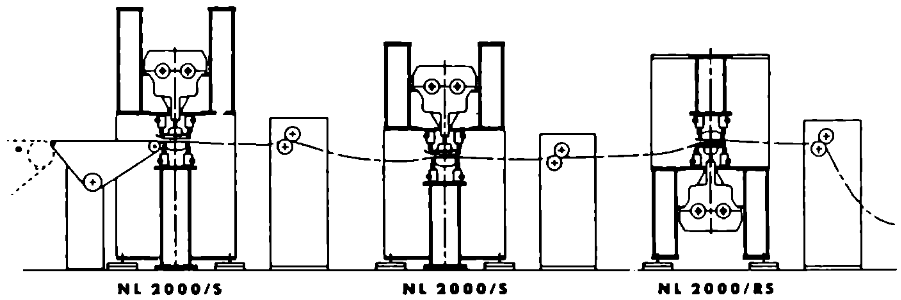

Fig. 8—High-speed needle-punching line for spunbonds

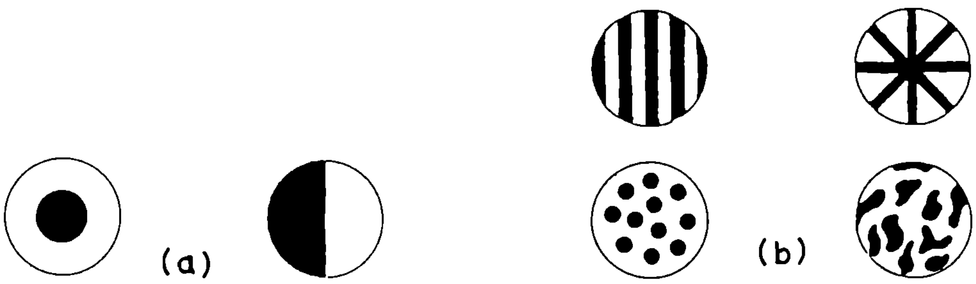

Fig. 9—(a) Bicomponent fibres and (b) microfibres

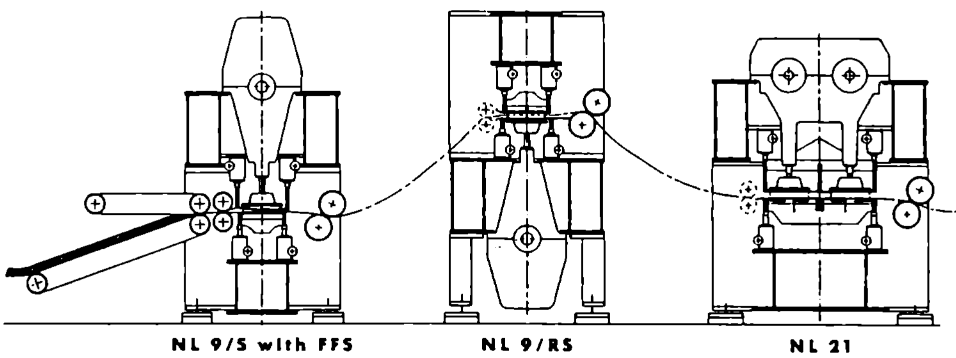

Fig. 10—Needle-punching line for filters

Table 1 — Fibres used for filtration
[Source: Nonwoven Industry - February 1990]

