Chapter 21
Recycled Cotton Fibers for Melange Yarn Manufacturing

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Abstract The textile industry delivers two types of wastes during production, namely hard waste and soft waste. These are used as a raw material in Blow Room mixing with virgin cotton with limited volume. Besides, the sector also releases a large amount of used garment/cloth and remnants (solid waste), which causes landfill and pollution. Recycling of used clothes and remnants was started in the late 1980s to reduce such an impact on the environment. Recycling also helps to reduce raw material costs in mélange yarn manufacturing. The used clothes, as well as the garment wastes, are collected and supplied to the factories. Before the processing, they are sorted depending on their color and fabric type. These fabrics are converted into fibers called "reclaimed/regenerated fibers" by a serious of machines, i.e., cleaning, cutting, conditioning, shoddying/tearing, and baling. The reclaimed fibers are mixed with virgin cotton in preset volume according to the desired end product. Mainly mixing/blending in factories is practical at Blow Room and Draw Frame. Sometimes it is done at Speed Frame. The conventional spinning types of machinery with different settings are used to process reclaimed fibers. But there are also supplementary processes. In this chapter, the fiber preparation methods, mixing types, spinning are discussed. Also, the advantages, disadvantages, and application areas of mélange yarn are discussed.

Keywords Mélange yarn · Recycling · Reclaimed fiber · Spinning · Virgin cotton

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21.1 Introduction

The story of yarn processing gets focus in early times of the nineteenth century during the ring-spinning enabled this practically achievable. After this, various technical advances were made, and optional process techniques were adopted for the best effective and suitable system of yarn processing. Yarn is an extended continuous span of twisted fibers, appropriate intended for application in the making of textiles, knitting, sewing, crocheting, weaving, embroidery, or rope making. Based on their manufacturing techniques, there are several yarns, for example, spun yarn, fancy yarn, twist less yarn, slub yarn, mélange or dyed yarn, and so on.

Technological innovation has helped the textile sector to manufacture different types of fancy yarns. Any intentional ornamental discontinuity or interruption is introduced in fancy yarns either in color or yarn structure, or both. Mélange yarns are renowned by their eye-catching shade and manifestation amongst the fancy yarns [1].

Initially made in the 1980s, Indians were the founders of making the mélange yarn. It can be characterized by merging more than two fibers. The name mélange is conventionally applied to those yarns that are generated by the mixture of two natural or synthetic fibers, regardless of whether a similar variety. However, unlike in color or type of fiber used is different. Cotton mélange yarns are spun using Ring Frame or Rotor spinning machines from a variety of different color cotton fibers. A popular technique of producing a variety of fancy yarns is the combination of dyed and undyed fibers of varying degrees [2].

In the context of cotton mélange yarn, "a mélange yarn is the yarn that is made with various mixtures of raw white and dyed cotton or dyed fiber." For instance, if 70% virgin white cotton and 30% dyed cotton of any color combined, subsequently, it is said to be mélange yarn [3]. The cotton fibers are mainly blended with either polyester fibers or viscose fibers to produce mixed yarns [4]. Moreover, mélange yarn may be divided into two of its most common categories:

Blended Mélange Yarn: this category of yarn where fibers of different origin natural or synthetic are mixed/blended collectively in a specified percentage, for example, PC (Polyester Cotton blend) 50:50, PC 60:40, PV 70:30, and CVC 50:50. Non-Blended Mélange Yarn: in this case, fibers of the same variety or origin having different colors as well as proportion is used to produce the yarn, e.g., 100% cotton dyed yarn, 100% jute [5].

Mélange yarn follows exclusive dyeing practice, and it is great technical regarding fiber dyes, color matching, and mixed textile of multiple fibers. Dyeing of fiber before spinning enables to maintain of power-saving, emission cut, and ecological security. Mélange yarn is capable of showing several colors on one yarn, giving it rich colors, slenderness, and tenderness. Textiles produced from such yarns have some unclear cyclic effects [3].

