PREPARATION AND PERFORMANCE OF STAINLESS STEEL FIBER/LYOCELL FIBER-BLENDED WEFT-KNITTED FABRIC

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Abstract:

Stainless steel fiber exhibits excellent flame retardancy and melting resistance, but it lacks thermal and moisture comfort. To compensate for these shortcomings, stainless steel fiber was blended with Lyocell fiber in ratios of 0/100, 10/90, 20/80, and 30/70%. The blended yarn was then formed into a single-sided plain stitch fabric of stainless steel fiber and finished with a phosphorus–nitrogen flame retardant. Next, the effects of the blending ratio on the fundamental properties, thermal and moisture comfort, and flame retardancy of the blended yarn and its fabric were studied. Considering these parameters alongside cost, the 10% stainless steel fiber-blended fabric was the optimal choice and showed potential applications for updating and upgrading welding service fabrics.

Keywords:

Blending process, stainless steel fiber, Lyocell fiber, yarn performance, flame retardancy

1. Introduction

The welding industry has strict requirements for protective clothing due to sparks sprayed during steel or iron welding that fall onto clothing [1]. The temperature of this metal spatter is approximately 500–700°C [2]. When the diameter of the molten iron sparks is greater than 1 mm, they will form holes in clothing if scattered 30–50 cm from the body and may burn human skin [3]. Protective clothing designed for welders must first consider the fabric’s melting point, but not many high-temperature-resistant fabrics are available for welding work clothes [4]. Currently available fabrics can withstand high temperatures as follows: thick cowhide fabric: 120°C, flame-retardant and water-repellent thickened cotton fabric: 150°C, and aramid and aramid composite fabrics: 260–280°C [5–7]. However, these commonly used fabrics generally do not fully protect welders due to their poor heat resistance, resulting in an urgent need to develop new materials to protect against welding spatter.

Stainless steel fiber fabric has a melting point of 1,350°C and can work well in oxidizing environments below 600°C, making it an excellent heat-resistant material [8]. Preliminary tests have confirmed that 900 g/m² pure stainless steel fiber-woven fabric can protect against welding spatter. However, because stainless steel fiber has poor spinnability, its resulting fabric is heavy, expensive, and has poor thermal and moisture comfort. Lyocell fiber, which has good thermal and moisture comfort and is inexpensive, can be used as the main material, and stainless steel fiber can be used as a supplementary material to enhance the flame retardance and melting resistance of the composite fabric. The resulting blended fabric may provide good thermal and moisture comfort, flame retardance, and anti-melting properties.

To enhance the flame resistance and resistance against melting holes in flame-retardant cotton fabric, improve the comfort provided by fabric made entirely from stainless steel, and reduce costs, stainless steel filaments can be integrated into a comfortable pure cotton flame-retardant fabric. Stainless steel fiber exhibits low resistance and is an excellent conductor, making it an excellent conductive fiber that is used to manufacture antistatic garments. Their conductivity eliminates static electricity generated by friction [9,10]. Notably, the higher the content of stainless steel fiber, the greater the amount of fuzz generated in the resulting fabric [11]. Due to its poor cohesion, stainless steel fiber is typically blended with other fibers [12]. The excellent mechanical and electrical properties of stainless steel fiber allow it to be applied for manufacturing smart textiles, as well as for motion detection, medical hygiene, electronic communication, personal protection, and industrial development for intelligent fabric sensors [13]. This material can also be a valuable tool for monitoring heart rate, blood pressure, and exercise intensity by doctors or athletes [14].

When blended with cotton fibers, stainless steel fibers can be used to make clothing that provides electromagnetic shielding and maintains such an effect even after repeated washing [15]. In addition, these materials exhibit high durability. The softness, moisture absorption, and breathability of cotton fibers endow electromagnetic protective clothing with superior softness, moisture absorption, and perspiration control, in addition to their ability to directly contact human skin [16,17]. The content of stainless steel fiber incorporated into a fabric directly affects the electromagnetic protection it provides [18].

