WP T2 INNOVATION ON TEXTILE WASTE MANAGEMENT

ACTIVITY A.T2.

Deliverable: Materials and chemicals for medical textiles

Additional ENTeR pilot case: Textile waste coming from medical devices concerning COVID-19 emergency

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Responsible partner:

LP Centro Tessile Cotoniero e Abbigliamento

(CENTROCOT - Italy)

CONTENT

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ENTeR – Expert Network on Textile Recycling

ENTeR works in five central European countries that are involved in the textile business, to promote innovative solutions for waste management that will result in a circular economy approach to making textiles.

The project will help to accelerate collaboration among the involved textile territories, promoting a joint offer of innovative services by the main local research centres and business associations ("virtual centre"), involving also public stakeholders in defining a strategic agenda and related action plan, in order to link and drive the circular economy consideration and strategic actions.

The approach of the proposal and the cooperation between the partners are oriented to the management and optimization of waste, in a Life Cycle Design (or Ecodesign) perspective.

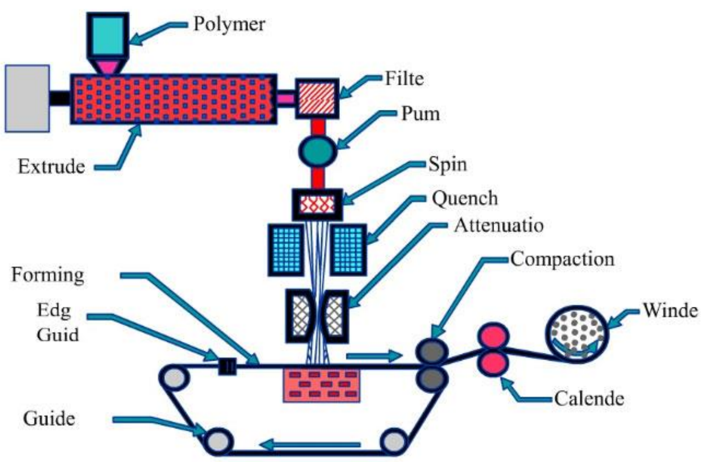
1. Scope

This report describes the materials and technologies used for the production of textiles in medical field and the chemicals present on the surface to obtain desired characteristics such as water repellence. In particular, the document treat the technologies and materials for production of surgical masks and respirators, that are the main protection devices used in the pandemic situation and the focus of this case study.

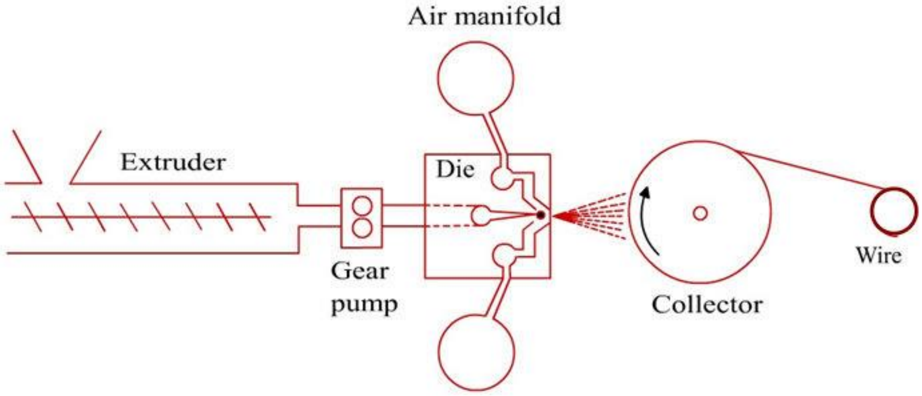
2. Technology

Surgical masks and respirators are made up of layers of non-woven fabric that are mainly produced using two technologies: spunbond and meltblown.

The nature of the production of non-woven fabric by means of spunbond technology is based on the direct spinning of polymeric granulates into continuous filaments (filaments) and subsequently manufactured non-woven fabric. Thus, the production of fibre characteristic for the other textile types and their subsequent conversion into the flat shape is excluded. Spunbond fabrics are produced by depositing extruded, spun filaments onto a collecting belt in a uniform random manner followed by bonding the fibres. The fibres are separated during the web laying process by air jets or electrostatic charges. The collecting surface is usually perforated to prevent the air stream from deflecting and carrying the fibres in an uncontrolled manner. Bonding imparts strength and integrity to the web by applying heated rolls or hot needles to partially melt the polymer and fuse the fibres together. Since molecular orientation increases the melting point, fibres that are not highly drawn can be used as thermal binding fibres. Spunbond products are employed in carpet backing, geotextiles, and disposable medical/hygiene products. Since the fabric production is combined with fibre production, the process is generally more economical than when using staple fibre to make nonwoven fabrics.



