THERMO- INSULATION MATERIALS FOR TEXTILE GOOD MANUFACTURING

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Abstract:

Different thermo- insulation materials are used manufacturing garments and other textile goods to create a layer of trapped air to retain heat of a human body. The insulation materials can be divided into two groups: flat 2D materials and free fibres. On the bases of the origin, there are available natural material waddings and synthetic fibre waddings. Cotton, silk, wool and down as wadding materials have longest application. They can ensure different comfort level and properties. Polyester waddings are used starting from 20th. They are hydrophobic and cheaper than the most part of natural origin waddings. Sustainable and advanced wadding materials improve performances to reduce negative properties of both, traditional natural and synthetic origin waddings.

Keywords: *Thermal insulation; Wadding materials; Natural fibres; Synthetic fibres; Sustainability; Comfort.*

1. INTRODUCTION

Bulky insulation materials called waddings (in Europe, UK, Australia) and paddings (in USA) are used in garments and other textile goods to create a layer of trapped air and with it to retain heat of a human body and add a fuller and more padded appearance (see Fig.1). Waddings are also commonly used in quilting to manufacturing bed cloths.

Figure 1: Garments with insulation materials

Insulation materials for textile goods can be divided into two groups: flat 2d materials and free fibres (see fig.2, a). 2D goods are non-woven fabrics which can be packaged and transported in rolls. They use to be cut in necessary shapes like any other fabrics [13]. Free fibres, down or feather consist of millions separate small items. They are stored in bags and manufacturing textile products blown in their separate parts (see fig.2, b).

a b

Figure 2: 2d flat (a) and free fibre (b)

2. ORIGIN OF ISOLATION MATERIALS

According to the origin of materials waddings can be divided in two groups: synthetic origin and natural origin materials.

2.1 Natural origin padding

Natural origin waddings have the longest application. They are used creating clothing and different other textile goods many centuries. Natural origin waddings are manufactured from plant and animal fibres and s of birds.

2.1.1 Natural origin fibre wadding

Natural origin fibre waddings are produced from cotton, hemp, silk, wool or cashmere. Currently the most often natural fibre waddings are used in quilting processes manufacturing bed cloths. Natural waddings are manufactured opening, carding, and layering natural fibres to form a web, and bonding them mechanically or thermally [13]. Using needle punching method the fibres are interlocked punching them with barbed needles. The fibres can also be bonded by heat. Then they pass through hot air ovens, infrared heaters, or heated rollers.
Cotton is the least expensive natural fibre wadding material. It has a low loft, drapes well, and is soft, cuddly. However, it is heavy. Bamboo wadding is softer and have silky feel, drapes well and also has low loft. Cotton and bamboo materials are good choice for textile goods used in warmer climates. Wool wadding is lighter, has medium to high loft. It is soft and has very good thermo-insulation properties. Silk wadding is a very soft and lightweight, good thermo insulator, too [1, 2]. Wool and silk waddings are preferable for goods used in cooler climates. There are also available blended waddings in the market. Polyester use to be added to cotton to reduce weight and price of a natural origin wadding. The most common blends found in the market are 80% cotton and 20% polyester. Eco-friendly waddings are a 50/50 blend of bamboo and cotton. Cotton, wool, silk and bamboo waddings have tendency to shrink. Comparing with other kind of waddings, natural ones are heavier and have higher cost.

2.1.2 Bird down and feather wadding

Duck and goose down and feather are usually used as wadding material in garments, bed cloths and other textile goods (see Fig.3). The quantity of down, in relation to feathers in textile goods can varies. The highest level thermo-insulation is obtained using proportion 90/10 when 100g of wadding has 90g down and 10g of farther. Down is the soft, small feather found underneath the larger feathers that give

the bird warmth and this down doesn't have a quill (see Fig. 3). Down has very good thermal insulation qualities. It is very light, able to trap air and has high resilience properties [16].

Figure 3: Bird downs

Down quality is characterized by two parameters: *down fill* power and *fill weight*. The *fill power* is a measure (in cubic inches) of how much space is filled by one ounce of down (see Fig. 4). A higher *fill power* number indicates greater wadding loft, meaning the down can trap more air and provides better insulation and a higher warmth-to-weight ratio. *fill power* of down can vary from around 450 to over 900, with most high-quality down products featuring a *fill power* of 800 or above.

