Compression Garment Engineering for Health Care Applications

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***Abstract*- The performance of the clothing has to improve the functions and activity of the wearer by engineered new product development. Many of the engineered fabrics are performed in the form of garments, that also next to skin wears. For such concert, stretch fabrics plays important role due to the presence of elastomeric yarn in its structure. The compression garments are stretch wears it can be used for health care and allied applications as in the form of upper body, lower body and whole body garments. These compression garments are imparted pressure between the clothing and wearer skin for various reasons like medical, sports and health care/monitoring intentions. This paper represents the production concepts and applications of such compression wears.**

***Index Terms*- Compression Garment, Pressure Therapy, Material, Knitting, Design.**

1. INTRODUCTION

The emergence and important part of the textile arena consists of medical and health care & hygiene sectors. The compression wears are the one plays important role in this field. The compression defined as the pressure applied to the limb by a garment. The swelling of the upper body, the compression garments with many styles available. Such as gloves, gauntlets, arm sleeves, vest and masks for facial swelling. Many factors deciding the selection of garment and level of compression required for the wearer, such as site extent shape distortion and swelling [1]. The textile structure is made from 100 % elastomers or in combination with other textile materials with high elongation and recovery property is called elastic knitted fabric. The ratio between the extension of material and the length of the material prior to stretching is high. These fabrics are applied in compression applications [2]. These characteristics can be achieved by combination of various fibers, fabric structure. The fibers include polyester, nylon, Lycra® and cotton. The fabrics like single, double and jacquard. If the geometric and technical parameters of the fabric varied, can be alter the mechanical properties of the fabric [3]. The compression garment are plays vital role in prevention and management of skin changes. The yarn linear density of the yarns, structure, and surface finishing of fabric influence the characteristics of the compression fabrics.

II.ELASTOMETIC YARM

The synthetic rubber made from the feedstock petrochemical product is called elastomer. It can be stretched at least two time of its original length. Most of the elastomeric fibers are stretch is about over 400% and when the tensile force is released from the fiber it return back to its original position. The elastomeric fibers includes synthetic rubber, cross-linked natural rubber, segmented polyurethanes (spandex fiber), cross linked poly acrylates (anidex fiber) and spandex & nylon bi-component fibers.

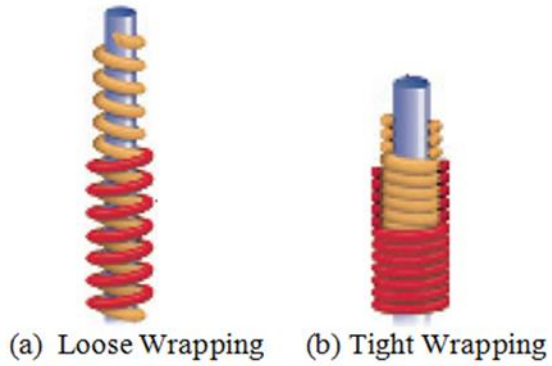


Figure 1: Elastomeric core and polyamide or Cotton wrapping as sheath

The elastomeric fibers/yarns are used for general and special purpose applications under comfort stretch and action stretch respectively. Usually the elastomeric yarns are used in combination with other

yarn in a fabric. The 100% elastomeric yarns or core-sheath (wrapper) yarn is used as elastic yarn and cellulose/synthetic yarns are used as ground yarn for the fabric development. The figure 1 shows the core-sheath elastomeric yarn. The durability and functional requirements of core-sheath yarn is varied based on the wrapping factors. The elastic fabric produced with such yarns imparts highest elongation and recovery.

The compression fabrics are produced from weaving and knitting manufacturing principles. Though, knitting provides perfect compression fabrics with adoptable technology and their principles. Both weft knitting and warp knitting principles are used for fabric development. The table 1 shows fabric structures and their principle involved in manufacturing of compression fabrics.