Fibre	Recommended continuous operation temperature (dry heat) °C	Water vapour saturated condition (moist heat) °C	Maximum (short time) operation temperature (dry heat) °C	Specific density	Relative moisture regain, % (at 20°C& 65% RH)	Supports combustion	Resistance to					
							Bacteria/ mildew	Alkalies	Mineral acids	Organic acids	Oxidizing agents	Organic solvents
Cotton	82	82	94	1.50	8.5	Yes	No (if not treated)	Good	Poor	Poor	Fair	Very good
Wool	94	88	110	1.31	15	No	No (if not treated)	Poor	Good	Good	Fair	Very good
Polyamide (Nylon 66)	94	94	121	1.14	4-4.5	Yes	No effect	Good	Poor	Poor	Fair	Very good
Polypropylene (Herculon)	94[a]	94	107	0.9	0.1	Yes	Excellent	Excellent	Excellent	Excellent	Good	Excellent
Polyester (Dacron)	132	94	150	1.38	0.4	Yes	No effect	Fair	Fair	Fair	Good	Good
Acrylic copolymer (Orlon)	120	110	120	1.16	1.0	No	Very good	Fair	Good	Good	Good	Very good
Homopolymer (Acrylic/Dralon T)	125	125	150	1.17	1.0	Yes	Very good	Fair	Very good	Excellent	Good	Very good
Aromatic aramid												
Nomex	204	177	240	1.38	4.5	No	No effect	Good	Fair	Fair	Poor	Very good
Teijinconex	200	180	250	1.37-1.38	4.5	No	No effect	Good	Fair	Fair	Poor	Very good
Polytetrafluoroethylene												
Teflon	260	260	290	2.3	0	No	No effect	Excellent	Excellent	Excellent	Excellent	Excellent
Toyoflon	260	260	290	2.3	0	No	No effect	Excellent	Excellent	Excellent	Excellent	Excellent
Expanded PTFE (Rastex)	260	260	290	1.6	0	No	No effect	Excellent	Excellent	Excellent	Excellent	Excellent
Polyetherimide (Akzo PEI)	170	170	200	1.28	1.25	No	No effect	Good (pH-9)	Good	Excellent	Good	Good[b]
Sulfar (PPS)												
Rylon	190	190	232	1.38	0.6	No	No effect	Excellent	Excellent	Excellent	Fair[c]	Excellent
Teijin PPS	190	190	230	1.34-1.35	0.24-0.25	No	No effect	Excellent	Excellent	Excellent	Fair	Excellent
Bayer PPS	190	—	230	1.37	>0.6%	Self quench (LOI 39-41%)	—	Excellent	Excellent	Excellent	Fair[d]	Excellent
Polyketone (Zyex)	240	240	300	1.30	0.1	No	No effect	Excellent	Very good	Excellent	Good	Excellent
Polyimide (P 84)	260	195	300	1.41	3.0	No	No effect	Fair	Very good	Very good	Very good	Excellent[e]

Table 1 — Fibres used for filtration (Contd.)
[Source: Nonwoven Industry - February 1990]

Fibre	Recommended continuous operation temperature (dry heat) °C	Water vapour saturated condition (moist heat) °C	Maximum (short time) operation temperature (dry heat) °C	Specific density	Relative moisture regain, % (at 20°C & 65% RH)	Supports combustion	Resistance to					
							Bacteria, mildew	Alkalies	Mineral acids	Organic acids	Oxidizing agents	Organic solvents
Glass (Fibreglass)	260	260	290	2.54	0	No	No effect	Fair	Very good	Very good	Excellent	Very good
Metal[f] (Bekinox)	550	550	600	7.9	0	No	No effect	Excellent	Good	Very good	Excellent	Excellent
Ceramic												
Nextel 312	1150	1150	1427	2.7	0	No	No effect	Good	Very good	Very good	Excellent	Excellent
Fibretax	1260	1260	1790	2.7	0	No	No effect	No effect	Very good	Excellent	Excellent	Excellent

[a] 121°C for type 154; [b] PEI fibre is dissolved by partially chlorinated hydrocarbons; [c] PPS fibre is attacked by strong oxidizing agents, e.e. at 94°C for 7 days; [d] depends on concentration; [e] soluble only in strong polar solvents (DMF, DMAC, DMSO, NMP); and [f] INCONEL 601.

the NL9/SRS Tandem with an FFS can be used as pre-needling and finish needling loom in one operation.