Stainless steel metal fiber can be used to manufacture stainless steel fiber-sintered felt [19]. This material, which is based
on 316L stainless steel, demonstrates exceptional corrosion resistance and is used as a porous metal material in numerous industrial applications [20], including filtering corrosive media [21]. The thermal stability of a stainless steel fiber is high, and the thermogravimetric analysis results from 25 to 900°C show that the weight loss rate of a stainless steel fiber tends to be stable within this temperature range, indicating its excellent high-temperature resistance [22,23]. Stability under high temperatures enables stainless steel fibers to be used as insulation and filtration materials in high-temperature environments [24]. Stainless steel fibers have an irregular cross-section, connected tortuous voids, and rough surfaces, allowing them to change the direction of sound. The viscous flow weakens the energy of sound waves, creating a sound-absorbing and sound-insulating effect [25]. This attribute renders stainless steel fibers more effective than ordinary sound-absorbing materials [26]. Thus, they are widely used as silencing materials in airplanes and cars to reduce engine exhaust noise [27]. Stainless steel fibers possess inherent antibacterial properties, with research and development efforts commencing in the late 1990s [28]. Antibacterial stainless steel can also be used in structural materials similar to ordinary stainless steel [29]. A stainless steel filament was used to develop electric heating elements for bending heaters, medical heating, and defrosting [30].

This study first spins a variety of ratios of stainless steel fiber/Lyocell fiber-blended yarns and then uses these yarns to prepare weft-knitted fabrics that are then finished with a flame retardant. Finally, the effects of different ratios of raw materials on the thermal and moisture comfort and flame-retardant functionality of flame-retardant fabrics are studied.

### 2. Experimental

#### 2.1. Experimental materials

The materials used in this experiment were 7 μm × 40 mm stainless steel fibers with combed sliver from Tenger Hui Co., Ltd., 1.33 dtex × 38 mm specification Lyocell fibers from Sedley (Changzhou) Co., Ltd., and a phosphorus–nitrogen flame retardant from Jiangxi Baichuan Fire Protection Technology Consulting Co., Ltd.

#### 2.2. Preparation and testing of stainless steel fiber/Lyocell fiber-blended yarn

The purchased slivers of stainless steel fibers and combed slivers of Lyocell fibers were mixed in the form of strip blending using a TMFD81(S) high-speed drawing frame.

2.2.1. Strip blending process

Table 1 shows the process parameters for the drawing process, in which stainless steel fibers and Lyocell fibers were precisely mixed. In Table 1, “A” represents the Lyocell fiber-combed sliver(s), “B” represents the stainless steel fiber-combed sliver(s), “C” represents the blended sliver(s) from the first drawing step,
and “D” represents the blended sliver(s) from the second drawing step.

When blending 0% stainless steel fiber and 100% Lyocell fiber, six slivers of combed Lyocell fibers were fed together into a TMFD81(S) high-speed drawing frame.

When blending 10% stainless steel fiber and 90% Lyocell fiber, the first drawing step involved feeding three slivers of stainless steel fiber and three slivers of combed Lyocell fiber into the drawing frame. For the second drawing step, one blended sliver from the first step and five slivers of combed Lyocell fiber were fed into the drawing frame. In the third drawing step, all six blended slivers from the second step were fed into the drawing frame.

When blending 20% stainless steel fiber and 80% Lyocell fiber, the first drawing step involved feeding one sliver of stainless steel fiber and five slivers of combed Lyocell fiber into the drawing frame. For the second drawing step, all six blended slivers from the first step were fed into the drawing frame. In the third drawing step, all six blended slivers from the second step were fed into the drawing frame.

When blending 30% stainless steel fiber and 70% Lyocell fiber, the first drawing step involved feeding two slivers of stainless steel fiber and six slivers of combed Lyocell fiber into the drawing frame. For the second drawing step, all six blended slivers from the first step were fed into the drawing frame. In the third drawing step, all six blended slivers from the second step were fed into the drawing frame.

2.2.2. Roving process

The roving process used an FA467E-type fly frame. The specific roving process parameters are listed in Table 2.

2.2.3. Ring-spinning process

The ring-spinning process was carried out using a BS529J-type ring-spinning machine. The specific spinning process parameters are listed in Table 3.

The yarn twist was tested according to the national industry standard GB/T 2543.2-2001 “Textiles – Determination of twist in yarns – Part 2: Untwist/retwist method.” The linear density of yarn was tested using a YG086c-type yarn length tester in accordance with GB/T4743-2009 “Textiles – Package Yarns – Determination of Linear Density by Skein Method.” The yarn’s breaking strength and breaking elongation rate were tested using a YG06G single yarn strength tester in accordance with GB/T 3916-2013 “Textiles – Yarns from Packages – Determination of Single-End Breaking Force and Elongation at Break.”

2.3. Preparation and testing of stainless steel fiber/Lyocell fiber-blended fabric

Single-sided, weft-knitted fabric was produced using a fully automatic flat-knitting machine from Cixing with a weft flat needle structure. The transverse density was set to 35/5 cm, and the longitudinal density was 60/5 cm. A phosphorus–nitrogen-based eco-friendly flame retardant was used as a finishing agent. Using the impregnation drying method, the finishing solution was prepared at a 1:1 ratio of flame retardant to water. The prepared finishing solution and sample fabric were immersed in the same container for 1 h. The soaked fabric was removed, wrung dry, and then placed in a mangle to roll dry, with a liquor pick-up rate of 53.12%. The rolled fabric was placed in a drying oven and baked for 2 h at 80°C. The dried fabric was rinsed with clean water and then air-dried.