III. COMPRESSION FABRICS AND ITS STRUCTURES

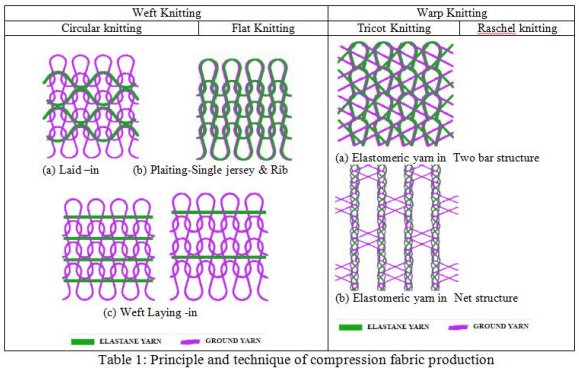


Table 1: Principle and technique of compression fabric production

The compression garments produced with two different threads such as ground structure is formed by the ground thread and the compression of the fabric is generated by the In-lay yarns [4]. The coarser yarn provides stiff fabric better for distorted limbs with less demerits [5]. The compression knitted fabrics in circular as well as flatbed knitting machine is achieved by two methods. The insertion of spandex yarn into the single jersey structure via sinker loop feeding like fleece knitted fabric production. In elastomeric yarn is fed in to the sinker loop of plain jersey by inlay without loop formation. The other concept of achieving the stretch fabric is plaiting. Plating is the process of knitting minimum two yarns together. The process of knitting with cotton and elastomeric yarn together is called as plating. The every course is knitted with cotton and spandex which is appeared in side by side is called as full plaiting. The lycra/spandex is placed alternate course in a fabric along with cotton knit loop is called as half plaiting [1].

The plating concepts are applicable for single jersey and double jersey structures. The extensibility of the fabric is also affected by the structural stitches (knit/tuck and float or miss stitches). The structure and pattern of weft laying-in in rib structure influences the compression properties. Raschel and tricot warp knitting machines are used for the elastic fabric production with wide varieties. The net produced with elastomeric laid-in concept gives highest elastic property in vertical direction.

The innovative production concept, seamless and finer circular knit fabrics are more comfortable to the wearer [4].

IV. MECHANICAL PROPERTIES OF COMPRESSION FABRICS

The elastin consumption of the knitted fabric increases has significant effect on dimensional and elastic properties of plated cotton/Lycra single jersey fabric. The fabric recovery increases with Lycra® proportion inside fabric [6]. The compression of the orthopedic support fabric is related to elastic thread properties and fabric conversion technique. The orthopedic knit product maintained low elongation during utilization. So the elastomeric core yarn is affected by the tensile force. The wrapper or covering thread doesn't have the influence on tensile force. The elasticity and extensibility of the elastomeric yarn is generated by the core and the sheath of the yarn provides aesthetic and hygienic properties [4].

In 1x1 rib structure the Inlay yarn density is varied from 1_4, 1_2, 2_2 and 1_1 (Number of inlay No of courses per repeat). The insertion density of inlay yarn has influence on compression of the fabric. At same density of inlay yarn every course inserted inlay yarn produces higher compression than others. Alternate course inserted weft inlay yarn fabric generated lower compression, which is used for low compression class application [7]. Elastic knitted fabric quality is determined by the reliability of the how the elastic yarn is fixed with in the structure. The level of fixing is achieved by the nature of loop formed by the elastomeric yarns. When increasing

the density of the knitting the contact point between the elastomeric yarn and cotton yarn is increased. Influence of elastomeric yarn miss and knit stitches in a repeat of the 1x1 rib structure formed by alternate cotton and elastance core spun yarn courses [8]. The lycra extension percentage increases the air permeability is decreased for full plated fabric than half plated fabric. (Because of stitch density, thickness, more tightness factor) [9]. The elastic fabric containing elastane yarn of every alternating course and tight structure provides highest fabric friction coefficient values. The fabric with half plating causes an unbalanced fabric surfaces due to bulky in alternating courses. So the fabric surface produces rougher appearance [10].

Figure 2: Pressure of Leg Wear

The fabric in the form of apparel is always touching with the largest organ of the human body. The typical clothing pressure nearer to upper limit is 4g/cm2, at which prickle is sensed. Based on the pressure between the skin and textiles the following response occurs. When the fabric displaces the skin surfaces, a neural response occurs, if the fabric contacting the skin eczematous response occurs [11]. Figure 2 shows the pressure level of the leg wear applied by the compression garments for providing the health benefits. The pressure of the leg wear is reduced at thigh and greatest at ankle. (100% compression at ankle, no more than 70% of ankle compression at calf and no more than 70% of calf compression at thigh)[11]. The compression class of knitted wears are, In British standard Class 1(14 – 17 mmHg), class 2(18 – 24 mmHg) and class 3 (23 – 35 mmHg). In European standard, Class 1 (18 – 21mmHg), class 2(23 – 32 mmHg) and class 3 (34 – 46 mmHg). The selection of class of compression wear is based on the severity of symptoms [4].