Mélange yarns are universal because of their distinguishing and a fantastic look in the cloth. The wavy like look as a result of the mixing of various fibers and the number of color tones because of the blending of different fibers makes it familiar

and attractive. The smooth cloth is very more durable. Mélange yarn is capable of displaying several colors in one yarn, making it stuffed in colors and tenderness. Fabrics manufactured from such yarn appeared to have some vague cyclic effect. Mélange yarn is an art of fashion design and production of interest and has no artistic limitations. The use of slub, chain, and stretch attachments just opens up a wide variety of products only possible in mélange yarns [6].

Mélange yarn's market share over conventional yarn is growing day by day [7]. Mélange yarn is commonly applied at weft knitting machines as well as warp knitting machines, a range of V-bed knitting machines, and cone winding machines. Mélange yarn is pertinent to underwear textiles, casual wear, sportswear, shirts, business suits, socks, and all sports clothing items, as well as bed sheets, towels, decorative fabrics, and other goods for home fabrics [3].

21.2 Fiber Preparation Methods

21.2.1 Dyeing of Virgin Cotton

Mélange yarn production is comparable to the best known conventional gray yarn. However, it includes additional supplementary processes that require explanation. At the start, the virgin cotton incoming from the ginning factories is stock up in the form of bales inside go downs. This raw cotton, after a definite period of acclimatization, is delivered to the manufacturing section for coloration operation. In the processing section, fibers are opened to flock form using conventional opening machines and, disperse dyes, reactive dyes, and VAT dyes are used for fiber coloration.

The recipe of the appropriate goal or standard colors offered by the buyer or selected from a catalog should be forecasted in the actual manufacture first. This recipe is a compilation of dyed fiber percentages. Simply stated, the prediction of the formula is an estimate of the components and percentages for a yarn or cloth. First, the colorists check the factory's warehouse for identical dyed samples, subsequently change the recipe concerning their expertise, and lastly spin a little sample (mostly 50 g), as well known as a 'hand sample', and evaluate the sample color with the required color change expressed as CIELAB or CMC (2:1). The entire cycle is repeated several times until the shade of the hand sample matches the desired color criteria [8].

Mélange yarns have a special coloration method through a low liquor-to-fiber ratio (typically below 10:1) that be able to minimize input consumption in terms of dyestuffs, chemicals, auxiliaries, and water consumption compared to yarn dyeing or fabric dyeing [9].

Following fiber coloration, they are pressed and come back to the spinning section; the fibers packed in the form of bales are once more opened, gently mixed, and stored in a ventilated room for 24 h for conditioning. Then after the flock of fibers are pressed together and assigned with a lot number. This number possibly will vary from mill

to mill for detection reasons. However, it is necessary to explain since we are not confident whether we get identical types of dyed fibers (in terms of dye-ability, dye affinity, rubbing & washing fastness) of the fibers every time or not. This could rely upon the dyeing situations, dye quality, recipe, process conditions, fiber used (mature/immature/ dead fiber content). These factors are crucial to recognizing as these are few unknown variables that trigger quite basic problems in mélange yarn, i.e., shade rejection. It is necessary to make the lots so we can easily trace where the mistake occurred [5].

This identification leads us to the proper issue of bales for particular order to overcome the shade variations. However, another method that is called "sampling" can be used. A specimen must be conducted and cross-checked with the customer's sample for each new lot or a new mix of the running order. In this way, it is possible to reduce the likelihood of defect, and shade variance can be restricted and expected in advance, so required corrective action can be taken.

21.2.2 Recycled Fibers as a Raw Material for Mélange Yarn

Among the various industrial sectors, the textile and garment industries are deemed among the significant pollutant around the whole world. Textile wastes and byproducts are growing to astonishing levels at superior rates because of the look, recognition, and obsolescence of fast fashion [10]. Some are recycled to reduce those wastes which are responsible for polluting the environment. Waste recycling is one of the best options for the yarn spinners to produce profitable products as well.

In addition to virgin fibers, recycled fibers are also used as raw material for mélange yarn manufacturing. The rags incoming from garment and textile factories are recycled and mixed with polyester and virgin cotton to produce mélange yarn. The processes steps in recycling the rags are explained in the paragraphs below.