Fig. 11 shows the influence of the needling density on strength and air permeability of a filtration product. It is observed that the increase in needling density increases the strength of the fabric but decreases the air permeability due to the increased density of the product.

Needle-punched fabrics are used in simple bag filters for liquid filtration as well as in complex industrial processes. Filtration can be generally divided into liquid filtration and air filtration. Whereas the filters can be divided into storage and cleaning filters. The storage filters are mainly for air filtration, with low dust contents, whereby voluminous webs are used which are produced on the V21/K12 production line.

Cleaning filters are used for dust extraction. In this case, woven fabrics, bonded webs and needled felts are used. The use of a needled web as a filter for dust extraction has several advantages

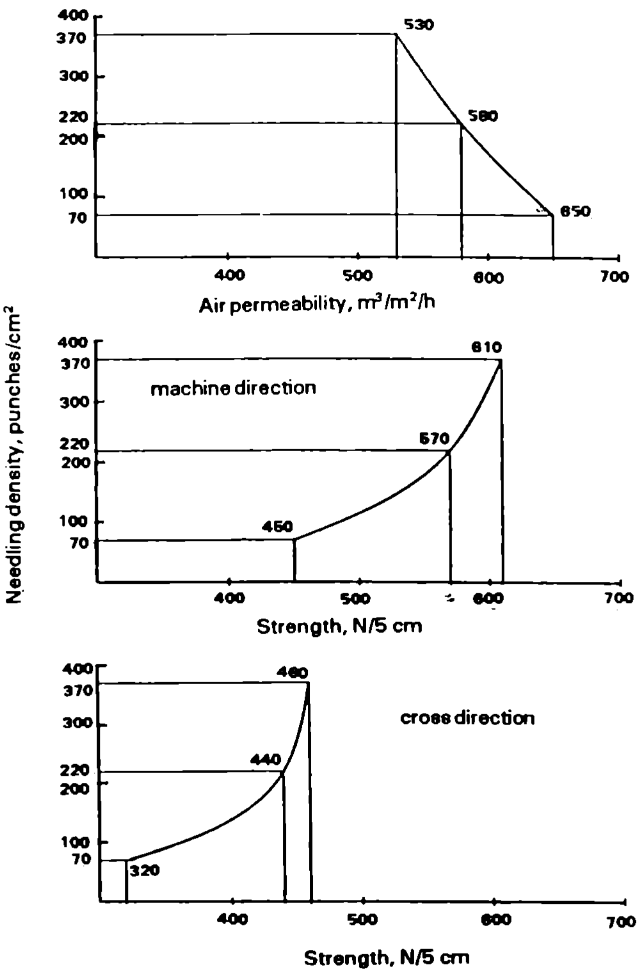

Fig. 11—Effect of needling density on filters' properties [Filter fabric: Polyester, 6.7 dtex; thickness, 60 mm; weight, 350 g/m²]

over a woven fabric. The web has a three-dimensional structure, cheaper in production and is a storage and surface filter, whereas a voluminous fabric is just a surface filter.

Needled felts are used with an integrated scrim in order to give strength and stability. The paper maker felts are also a very special system in filtration. Fig. 12 shows the structure of a paper maker felt which consists of a back-layer, a base fabric and a covering layer. This structure gives a lot of possibilities of designing these fabrics which are custom made for different paper maker machines.