The medical compression fabrics of open structure made of nylon as ground fabric and spandex as core in wale direction. The author concluded with the medical compression fabrics are stronger with higher breaking load above 200N and excellent stretch ability above 200% breaking extension in both wale and course direction [12]. The knitted structures significantly affect the course and wale extensibility compression of the fabric. The number of inlay yarn in the structure increases, there is increases in wale way extensibility and decreases in course way extensibility values. The fabric with finer inlay yarn produces highest wale way extensibility. The body yarn of stockings with coarser yarn provides lowest extensibility in both directions. The inlay yarn is very effective on extensibility value for production of stockings [13]. The stretch of the knitted fabrics is affected either the combinations of their loop length, course wale ratio and stitch/loop density of the fabric. Fabric cover factor themselves affect the stretch of the fabric [14]. The compression garment material, style and fit influence the appearance and comfort of the wearer.

V.APPLICATIONS

The compression garments are mainly used for long term management. Compression garments available in ready-to-wear, custom-made, flat-or circular-knit. The compression garments used for hand and finger edema, Forearm edema, Upper arm edema, Trunk and breast edema [15]. Medical bandages are directly contact with the skin, If synthetic fibers are used in bandages may provide comfort or cause heath problem like allergies. The natural fiber made bandages have very good compression and comfort properties linked air and water vapor permeability [16].

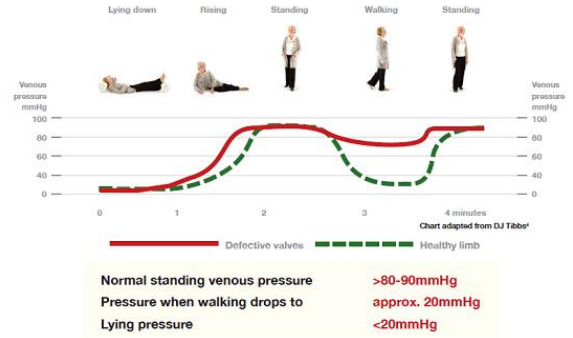
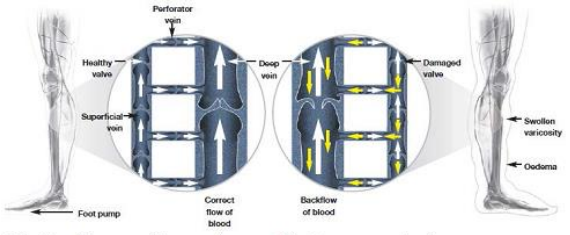


Figure 3: Effect of human posture, exercise on venous pressure at ankle part

Compression therapy provides right pressure for permanent usage. The activity undergone by the wears also influencing the pressure developed in a body. The figure 3 shows the effect of human posture and their exercise on venous pressure at ankle part. Usually the compression garments applies higher pressure as compared to normal garments to the skin. The skin changes in its color and its nature by lymphatic and venous disease. The damaged valves in a venous system as shown in figure 4. is prevented by compression therapy with compression wears.



(a) Healthy working valves (b) Compromised venous system

Figure 4: Venous system

At the applied pressure between the skin and the textile is 16kPa or more pressure applied than 16kPa, the skin blood flow decreases to zero. The pressure is directly influenced by the several components of a garment. The compression garments used in sporting are smaller in size than the corresponding body site to be covered [17]. The innovative approaches in compression wear are smart compression garment (SCG), the integration of soft sensors in the stretch fabric for health monitoring applications [18].

VI.CONCLUSION

The stretch fabric production techniques and applications as compression garments in medical and health care sectors are described. For the body activity and monitoring, the compression garments are used as blood circulation, body shaping and other medical purposes. The stretch fabric used for such applications are selected based on the requirements. The characteristics of the compression fabric are influenced by the various aspects like fiber, fabrics and principle of fabric production. The selection of fabric and its structure (both ground yarn and elastic yarn) for the new design/developments is important approach in health care application.

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