

SEAMLESS TECHNOLOGY ON CIRCULAR KNITTING MACHINES

CRETU Viorica¹

¹ University “Gheorghe Asachi” of Iassy, Romania, Department of Knitting and Clothing Engineering, Faculty of Textiles, Leather and Industrial Management, Postal address 1, D. Mangeron, 31, 700050, Iassy, Romania, E-Mail: vcretu@tex.tuiasi.ro

Corresponding author: Cretu, Viorica, E-mail: vcretu@tex.tuiasi.ro

Abstract: *With industrial progress, the advancements in garment manufacturing have evolved from cut & sew to complete garment knitting, which produces one entire garment without sewing or linking process. Seamless knitting technology is similar to sock manufacture, the specialized circular knitting machines producing 3 dimensional garments with no side seams, with the waistband integrated with body of the garment and with knitted washing instructions and logos. The paper starts by presenting the main advantages of seamless garments but also some limitations because the technology. Because for a seamless garment, which is realised as a knitted tub, is very important to ensure the required final chest size, it was presented the main components involved: the knitting machine, the garment design and the yarns used. The knitting machines, beside the values of diameters and gauges with a great impact on the chest size, are characterised by a very innovative and complex construction. The design of a seamless garment is fundamental different compared to garments produced on a traditional way because the designer must to work backwards from a finished garment to create the knitting programme that will ultimately give the correct finished size. On the end of the paper it was presented some of the applications of the seamless products that cover intimate apparel and other bodywear, outerwear, activewear and functional sportswear, upholstery, industrial, automotive and medical textiles.*

Key words: *seamless products, advantages, design, yarns, applications.*

1. INTRODUCTION

Seamless knitting is a relatively new technology, developed from technology used to make socks, when a body panel is ejected immediately after knitting. In traditional “cut make and trim” (CMT) [1] a circular knitting machine knits a continuous tube of fabric, which is subsequently dyed and then slit to make an open width fabric. This fabric is multi-layered on a cutting table and the pattern of the garment would be placed on top and cut around; the individual panels would be cut from the layered fabric. The garment is assembled from the cut pieces. As this type of garment is sewn together every join has a seam. The seamless technology can directly produce nearly finished products/garments, with no side seams, and lessens traditional process of the production. By eliminating the fabric cutting and sewing process, there is an optimisation of the production process, making seamless production a lot faster then conventional. So, this technology can reduce the traditional process of the production costs up to 40% compared to that of traditional knitting [2]. There is also a fewer product failures since most errors, since most of the garment failures are due to seam failure, which translated in better quality pieces.

2. SEAMLESS GARMENTS VERSUS CUT AND SEW GARMENTS

Seamless garments, compared with cut and sew garments, offer a large number of advantages, bur there are also some limitations because of the technology. As advantages [1], [2] there are:

- higher comfort and better fit to consumers by eliminating seams;
- soft handle;
- nearly invisible under clothing;
- no waistband or side seam failures;

- knitted-in crotch in panties giving additional comfort;
- stretch and recovery can be engineered to reduce chaffing;
- waistband is integral with body of the garment;
- washing instructions and logos can be knitted into the waistband (Fig.1), using polypropylene yarns, which give perfect wash fastness under any condition;

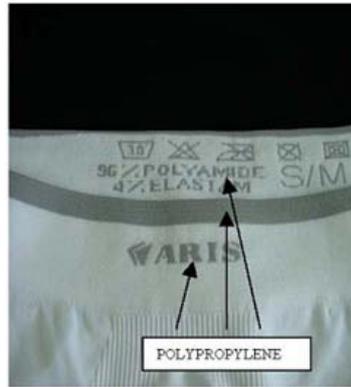


Fig. 1: Waistband knitted together with logo and washing instructions, using polypropylene yarns

- reducing on minimum the cutting and sewing processes result in a substantial saving in cost time, higher productivity, fewer machines required, and just-in-time production;
- comparing to traditional production methods, where the fabric is the starting point for most garments, fabric being dyeing, patterns cutting (Fig.2)[3], and then pieces sewing together, on seamless production result almost finished knitted products. The specialised circular knitting machine can make the entire product in few minutes and save up to 40% of the original fabric that may go as waste or cut-loss in the conventional method;
- automatically knits components like waistband.