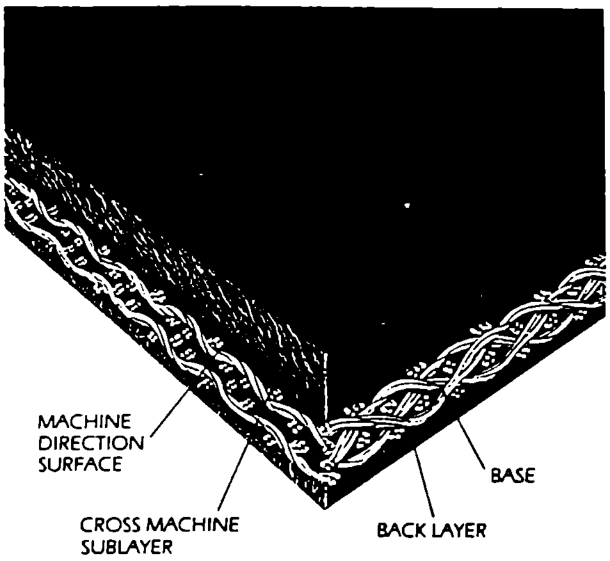

Fig. 12—Structure of a paper maker felt

Fig. 13 shows the different paper maker felt designs that can be produced by variations in the scrim and layers. Even the fibre orientation in the felts can be influenced. The Fehrer Variofelt System offers the possibility of producing these felts in which the fibres are in machine direction.

Fig. 14 shows the cross section of a paper maker needle loom NL20/3 + Variofelt for the production of endless paper maker felts.

As already mentioned, high-loft webs are used in air filtration with low dust contents. In this field the Fehrer K12 is used, which has been recently improved and the improved version is called as the K12-high loft system.