21.2.2.1 Sorting and Cleaning

The rags/remnants are supplied from textile and garment factories. Besides, the factory, which is manufacturing mélange yarn, releases such wastes. The rags are sorted based on their color and fabric type. The rags are mostly knitted fabrics. In addition to segregation, unnecessary materials like foreign fibers, metal pieces, plastics, and trashes are also removed at this stage (Fig. 21.1).

21.2.2.2 Cutting

In this stage, the fabric is cut into pieces by the fabric cutter. The size of remnant fabrics reduced to make them suitable for the shoddying process. Besides, water and

Fig. 21.1 **a** Rag or remnant supplied from textile and garment factories **b** cleaning and manual segregation of remnants depending on their color [Picture was taken from ETUR Textile PLC, Adama, Ethiopia]

Fig. 21.2 Rag cutting machine [Picture was taken from ETUR Textile PLC, Adama, Ethiopia]

oil are sprayed on to the fabric to overcome the action of beaters during the shoddying process (Fig. 21.2).

21.2.2.3 Material Conditioning

A large conditioning box is used at this stage. Besides, it is used for temporary storage. The cut pieces are transported from cutting machines to the conditioning box via transport pipes. Conditioning is done for 24 h at standard temperature and

Fig. 21.3 Conditioning box [Picture was taken from ETUR Textile PLC, Adama, Ethiopia]

relative humidity. Absorbing water helps the cut pieces to withstand the action of beaters and rollers (Fig. 21.3).

21.2.2.4 Shoddying or Tearing

The main step in recycled/regenerated fiber processing is shoddying. In this machine, the conditioned rag is changed in to fiber. The machine has openers which convert the cut pieces of fabric into fibers. Tearing is accomplished stepwise. There are six stages of the opening where the density of the tooth increases stepwise (Fig. 21.4).

21.2.2.5 Baling

The final stage in recycling is baling. The reclaimed fibers are compressed into bales, which must then be covered to protect them from contamination during transportation and storage. Bales can be produced into three forms, i.e., modified flat, compress universal density, and gin universal density. These bales are packaged at densities of 14 and 28 lb/ft^3 for the modified flat and universal density bales, respectively (Fig. 21.5).

Fig. 21.4 Shoddying machine [Picture was taken from ETUR Textile PLC, Adama, Ethiopia]

21.2.2.6 Regenerated Fiber Storage

The regenerated fibers which are sorted based on their color are stored for further processing. The store should be well ventilated and a vast room which can hold a stock for several months. The bales must be stored in a segregated manner according to their lot number. Bales are recommended to be laid down on their smaller side to minimize contact with the floor to reduce contamination. Enough space must be left for conditioning of bales before introducing for production (Fig. 21.6).

21.3 Fiber Mixing and Blending

The various categories of blending or mixing yield different aesthetic appearances of the end yarn and, therefore, different final appearance of the fabric [10]. The types of blending or mixing systems affect the quality as well as the consistency of melange yarn produced either in Ring spinning or rotor spinning. The main objectives of mixing are to get the required characteristics of the end product, to give variations in

Fig. 21.5 Bale press machine [Picture was taken from ETUR Textile PLC, Adama, Ethiopia]

Fig. 21.6 Regenerated fibers [Picture was taken from ETUR Textile PLC, Adama, Ethiopia]

the characteristics of the raw material, to minimize raw material cost, to attain effects by altering color, fiber characteristics. For better processing, blended fibers must be compatible in respect of length, fineness, strength, and elongation. Usually, the types of blends depend upon the proportion of shade or colored fibers in the mixing recipe or yarn. Accordingly, the following categorization is principally based upon the Shade proportion. Cotton mélange yarn quality and consistency are significantly impacted by the mixing process (cotton for Nonwovens). The draw frame blending techniques accomplish enhanced mélange yarn quality than blow room blending technique [11].