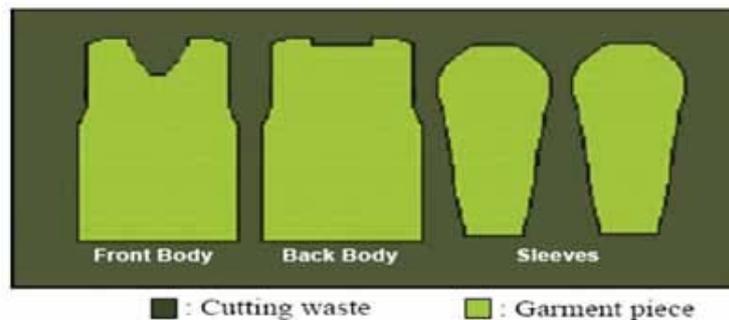


Fig. 2: Conventional method – the patterns for the product are cut out from the fabric

As limitations, because of the technology, there are:

- garments that can be made by cut and sew methods cannot always be translated exactly into a seamless garment. When designing a seamless garment it must work backwards from a finished garment to create the knitting programme that will ultimately give the correct finished size. This is difficult because a seamless knitted garment changes size from the minute it is knitted and the degree of shrinkage has to be controlled at all stages.
- a seamless knitting machine produces garment blanks instead of rolls of fabric and corrections are almost impossible after knitting;
- any fabric defect results in garment rejection;
- seamless garments have poor counter appeal, resulting wrinkled when relaxed;
- garments look smaller than indicated size and that required a mannequin presentation in store;
- relaxed size variation is higher than at cut and sews garments.

3. SPECIFIC ELEMENTS REGARDING SEAMLESS TECHNOLOGY

Because the seamless garment is knitted in the form of a tube, first of all is important to ensure the required final chest size, in which are involved the knitting machine (a combination of machine gauge, machine diameter and knitted structures), the garment design and the yarns used.

3.1. Knitting machine

Circular knitting machines used for making seamless garments are based on programmed computer commands that allow a variety of different stitches, for example a jersey knit, a mesh knit, a rib knit or a jacquard knit can be placed side-by-side in a single garment and also can combine different textures and levels of compression.

The main characteristics of seamless circular knitting machines [4] are:

- the capability of individual needle selection, which is programmed electronically by the programmer;
- the knitting on three technical ways – by individual needle-by needle selection;
- stitch formation adjustment by using step-by-step motors, with the possibility of loop widening, tightening and shading on the same course;
- three transfer position from the dial to the cylinder;
- knitting mesh areas anywhere on the garment including diagonally aligned holes and extremely small mesh;
- they allow the production of different stitches such as rib, net, jacquard, piquet, stripes, lace etc., as well as pre-shaped structures such as hidden reinforcement, pockets, collars and hoods;
- knitting double face fabrics using two different yarns – polypropylene yarns on the inner layer, that ensures better protection and maintenance of natural body temperature, and long-staple cotton fabrics on the outside, that keeps the skin perfectly micro-climate controlled, releasing body moisture and keeping the skin dry.

As diameters, the generally available values are 12”, 13”, 14”, 15”, 16”, 17”, 18”, 19” and 20”, and as gauges, available are 16, 22, 24, 26, 28, and 32 npi., the most common being 28 gauge. Because machine diameters increase in 1 inch (2.54 cm) that generally increments the chest size, and many buyers require small, medium, large, extra large and sometimes extra extra large products, that imposed to the producer to own five different machine diameters.

3.2. Garment design

The way the seamless garment is designed and how the final size is obtained is fundamental different compared to garments produced on a traditional CMT route. The designer of a seamless garment must to work back from a finished product to arrive at a knitting specification, because an original undyed garment can have dimensions 10-35% larger than the finished garment [1]. The customer must offers a full detailed specification to minimize rework, because any minor change such as leg opening or side length can affect other dimensions and a new sample is required. More, errors to dimensions cannot be corrected at a later stage; therefore a great deal of attention must be given at programming stage to ensure the garment is correct. The cutting lines, which are knitted into the tube, must be modified each time a change of dimension is required by the customer.