Meltblown process is a one-step process in which high-velocity air blows a molten thermoplastic resin from an extruder die tip onto a conveyor or take-up screen to form a fine fibrous and self-bonding web. The fibres in the melt blown web are laid together by a combination of entanglement and cohesive sticking. The ability to form a web directly from a molten polymer without controlled stretching gives melt blown technology a distinct cost advantage over other systems. Melt blown webs offer a wide range of product characteristics such as random fibre orientation, low to moderate web strength. About 40% of meltblown material is used in the separate (monolithic) state. The remainder of melt blown materials are composites or laminates of melt blown webs with another material or nonwoven. The largest end-uses for monolithic melt blown materials are oil-sorbents, air and liquid filtration media.



3. Surgical masks

Surgical masks are typically constituted by the superposition of 3 layers of non-woven fabric with different functions:

- OUTER LAYER; non-woven fabric produced with spunbond technology; this layer has the function of giving mechanical resistance to the mask.
- INTERMEDIATE LAYER; non-woven fabric produced with meltblown technology and consisting of microfibers with a diameter of 1-3 microns; this layer performs the filtering function.
- INTERNAL LAYER; non-woven fabric produced with spunbond technology; this layer has a protective function for the face, avoiding direct contact of the skin with the intermediate filtering layer.

It is possible to make masks with different layers but containing at least 3 layers with the above characteristics provided that the functionality requirements are met.

The most suitable material for the realization of the 3 layers of the mask is non-woven polypropylene, to a lesser extent polyester and hydrophobic cotton are also used. To meet the requirements on the effectiveness of the filtering capacity and the breathability of the mask, the laminate of which the mask itself is made must have an adequate meltblown content (generally greater than 20 g/m^2) in a single layer or as the sum of several layers. In fact, the filtering layer of the mask can also be produced through a laminate called SMS in which there is a reduced layer of meltblown placed between two layers of spunbond. The overlapping of 2 or more layers of this laminate allows to reach a meltblown content suitable to guarantee a sufficient filtering capacity.

The surgical masks also has laces that can be of 2 types:

- 2 elastics fixed each at the 2 vertices of the short side of the mask of suitable length.
- 4 laces of cotton cloth or the like fixed to the 4 corners of the mask.

In addition, they can be equipped with a nose pad or nose clip attached to the centre of the upper edge.

4. Respirators

A respirator consists of multiple layers of nonwoven fabric, often made from polypropylene. The two outward protective layers of fabric, covering the inside and outside of the mask, are created using spunbond technology. The two outer layers of the respirator, between 20 and 50 g/m^2 in density, act as protection against the outside environment as well as a barrier to anything in the wearer's exhalations.

Between the spunbond layers, there is a pre-filtration layer, which can be as dense as 250 g/m^2, and the filtration layer. The pre-filtration layer is usually a needled nonwoven. Nonwoven material is needle punched to increase its cohesiveness, which is accomplished by sending barbed needles repeatedly through the fabric to hook fibres together. The pre-filtration layer is then run through a hot calendaring process, in which plastic fibres are thermally bonded by running them through high-pressure heated rolls. This makes the pre-filtration layer thicker and stiffer, so it can be moulded to form the desired shape and stay in that shape as the mask is used.

The last layer is a high efficiency meltblown electret (or polarized) nonwoven material, which determines the filtration efficiency.

The full respirators are made through converting machinery, which combines the layers through ultrasonic welding and adds elastic straps and metal strips to adjust the mask over the user's nose. The respirators are then sterilized as a last step before being shipped.

5. Chemicals

Most of these protection systems consist of disposable non-woven fabric, which must provide protection against any reasonable professional exposure expected and must not allow blood or other materials to pass through or reach work clothes, undergarments, skin, eyes, mouth or other mucous membranes of the operators in normal conditions of use. For this reason, a water-repellent coating is applied to most of the products in the healthcare sector, usually hydrocarbons, silicones and fluorocarbons coatings, the most commonly used of which are fluorocarbon-based coatings. Fluorocarbon repellents are unique in that they give the fabric high water repellency and simultaneously lower the surface tension of the fabric. This property is important because there are low surface tension liquids such as blood and alcohol in the operating room that can be blocked. The application of these finishes with liquid technology requires the impregnation of the fabric through a bath where the finishing chemicals are present, including catalysts and crosslinkers, and the application of wetting agents to the fabric in order to increase wettability.