21.3.1 Blend Shade in Blow Room

Mixings that are performed in successive blow room opening, mixing, and cleaning machines are called "Blow Room blends". In general, darker shades and shades components range of colored fibers are manufactured as blow room blend shades. Typically, shades which have a proportion more significant than 15% are processed as blow room blends. It enables us to attain the highest blending and consistency in the shade. It must be noted that by the name "shade" at this point, it means the whole proportion of colored fibers in the yarn structure. Different mixing systems are used to achieve the desired shade in Blow Room. Compared with other techniques, Blow room blending is more useful, considering the shade uniformity point of view [12].

Before Mélange Yarn spinning, the mixing of various shades is going to be done mainly manually. Specific weights of different colored fibers are measured, then mixed manually. The manual mixture of the fibers results in better-finished product properties as the cotton fibers after dyeing lose their strength, and Short Fiber Index is increased if they are mixed automatically [13].

Stack Mixing

This system of mixing is often called 'sand witch mixing'. It is the most convenient way to blend different kinds of fibers. In this system, fibers are to spread in a bin in horizontal layers and cut in vertical slices. This process is carried out two times to attain homogeneity.

Bale Mixing

This is carried out at the beginning of the blow room process. Depending on the fiber type, about 40 to 80 bales are laid out for simultaneous flock pulling out. With cautious utilization, this enables the yarn quality to be maintained almost regularly. This type of mixing is very complimentary if all bales have the same mean values for length, fineness, strength, and trash. This type of blend is inappropriate for strongly differing fibers, for example, cotton and synthetic fibers.

Flock Blending

Flock blending is carried out at the blow room itself. Flocks are very small tufts of fiber. It is also carried out for synthetic fiber mixing after opening out the fiber

by bale opener. It generally occurs in an uncontrolled manner. It can be made in a controlled manner if weighing pan and mixing blenders are used. It has the same kinds of advantages and disadvantages as bale mixing has.

Lap Blending

This is barely used this day. But it was previously used occasionally for the blending of cotton and synthetic fiber. For this, a doubling scutcher is needed, on which 4–6 laps could be laid. The laps are processed using the beater. Then a pair of cages are used to re-condense and form a lap sheet. Lap blending provides perfect transverse mixing and also the longitudinal blending. This is an uneconomical process as it essentially requires an additional machine and process.

Web Blending

Its major objective is to achieve better uniformity at the stage of comber lap as well as to obtain fiber blend in comber lap. Besides, this technique is also used for nonwovens. Now a day, the method is hardly used in the industry. Now despite web doubling, sliver doubling is used at the draw frame stage. However, web blending provides better longitudinal as well as transverse blend comparing to that of sliver blending.

21.3.2 Sliver Blending

These shades that are mixed on the drawing frame in the form of duplicate alterations are called "Drawing Blends." Predominantly, lighter colors are merged onto the draw frame, because they are trouble-free to blend as well as promote the process's balance. We can mix in drawing blends with shades of 15% each. This technique is used for the blending of natural fibers and synthetic fibers. It is carried out in the draw frame stage. For this, each material is to be processed separately up to the stage of the draw frame. The desired blend ratio can be obtained by selecting the suitable number of slivers of the fibers to be blended. This provides a high degree of homogeneity of blends in a longitudinal direction. Draw frame blending can be used in special cases for the production of fancy mélange yarn [12].

21.4 Mélange Yarn Spinning

The fiber of dyed mélange yarn is becoming an emerging product in the field of textiles. Cotton mixed yarns are spun from a variety of different colored cotton fibers. Mélange yarn is manufactured by combining some pre-colored fibers. The steps involved are dyeing, mixing (opening, carding), combing, drawing, roving, spinning, and knitting [8]. Colored spun yarn is spun usually by conventional ring

spinner with a limited manufacturing capacity [1]. A common method of producing a variety of fancy yarns is combining dyed and undyed fibers of varying degrees.

First, the fibers are dyed and then mixed to spin mélange yarn with other gray fibers, thus reversing the conventional yarn forming cycle [7].