Figure 4: Fill power measuring tubes

Down *fill weight* is the actual amount of down insulation in a product, measured in grams or ounces. A higher *fill weight* generally indicates a warmer but a heavier and bulkier textile product [4].
Down is famous for its ability to deliver extraordinary warmth. The structure of down (its loft) allows it to trap body heat very efficiently. The same time goods with down wadding are very light, easy to compress. After relaxing pressed goods, down does not lose its loft. Down is very durable. However, down has also several disadvantage. When it gets wet or damp, it loses shape and insulation ability. Down takes a long time to dry, it sticks together drying. The down as a wadding material also has high cost, goods with down wadding are usually more expensive than others with synthetic fill. Down can also cause allergic reactions to sensitive people [5].
Has to be added that several serious problems exist using traditional down and feather production methods. Firstly, the down is obtained from animals - geese and ducks. For people who do not want to use animal products, this is a significant drawback. Secondly, in farms the birds use to be force-fed to grow faster. The down use to be plucked from live animals, creating them stress and pain. To avoid

these disadvantages, many manufacturers of textile products already use down certified by the Responsible Down Standard (RDS) [7]. The RDS is a global certification given to high quality down products to ensure that the birds were treated humanely and not subjected to unnecessary harm, such as force-feeding or live-plucking. In addition to RDS, some companies have developed their own standards and means of controlling their down sourcing, for example, Traceable Down Standard by Patagonia [6,8] and Mountain Equipment's Down Codex [9].

2.2 Synthetic fibre wadding

Synthetic waddings are developed in 20 century when polyester fibres got wide application in textile industry. Generally, synthetic waddings are more breathable than down waddings, but they are less warm, and less compressible than down. Being hydrophobic they are best choice for textile goods used in damp climates. Wet synthetic fill does not lose its loft, continues to insulate human body even when soaked, and dries out quickly. However, over time, synthetic waddings compress, lose their ability to loft, become less warm resulting in a shorter lifespan. Often synthetic waddings are cheaper than other kind of fill. Advanced synthetic insulation can also be pricey, particularly newer high-end products designed to replace down. As synthetics are petroleum based, they result in greenhouse gas emissions. Some synthetic waddings can release micro pieces of plastic into the water during each wash. Currently many wadding manufacturers already use recycled polyester to make their production more sustainable. Manufacturing 2D rolled waddings two different techniques are used to hold synthetic fibres together: thermal and resin bonding [13]. Thermal (heat) bonding method uses small low melt polyester fibres which melt easy under heat. They stick or bond to the larger polyester fibres. Bonding creates a lofty wadding product. Using resin bonding method fibres are glued by specially selected polymer resins. They provide elasticity to the end product and prevent individual fibres from migrating. Advanced waddings are manufactured from bi-component fibres which consist of a standard polyester core and a low-melting membrane on the outside [14].

3. ADVANCED WADDING MATERIALS

During the last decades many companies are developing new kind of wading materials which are friendlier to nature and human society. The most part of manufactures are already offering synthetic materials produced from recycled polyester. Advanced polyester waddings are manufactured from hollow fibres (see fig, 5) which ensure higher thermal resistance [9, 15].

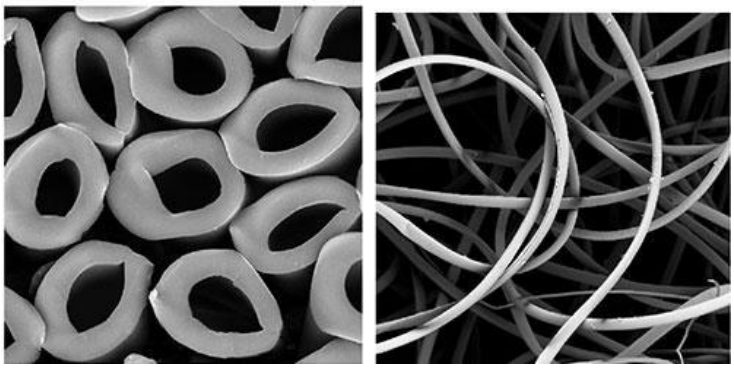

Figure 5: Hollow fibre cross section

Companies Freudenberg and Vilene (Vlieseline) produce 100% biodegradable wadding from Lyocell fibres [11, 12, 17]. These fibres are obtained from eucalyptus or bamboo and can break down into soil over time. New blends of different natural origin waddings, such as, merino wool and down can ensure increased thermo-isolation level suitable for both summer and winter textile goods [10]. Researches are conducted to create down composite wadding materials from down and melt-blown polypropylene. Such material has increased thermo-insulation and higher moisture permeability comparing with 100% down waddings [13].

4. CONCLUSION

Different thermo-insulation materials are used in textile industry manufacturing wide variety of goods. There are ensuring higher or lower thermal resistance and specific appearance to garments, bed cloths, and other products. The most important properties of wadding materials which determine their application are: thermo-isolation ability, moisture permeability, weight, loft, composition, and manufacturing cost. Generally, the longest application and best qualities can ensure natural origin wadding materials. However, because of their several disadvantages synthetic wadding materials are developed and used starting with 20th. Advanced wadding materials try to reduce negative properties of both, natural and synthetic origin waddings.

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