A programmer is generally given a finished garment and from this has to predict the measurements at knitting that will give the finished dimensions. The beginnings steps are:

- analyse the yarn types used in the garment.
- check the g/m² of the fabric.
- measure all relevant dimensions of sample supplied.

From this information the programmer will select an appropriate diameter of knitting machine, based on previous experience with this yarn combination, to give the required chest size. To verify this, a knitted tube in the correct knitting structure would be dyed and from the measurement information on garment shrinkage from knitting, autoclaving and dyeing would be able to predict the appropriate knitting machine diameter.

In the cost of seamless garments, a significant factor is the cutting waste. This waste is negligible compared with cut make and trim (CMT) garments, because in seamless knitting a body blank in the form of a tube is made to the required body width. Waste factors vary depending on the garment, that waste comprises knitting overheads plus full yarn cost. Typical waste values that can be expected are as follows: thong - 54%, panty - 25%, camisole - 9%, T-shirt - 5%. In Figure 3 the chevron line indicates the amount of waste generated in the camisole, the thong and bikini panties, the two last garments showing a pre-dyed cotton gusset knitted in. To reduce waste factors seamless machines are available to manufacture shaped garments utilizing a reciprocating cylinder.

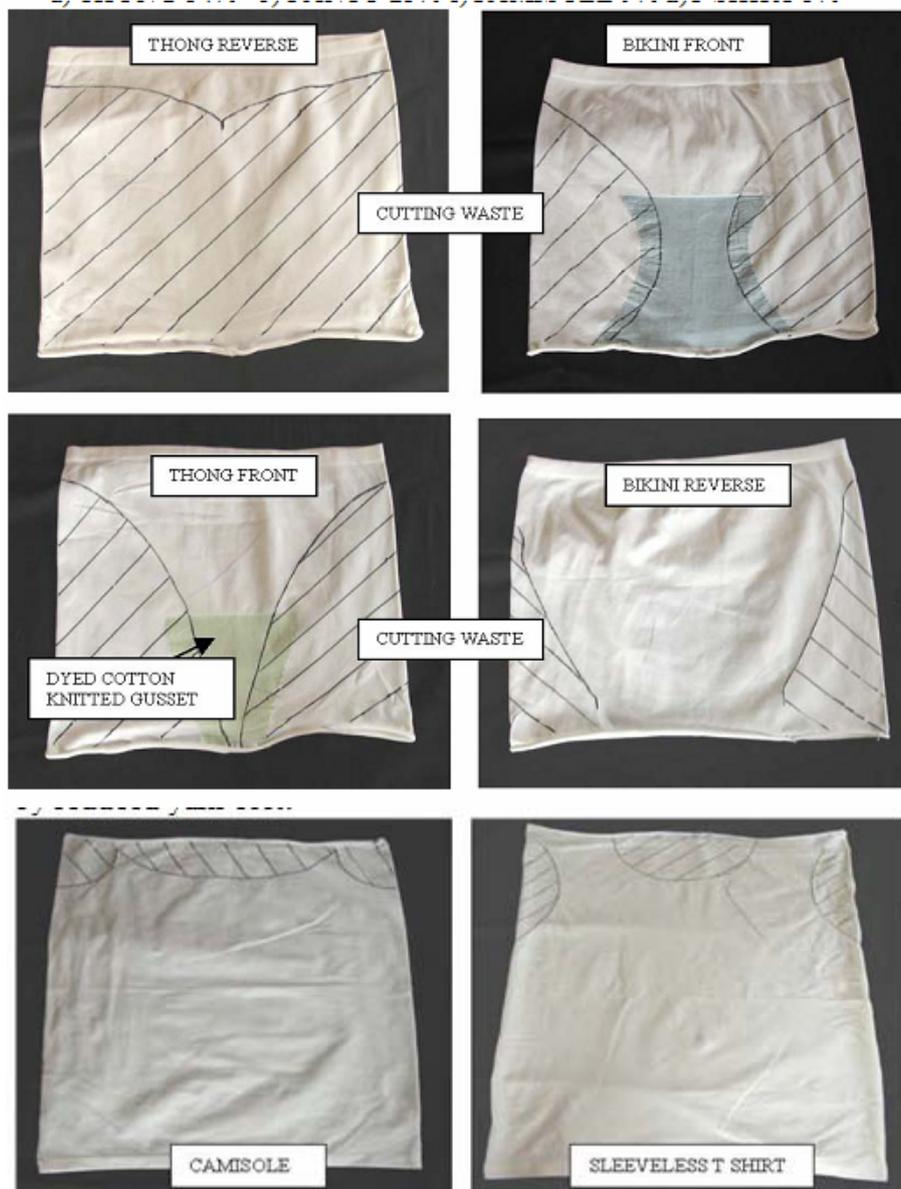


Fig. 3: The amount of waste generated in the camisole, thong and bikini panties

3.3. Yarns used in seamless garments

Usually, seamless garments used the plating technique, where two yarns are fed through a needle at the same time: a yarn appears on the side of the fabric in direct contact to the skin, and the other yarn appears on the external side of the fabric. Yarns choice is extremely important in seamless knitting.