Mixing of fibers with various colors could be achieved either at the beginning of the spinning preparation in the blow room section or by providing/input various colored fibers into the draw frames. Studies have found that the scoring and dyeing phase of cotton fibers results in higher entanglement and cohesion between them, reducing the strength of fibers and eliminating a portion of the wax present on the cotton fibers surface. Yet more mechanical operations on these fibers cause fiber damage and their length to decrease. These irregularities in fibers not only affect spinning process performance, yet also the final yarn and fabric's mechanical and physical properties [2] (Fig. 21.7).

The processing of colored cotton fibers and they are blended with grey cotton fibers in the rotor spinning system isn't quite so common compared to the ring-spinning method, possibly due to an issue of premature fiber breakage due to roller opening and deposition of trash and dye particles in the rotor groove. Fiber damage in rotor mélange yarn is more than ring mélange yarn because of the additional opening by opening roller [2]. The key advantage of dyed cotton fibers manufactured using open-end spinning is that even when mixed at draw frame, random and homogeneous mixing of dyed and grey fibers is possible.

Fig. 21.7 Mélange yarn [Picture was taken form ETUR Textile PLC, Adama, Ethiopia]

21.5 Factors Affecting Spinning Mélange Yarn

The very first and paramount concern in the spinning of mélange yarns is to align the shade according to the specific specimen given by the product customer and get agreement and manage the same throughout the whole manufacture of the mass amount. It needs expertise in mixing department preparation and tracking. The knitting efficiency issue is also another influential factor to bear in mind. Thus it is mandatory to give attention to the entire process flow, including card clothing, output capacity, draw frame roller settings and machine speed, roving frame job efficiency. The third important consideration is the question of color fiber contamination that typically happens because of the use of various colored fibers in the factory, making mixed products. Conscious attention must be made to reduce fiber contamination. Besides the usual measures followed to make knitting yarns, the aspects mentioned above are the main critical to take care of without mistake, or else the fabric created would be downgraded because of noticeable problems.

Fiber Selection: while processing a variety of fibers in the same process flow/machines, the length of fiber variation must be minimized as much as possible.

Blending: The blending systems must guarantee that at the last phase, the desired shade composition should be fulfilled as much as possible.

Processing: The machines should be fixed with the process of the utmost fiber amount if there is blending 10% colored viscose in 90% cotton fiber. A considerable quantity of virgin cotton fibers (which is not colored) are typically applied in the making of mélange yarn to minimize the use of dyes [8]. The machine parameter may be close to cotton; however, at each step allowance to be prearranged considering colored viscose, relative humidity percentage in the department must as well be set, taking consideration both fibers. There is higher fiber damage in rotor mélange yarn due to the rotation of opening roller comparing rotor mélange yarn and ring mélange yarn [2]. The saw tooth coverings on the opening roller further break the individual fibers before twisting operation at the rotor groove.

Critical things to remember in traveler use, when spinning mixed yarn

(1) Because dyed fibers are in mélange yarn, one must pick the travelers with considerable bow height to have adequate yarn clearance.
(2) Because of decreased strength in mélange yarn, lighter travelers should be used, and spindle speed should also be held lower than the conventional yarn.
(3) Periodic cleaning of the ring should be done to avoid the deposition of dye on rings.

21.6 Classification of Mélange Yarn

One may classify mélange yarn into two of its most essential categories:

- Blended
- Non-blended

21.6.1 Blended

Mixed type of mélange yarn wherein various fibers are mixed/blended jointly at a known proportion, for example, PC (Polyester Cotton blend) 60:40, PC 50:50, PV 70:30, and CVC 50:50.

21.6.2 Non-Blended

In this category of mélange yarn, there is only one type of fiber use, but different colored fibers of the same origin are used to manufacture the yarn, e.g., 100% cotton dyed yarn, 100% jute yarn. Besides, any other natural or synthetic fiber could be used to produce non-blended mélange yarn.