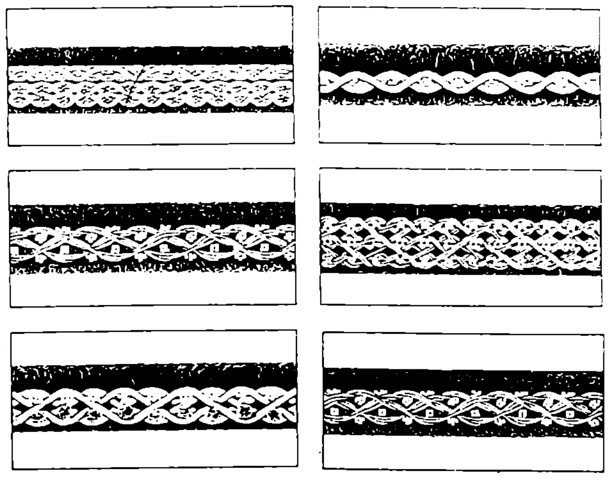

Fig. 13—Designs of paper maker felt

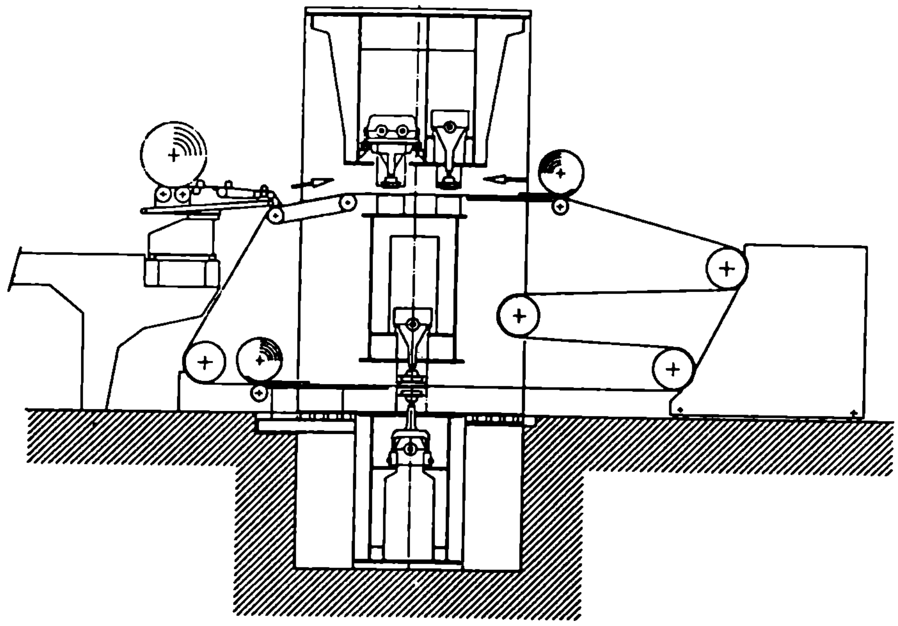

Fig. 14—NL20/3 + Variofelt system

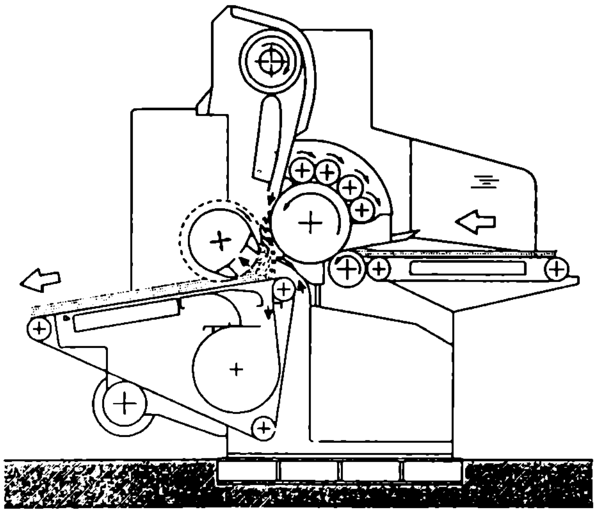

Fig. 15—K12-high loft system

In filtration, thermobonded products are preferred to spraybonded webs. Apart from filtration, these thermobonded webs are used for waddings and insulation. The development of thermobonded webs was not only demanded by the properties of the products but also from an environmental point of view. The thermobonded fibres, which are bicomponent fibres made out of polyester and copolyester, are replacing the spraying of the webs with chemical binders. By using these bicomponent fibres, a better bonding is achieved as the bonding goes all through the product and is not only on the surface as in case of spraybonding.

The K12-high loft system (Fig. 15) increases the web height at the same web weight. Figs 16 and 17 show a comparison of the web structure and web thickness respectively for K12 and K12-high loft system. The web height produced on K12-high loft system can be 80% higher than that produced on a standard K12.

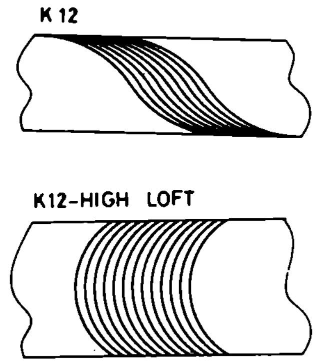

Fig. 16—Comparison of web structure produced by K12 and K12-high loft systems

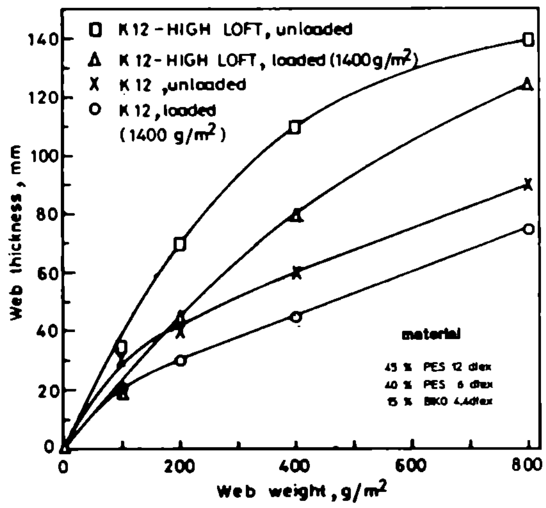

Fig. 17—Comparison of web thickness obtained on K12 and K12-high loft systems

Technical textiles will be a main field of development for the future and all nonwoven processes will have a main share in this development. Fehrer, as a machine producer, is participating in this current development, by extending support to the customers in solving their problems of web forming and needle punching.