The inside yarn. In addition to garment size (a lighter fabric using finer yarns requires an increased machine diameter for the same chest size) and weight per square metre, the fineness of the individual filament largely determines the handle or “feel” of the garment. There are a large variety of yarn counts available to the seamless knitter to give different fabric weights and handle. The diameter of the individual filaments of the yarn determines the handle (softness) of the fabric, most seamless garments being made from microfibres filaments, which gives a soft handle. There are a large variety of yarn counts available to the seamless knitter to give different fabric weights and handle. Special yarns such as cationic dyeable, deep dyeing or melange yarns enable a variety of colour effects during garment dyeing. A trend in developing seamless products is to use more natural fibres such as wool or well-being and comfort yarns such as Cupron and Cocona [4] which is derived from the byproducts of coconuts and is designed to improve wicking by expanding the fibres of the fabric over a large surface area, fibres that offer natural anti-bacterial and anti-odour capabilities, enhanced ventilation, natural UV and skin soothing properties.

The outside yarn is the bare spandex or covered yarns. Spandex or elastane is the key to the comfort and fit of seamless garments. Generally the spandex content of seamless knitted goods lies between 3-20% of the total fibre content. There is a direct relationship between the elastane

component and the chest or waist size for a given diameter of knitting machine. A high power elastane will give a smaller chest size and shorter body length for the same number of courses knitted. The effect of using spandex is to “cram” the yarns in the knitted structure, making it tighter with an increased cover factor.

The stretch yarns available to the knitter are (Fig.4):

- a) Bare spandex (elastane).
- b) Air covered yarns.
- c) Single or double covered yarns

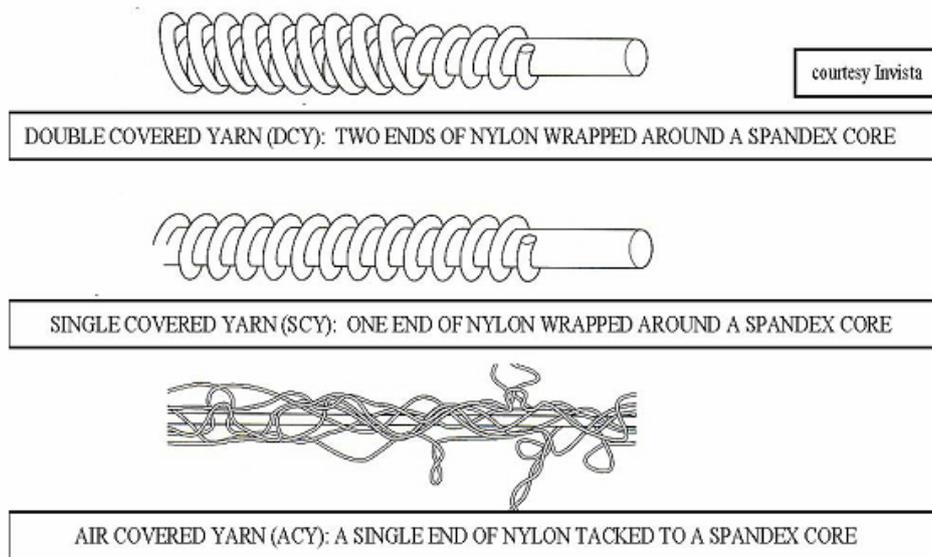


Fig. 4: Covered yarns

In one seamless garment can be combined different fibres with different benefits and performance aspects, giving mesh areas, opaque areas, creating ventilation areas, comfort zones and variegated compression in the same garment.