The thickness of the fabric was measured using a YG(B)141D digital fabric thickness gauge from Wenzhou Darong Textile Instrument Co., Ltd., in accordance with the ISO5084:1996 standard for determining the thickness of textiles and textile products. The resistance of the fabric to pilling and its hairiness were tested using the circular trajectory method with reference to the ISO 12945-2 standard for determining the pilling and hairiness of textile fabrics. The equipment used was a YG(B) 502 fabric pilling balloon instrument supplied by Wenzhou Jigao Testing Instrument Co., Ltd. The air permeability of the fabric was measured using the equal pressure method with reference to the ISO 9237-1995 standard for determining the air permeability of textile fabrics. The equipment used was a YG(B)461X fabric air permeability tester supplied by Wenzhou Darong Textile Instrument Co., Ltd. The moisture permeability of the fabric was evaluated using the moisture absorption method with reference to the ISO 11092 standard for testing the moisture permeability of textile fabrics. The instrument used was a YG(B) 216-II fabric moisture permeability meter supplied

http://www.autexrj.com/
by Wenzhou Ruibo Testing Instrument Co., Ltd. The stiffness of the fabric was measured using the inclined plane method with reference to the ISO 9073-7:1995 standard for determining the bending length of textile fabrics using a YG 022 automatic fabric stiffness tester from Wenzhou Darong Textile Instrument Co., Ltd. The mechanical properties of the yarn and fabric were evaluated using a 3365 universal material testing machine from INSTRON according to the ISO 13934-1:2013 standard for determining the tensile properties of fabrics. The burning performance of textiles, specifically the damaged length, afterburn, and afterglow time in the vertical direction, was measured according to the ISO 15025 standard. The flame resistance of the fabric was determined using a YG815A-III fabric flame resistance tester from Wenzhou Fangyuan Instrument Co., Ltd. The surface morphology of nanofiber bundles was investigated using a scanning electron microscope (SEM, JSM-6390).

3. Results and analysis

3.1. Blended yarn analysis

3.1.1. Sliver-mixing process

After the stainless steel fibers were carded by an FA204 cotton carding machine, they became very short, and the single fiberization of the stainless steel fibers was not ideal and showed a tendency to knot. After two rounds of sliver blending, the blend was not uniform. The roving test spinning resulted in too many breaks, making it nearly impossible to operate normally. This was because the stainless steel fiber had a larger specific gravity and higher rigidity, giving it a large performance difference from Lyocell fiber. Therefore, after the two raw materials were opened and mixed in the carding machine, they could not be easily transferred to the tin sliver, so we chose to mix them on the drawing machine and combined them through multiple passes.

3.1.2. Roving process

The roving hank was 12.5 g/10 m (the hank cannot be too large, or it will block the process channels). In this experiment, a small draw ratio of 5.2 was chosen to improve the evenness of the sliver, reduce the thick and thin parts, and thereby improve the yarn quality. Second, due to the large friction coefficient between stainless steel fibers, the sliver was difficult to draw. The roving twist multiplier was selected based on the spinning experience. In general, for pure or blended spinning of synthetic fibers, the selection range of the roving twist multiplier should be between 75 and 120. In this spinning experiment, due to the small curl of stainless steel fiber and Lyocell fiber and poor fiber cohesion, accidental drawing occurred during the spinning process, and it easily broke. Therefore, 109 was chosen. During the operation of the roving machine, excessive tension prevented the yarn from being drawn during the spinning process. Then, the tension was too low; the blended sliver tended to be blocked in the roving output pipe. Driving too fast caused roving breaks, which made it necessary to choose an appropriate speed and tension to ensure product quality; therefore, a tension of 800 was chosen.

The twist could not be too large to ensure that the roving twist was not too high and could not be drawn during spinning. The twist should also not be too low, to prevent accidental drawing. If it is too low, the roving will also be prone to looseness and breakage. Therefore, the roving twist was set to 2.7 twist/meter. When choosing a spindle speed, the spinning efficiency and yarn quality should be considered. It should not be too high, or it will increase the hairiness of the yarn. Therefore, the spindle speed was set to 500 rpm. The roller gap was determined by the main length of the fiber and roller diameter and was set by adjusting the drawing force and grip force on the fiber during spinning. An excessively narrow roller gap prevented the fiber from being drawn and even broke some fibers, leading to hard heads and a poor sliver. An excessively large roller gap prevented the fiber from being controlled during the drawing process and gave it thick and thin sections, which also produced poor slivers. The roving roller gap was set to 12 mm × 26 mm × 40 mm. The apron spacer was used to control the top and bottom aprons on the fiber. When the apron spacer was too small, the control force was too large during fiber drawing, which affected the sliver and even prevented it from being drawn. If the apron spacer was too large, the top and bottom aprons lost control of the fiber movement. Therefore, a suitable apron spacer guaranteed that the top and bottom aprons could control the movement of the fiber, and the apron spacer was set to 7.5.

