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SPUNLACED COTTONS

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Abstract

Skin wounds have traditionally been covered to protect the wound from contamination and to permit the skin to heal preferrably without leaving scars. These wounds may be treated in hospitals, clinics or at home. Fresh wounds initially produce a little to large amount of fluid exudate which provides an environment for bacterial growth and infection. One of the purposes of the dressing and bandage is to absorb the body fluid and maintain a sterile environment for wound healing.

The preferred material for medical/surgical dressings, sponges, and bandages for the past one hundred years has been woven cotton gauze in several plain weave variations. These materials, made from Absorbent Gauze, are described in the United States Pharmacopeia (USP). Because the gauze is used to convert it to dressings and bandages for wounds, the standards of construction and chemical purity of gauze are well defined in the Absorbent Gauze monograph. Sterilized dressings and bandages are used as wound care materials.

Most surgical sponges, pads, topical wound dressings and bandage rolls are made from USP Absorbent Gauze or gauze processed to USP purity standards. (Refer Table 1). The test proceedures are to be performed as per the U.S. Pharmacopeia.

Table 1: Purity Standards for USP grade Cotton Gauze

Test	**Specification**
Absorbency	Less than 30 Seconds
pH	6.0 to 7.5
Water Soubles	Max 0.6% (owf)
Ignited Residue	Max 0.16% (owf)
Ash	Max 0.12% (owf)
Ether Extract	Max 0.7% (owf)
Alkalinity	Negative
Acidity	Negative
Starch	Negative

During the past ten years newer fabrics based on an alternate nonwoven technology, spunlacing (hydroentangling), have reached sales and production levels that challenge the previous exclusive use of woven gauze. Spunlaced fabrics often better the aesthetic and physical characteristics of traditional woven gauze products used as absorbent medical devices. They are safe, cost competitive and may provide functional advantages not provided by gauze or other types of nonwoven fabrics.

In spunlacing fine, high speed jets or curtains of water of high energy impact onto a fibrous web. This causes the fibers to curl, entangle, interlace and knot about each other. The advantage of this process over chemically bonded products is the absence of binders which glue fibers to one another. Thus, binder-free nonwovens are produced for applications where chemicals are not desired, especially in hospital operating rooms. Since the water-jets in this process perforate the web, the product takes on an aesthetically pleasing woven appearance. This appearance can be

controlled or changed by supporting the web on a perforated or patterned screen, plate or drum so that the fibers become entangled and the product assumes the pattern of these web supporting devices. Spunlaced fabrics made with bleached cotton are being produced around the world, most prominently in Japan. Cotton, polyester and rayon are the most frequently used fibers and they are often blended to obtain certain desired physical and functional characteristics. The broadening of the spunlacing markets results essentially from technology improvements, and above all, improvements in manufacturing costs.

Spunlacing fabrics for medical devices are produced in the U.S.A. by Dupont, PGI, BB Nonwovens and others. Finished sponges and bandage rolls are converted and sold by Johnson & Johnson, Kendall Healthcare and others for the hospitals, dental, consumer and other institutional markets. Spunlaced fabrics are also produced in Europe and the Far East for a variety of medical industrial uses. The market is expected to grow around 12% per year for the next few years.

Market data show a 25% dollar penetration of spunlaced fabrics into a medical market that formerly used woven gauze exclusively. Medical sponges and bandage rolls utilize approximately one billion square yards of woven and nonwoven fabrics in the United States. The continued increased use of hydroentangled fabrics demonstrates the acceptance of medical professionals and other consumers who have recognized the unique fabric features, desirable functional attributes and economics of spunlaced sponges and bandage rolls.

There are differences in the physical and functional attributes of woven and nonwoven medical fabrics used for the same purposes but made by dissimilar technologies. Plain woven Absorbent Gauze, as described in the current USP monograph is modified by increasing the fabric weight by increasing the average thread count. (Refer to Table 2 reproduced from USP monograph). This is required because the warp and fill threads are usually of standard sizes and weights for each fabric construction type. This facilitates yarn and fabric manufacturing. Surgical Nonwoven Fabric made from spunlaced fabric via hydroentangling technology achieves different fabric weights by varying the base fiber web weight while the yarn fiber bundle pattern remains constant due to the fixed patter drum or screen used in the process (refer to Table 3). For example, a Type C Surgical Nonwoven Fabric having a nominal fiber bundle count of 20 x 12 may range in weight from about 10 to 70 g per sq. meter, depending on the weight of the fibrous web processed through the hydroentangling equipment. The fabric pattern will remain the same although the fabric weight changes. This is different than in the Absorbent Gauze monograph where the fabric weight increases or decreases as the pattern (thread count) is changed due to the use of standard yarn sizes in the woven constructions.