4. APPLICATIONS OF SEAMLESS PRODUCTS

The seamless technology is not only replacing traditional knitting but is also replacing anything stitched or with seams, and cover trends from the very chic, the technically-sporty and the casual, to the more practical and basic needs. Seamless products are being used for a variety of applications [5], [6] as they offer numerous benefits to the user.

Intimate apparel

Intimate apparel produced on seamless machines blend comfort, fit and versatility. They are seam-free, easy-care, silky-smooth garments that feel similar to one's second skin and are designed to be worn under today's fluid, lightweight apparel.

Protective textiles

On the market are available seamless filament-knit gloves and apparel. They are lightweight, flexible and comfortable for workers in the electronics, food-handling, paint, plastics and other high precision business sectors which require high levels of safety in addition to contaminant-free cleanliness.

Sports textiles

Seamless apparel construction focuses on:

- supporting muscles and areas where they need it the most;
- moisture management for evaporation of perspiration
- compression areas that offer both body support and better temperature management
- padding thicknesses for greater body protection while still maintaining the all important moisture and temperature management requirements
- venting to remove heat from specific areas

- thermal pockets strategically placed to trap body heat, again in specific areas
- an engineered fit and micro massaging features by blending of various technical fibres and yarns.

A diverse range of products such as gloves, hats, and socks are some of the more obvious applications. Swimwear also offers exceptional fit through the use of elastic and quick-drying yarns.

Sports bra features heart sensing technology

A new seamless heart-sensing controlling sports bra is offered on the market. It is designed to give greater support during high impact sports. Textile electrodes are knitted into the bra and stretch and move with the wearer, maintaining contact with the skin and sensing the heart's electrical pulses. Dr.Rita Paradiso, Ph.D., Research Director of Smartex, Italy, explains: “Conductivity is the main property being exploited and for our applications, knitted technology is the right one, because we need different domains within the fabric structure with different types of yarns. We have to decide in which places we need to put the conductive yarns and where background yarns are used, because the values of resistance change depending on their position. Of course, we need a garment which fits like a ‘second skin’ because the bio-electrode is in direct contact with the skin.”[3]

Medical textiles

The onset of seamless technology in the medical arena has led to advantages for those times when the body needs it most. By example tubular dressing is a light-weight tubular bandage ideal for dressing retention and for covering the skin in any area of the body. It is manufactured from viscose with very fine elastane threads knitted into the fabric radially and longitudinally to provide a light elasticity. Because of this tubular construction, bandages are particularly suitable for holding dressings in place on difficult areas of the body. The tubular bandages hold dressings securely, without constriction or compression. The light elasticity promotes freedom of movement. An other example is the tubular rib fabrics of small diameters. Due to their compressive effect, they are commonly used to close and secure the sleeves of surgery uniforms, optimising their capacity to close and avoing the dispersion of micro-organisms arising from surgery. Wellness applications, massaging properties and shapewear that offers support pre/post surgery provide the ability for improved recovery. These types of engineered garments offer preventative measures to delay and/or avoid certain medical procedures.

5. CONCLUSIONS

The introduction of the Seamless product has revolutionized the global production process, allowing the knitting of ready-made apparel, very different from cut & sews classical process. The seamless concept spread all over the world with a surprising quickness because it allows to get to the finished garment in a few minutes starting from the yarn and without passing through cutting and sewing operations, it offers savings in terms of production times and cost, and it minimizes yarn consumption. Starting with intimate apparel and other bodywear, today seamless technology has emerged into areas such as fashion, outdoor, activewear and functional sportswear, upholstery, industrial, automotive and medical textiles.

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