21.7 Pros and Cons of Mélange Yarn

21.7.1 Advantages of Mélange Yarn

Mélange yarn is famous for all good reasons. It can provide a wide range of shades, some shades maybe just 0.5%, and some can even be one hundred percent [13]. It also makes the fiber dyeing, color matching, and fiber blending processes easy. It's the yarn of the modern textile industry. It's an environment-friendly yarn made of organic elements. It is dyed before the spinning process, which ultimately preserves the energy and adds to the environmental safety.

Different proportions of colored fibers of various colors and textures can spin into mélange yarns. Through the benefits of power-saving, conserving water, as well as reducing pollution in their processing, mélange yarns are becoming increasingly common in manufacturers [9].

Mélange yarns also trend in the fashion industry. Now a day, there is an extensive market possibility for fancy yarns compared to conventional yarns that stay more eye-catching [14]. At a reasonable cost, a buyer gets a blend of various colors on the same fabric and high tensile strength and a great color holding capacity. An enduring brightness and opulence in the fabric color can be achieved through mélange yarns.

These fancy yarns have fabric beauty advantages and could be applied in informal wear, sportswear ties business suits, socks, and all kinds of textile items, as well as bed sheets, towels, ornamental fabrics, and other home-made fabrics [1].

21.7.2 Significant Problems in Manufacturing Mélange Yarn

Almost all wet treatments in all steps of the textile processing alter the fiber morphology and physical properties of the fibers significantly [13]. The coloration process of cotton fibers leads to increased interference and cohesion between them, and subsequent mechanical means contribute to fiber rapture that makes the process of manufacturing yarn more difficult [1]. Before coloration, there are fiber pretreatment processes, including bleaching and scouring. These processes remove natural wax present on the fiber surface. Depending on temperature and time, there can be a decrease in fiber strength after dyeing. Even if mélange yarn presents a vast diversity of shades, however, its strength is lesser than usual conventional yarn, and the loss in strength rises with an increase in the volume of colored fiber. There could be several problems happening in the manufacturing process, but the topic just emphasizes those issues that are especially relevant to the mélange yarn. Any of these problems will result in the output being rejected and eventually experiencing a significant loss. And, to get rid of this, we need to find certain significant defects and concentrate on their remedies. Those situations are:

(1) Shade variation
(2) Variation in proportion (esp. in PC/PV/CVC) yarns
(3) Unnecessary spots at the fabric surface

(1) **Shade Variation**

- Twist variation in the yarn produced either by ring frame (T.M/T.P.I variation) or rotor spinning
- Foreign fiber blended/percentage of fiber is not the same
- The moisture content of the yarn
- Count variation
- Colored fiber

Selected quality parameter tests, which include yarn count, tenacity, evenness, elongation at break, shade matching, variation, and the visual appearance of end products, are accomplished before shipment to eliminate the cancelation of orders. In the late 90 s, shade matching and variation were among the main causes of the cancelation of orders [14].

Twist Variation

The variations are spotted in the shade, whereas identical shades are being spun on two machines but with differences in TPI. This represents like more the TPI may result in the deep shade as evaluated to the lower TPI. TPI checks must be firmly enforced to prevent the occurrence of such kind of problem.

Foreign Fiber Blended (Improper Mixing)

Among the problems, the one and significant fault found is the addition of inappropriate fiber/inadequate fiber proportion of foreign fiber that contributes to changes in

the knitted fabric's tone and depth. So, to avoid this significant flaw, it is important for proper selection, and the exact proportion is a fundamental requirement. The tint is coloring that makes a substantial pale shade. A tint mainly reflects the least volume of color, which may deliver a detectable form of dyeing. In yarn manufacturing, fugitive tints are applied for detection and then removed in the finishing section.

Moisture Content

It is mostly known that Cotton fibers are naturally hydrophilic and absorb or adsorb the water vapor from the environment depending upon their percentage regain. Cotton, as well as other cellulosic fibers, exhibit such unique property. Yarn conditioning enables the cotton fiber to swell water hence improvement in tensile strength. Also, fiber will gain additional weight. As a result, if the yarn is manufactured from the mixture of conditioned and unconditioned yarn cones, a form of shade appears in the knitted fabric.