Table 2. Construction of Different of USP Woven Gauze

Type	Threads per 2.54 cm. Warp	Threads per 2.54 cm. Filling	Average Count Threads per 6.45 sq. cm.	Weight g* per sq. meter
I	41 to 47	33 to 39	76 to 84	43.8 to 55.8
II	30 to 34	26 to 30	57 to 63	32.9 to 41.9
III	26 to 30	22 to 26	49 to 55	28.4 to 36.2
IV	22 to 26	18 to 22	41 to 47	24.5 to 31.1
V	20 to 24	16 to 20	37 to 43	22.5 to 28.8
VI	18 to 22	14 to 18	33 to 39	19.8 to 25
VII	18 to 22	8 to 14	27 to 35	18.1 to 23.1
VIII	12 to 16	8 to 12	21 to 27	12.1 to 15.5

Most Surgical Nonwoven Fabrics have been designed to replace the common gauze fabrics used for sponges, bandages and dressings. In an attempt to have the nonwoven fabrics appear similar to woven gauze, the fiber bundles tend to have counts like the woven gauze fabrics. Although the nonwoven fabrics are similar to gauze, the bundle counts are usually not the same due to the available screen and drum patterns.

The design and production of Surgical Nonwoven Fabrics for the medical end uses described in the current Absorbent Gauze monograph may equal or exceed the openness of woven gauze because of the high density of the hydroentangled fiber bundles and their interconnected junctures. The uniformity of the fabric pattern, the open spaces, the stability of fabric openings and the various physical and functional characteristics, the open pattern impart to the fabric are different than those obtained with plain woven gauze.

Table 3. Suggested Construction of Different Types of Nonwoven Surgical Fabric

	Fiber Bundles per 54cm			
	Range of Bundles		Bundle Count	Fabric Weight
Type	MD*	CMD**	per 6.45 sq. cm.	g per sq. meter
A	32 to 24	28 to 20	60 to 40	10 to 70
B	23 to 17	23 to 17	46 to 34	10 to 70
C	23 to 17	14 to 10	42 to 30	10 to 70
D	23 to 17	11 to 5	34 to 22	10 to 70
E	17 to 11	11 to 5	28 to 10	10 to 70
F	14 to 10	14 to 10	28 to 20	10 to 70
G	14 to 10	8 to 4	22 to 14	10 to 70

The fiber bundles may be designed with high density areas that provide a fine capillary structure. This allows a rapid absorbency rate or less dense areas with larger capillaries that create high absorbent capacity. These absorbency rate and capacity features can be engineered into spunlaced fabrics as performance advantages and tend to be unique to these fabrics. The reduced openness of woven fabrics described in the Absorbent Gauze monograph can be related to loose spun cotton yarns and relatively unstable plain weave constructions. Fiber bundle density and fabric stability in the spunlaced fabric are due to the fiber bundle interconnections.

Nonwoven fabrics with well-defined open patterns exhibit physical and performance characteristics equal to or better than those of woven gauze and are ideally suited for sponges, dressings, and bandage rolls. Surgical Nonwoven Fabric conforms to all chemical analysis requirements of the present Absorbent Gauze monograph and is safe to use for all similar products.

The described physical attributes of Surgical Nonwoven Fabric when made into sponges, dressings and bandage rolls provide improved wicking and greater absorbent capacity than similar Absorbent Gauze products. This may create drier wound sites with less potential for bacterial growth. Nonwoven dressings made from Surgical Nonwoven Fabrics also produce less lint and fragments which can cause granulomas and delayed wound healing. When used as post-operative and trauma dressings, Surgical Nonwoven Fabrics are less adherent to wounds than comparable gauze products and therefore enhance wound healing and patient comfort. One of the problems with gauze dressings is trauma to the wound when the dressing is changed. The fibers from the gauze dressing tend to adhere to fluid exudate or get trapped into the newly formed tissues. When the gauze dressing is changed it tears some of the newly formed tender tissues. The nonwoven spunlaced dressings are thus non-adhering dressings.

Fibers Used Are:

- bleached cotton (most prominently in Japan and Germany); cotton is most suited to spunlacing.
- wood pulp
- lyocel
- polyester and rayon, and their blends to obtain certain desired physical and functional characteristics.

Spunlacing Line Fabric Manufacturing Possibilities include production of composites using combination of technologies:

- Carded web + spunlacing
- Air-laid web + spunlacing
- Marriage with other technologies to produce composite structures

In summary, we can say that the broadening of the spunlacing markets results essentially from technology improvements, improvement in machine manufacturing (Newer generation machines with water and energy savings and wider widths) increased line speed, and above all, improvements in manufacturing costs.