Count Variation

An inside shade sort, noticeable while the fabric is exposed to the sunlight in the tilted situation, is observed on the fabric if there is found a minute variation in a count of the two cross-matched yarns. So wrapping should be performed regularly to eliminate the differences in sliver hanks, roving hank, and yarn count.

Dyed Fiber

Fiber dyeing is among the factors which are not given much attention. Manufacturers are not confident regarding the dye rubbing and washing fastness. Therefore due to this, most mélange yarn producers are facing many limitations in fabrication. Thus, to overcome this issue, manufacturers required conducting washing as well as rubbing fastness tests of fiber used and must allocate the "LOT NUMBERS" as explained in the previous topics.

(2) **Variation in Proportion**

In Blended mélange yarn, i.e., mainly in PC/PV/ Heather Grey yarn, this fault is observed. This may help the shade either dark or lighter. This is attributed to the percentage change in each of the yarn components. This can be eliminated once more by periodic wrapping and sliver hank checking at the draw frames and the Speed frames. The proportion may also be verified as well as validated whether the measurements have been made as required or not.

(3) **Unnecessary spots at the fabric surface**

While the colors of two "LOTs" in the identical running product fluctuate, it is called "Shade Variation". The color of the yarn or knitted fabric will vary overall, which should be omitted to prevent the elimination of LOT. There are several explanations for the deviation in the shade. Among them, some are described below:

Such a problem has to do with fabric quality parameters. Unnecessary spots at the surface give a clue about the last fabric/yarn quality. It is always vital to recognize that

the surface of dark shades must not include any of the white spots (neps). Similarly, at lighter shades, there should be no dark neps. And to prevent these problems, the raw material used should be considered beforehand. Any darker shade, for example, like 70%, is shade, and 30% is virgin cotton. Thus it is better to use combed sliver in mixing in place of cotton bales, which could result in neps in the final fabric.

21.8 Application of Mélange Yarn

Such fancy yarns are commonly manufactured in the textile sector, and their application is predominantly in the hosiery clothing segment. Mélange yarns are common because of their distinctive and exclusive fabric look. The wavy like outcome due to various fibers mixing and several color tones due to different fibers blending makes it very common and abundant in appearance. A fabric made of mélange yarn has much better smoothness compared to that of conventional. The use of slub, chain, and stretch attachments just opens up a wide variety of products only possible in mélange yarns [4].

Mélange yarn is usually used in warp and weft knitting machines, in different V-bed knitting machines, as well as winding machines. It is also used to manufacture men's and women's underwear, casual wear, sportswear, shirts, business suits, socks, as well as bed sheets, towels, decorative fabrics, and other home fabrics items [3]. With continual developments in production technology in recent years, mélange yarns are extensively used in denim, upholstery, and even luxurious fashion fabrics in the garment industry [9].

21.9 Conclusion

Among the various industrial sectors, the textile and garment industries are deemed among the significant pollutant around the whole world. Textile wastes and byproducts are growing to astonishing levels at superior rates because of the look, recognition, and obsolescence of fast fashion. For example, more than 16 million tons of used textile waste is generated each year in the United States, according to the Environmental Protection Agency. Among this amount, most of it sent to landfill.

Second, to oil, the clothing and textile industry is the world's biggest polluter. Recycling of textiles and clothing is a potentially beneficial practice from environmental, social, and economic aspects, as opposed to landfilling or energy use. The key advantage of textile recycling operations is the prospect of reusing clothing. It is possible to minimize pollution and the energy-intensive development of new garments by the recycling of clothes and textiles.

Mélange yarns are renowned by their eye-catching shade and manifestation amongst the fancy yarns. Mélange yarn follows exclusive dyeing practice, and it is excellent technical regarding fiber dyes, color matching, and mixed textile of

multiple fibers. Dyeing of fiber before spinning enables to maintain of power-saving, emission cut, and ecological security. Mélange yarn's market share over conventional yarn is growing day by day. Therefore, using textile garment wastes for mélange yarn manufacturing has an opportunity to minimize landfilling. Besides, recycling spinning section soft wastes, as well as used clothes, significantly reduce the production cost.

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