3.1.3. Spinning process

The spinning process adopted the rotor-spinning method to improve the uniformity of the yarn sliver, reduce the unevenness of weight and strength, and reduce yarn hairiness. The spun yarn count was 98.4 tex. This spinning draw ratio was chosen for the same reason as those of the roving process and was set at 26. The spinning twist factor was chosen according to the purpose of the yarn: whether it was for weaving or knitting. In this experiment, it was for weft-knitting fabric. The twist factor of knitted fabric is generally in the range of 320–360, so it was set to 320. The spindle speed was set to 5,000 rpm after considering spinning efficiency and yarn quality. The roller gap was chosen for the same reasons as those of the roving process and was set to 20 × 45. The spacer block was chosen for the same reason as that of the roving process and was set to 4.5. The model of the steel ring was chosen according to the size of the spun yarn count and the model of the steel collar. If it was too small, the yarn would have a large air ring during the spinning process, which made it easily collide with the anti-yarn board. This resulted in many yarn breaks and higher yarn hairiness. If it was too large, the friction between the steel collar and the steel ring would be large, resulting in many large yarn breaks, which would affect the spinning efficiency.

Figure 1 shows that under the same processing conditions, a higher stainless steel fiber content resulted in a lower average twist of the yarn and greater unevenness. A higher unevenness in the twist led to an uneven yarn break strength, which may have formed a weak link in terms of mechanical properties, possibly causing certain difficulties for yarn weaving. As the stainless steel fiber content increased, the average twist value decreased accordingly because the stainless steel fibers were
highly rigid and were more difficult to twist under the same conditions compared with the softer Lyocell fibers. Therefore, under the same spinning conditions, the twist of the blended yarn should be lower. Because there is a set distance for twist transmission during the yarn-twisting process, and due to the high rigidity of the stainless steel fibers, a higher content of stainless steel made transmission more difficult. This caused a delay that increased the unevenness of the twist.

Figure 2a–d, respectively, shows the SEM images of blended yarns with stainless steel fiber contents of 0, 10, 20, and 30%. The stainless steel fibers were straighter and smoother than the Lyocell fibers, and the number of stainless steel fibers increased from Figure 2a–d. The degree of twisting of stainless steel fibers was significantly lower than that of Lyocell fibers, and the degree of twisting between different fibers was also different, further confirming the lag in the transmission of twists to stainless steel fibers during yarn twisting.

Figure 3 shows that upon increasing the stainless steel fiber content, the elongation at break and breaking strength of the stainless steel fiber-blended yarn decreased. The standard deviation of the breaking strength did not differ much, while that of the breaking elongation was larger. This was because the surface of the stainless steel fiber was smooth, and the cohesion between it and other Lyocell fibers was poor. The overall structure of the yarn was not tight and appeared fluffy, especially when the twist of the yarn for knitting was low. At this...
time, the entanglement and cohesion between the stainless steel fiber and other fiber components were weak, and the high strength of the stainless steel fiber was not used. When subjected to a tensile force, the stainless steel fiber was not broken and slipped. At this time, the higher content of stainless steel fibers resulted in worse entanglement and cohesion with Lyocell fibers, making them easier to slip. This made the blended yarn easier to stretch and break, ultimately decreasing the breaking strength and elongation of the yarn.

3.2. Analysis of fabric stiffness

The bending stiffness of a fabric refers to its resistance to bending deformation, in which a greater bending stiffness indicates a harder and stiffer fabric. As can be seen in Figure 4, the bending stiffness of the 0% stainless steel fiber-blended fabric was far lower than the other three proportions because Lyocell fiber is soft. Due to the inherent softness of the fiber, the bending stiffness of the resulting fabric was low. The longitudinal bending stiffness of the weft fabric was greater than the transverse bending stiffness. This was because yarn gathered due to the coil stems in the longitudinal direction of the fabric, while the transverse direction is where the coil extension lines played a connecting role. The degree of yarn aggregation was far lower than in the longitudinal direction.

Figure 4 shows that as the content of stainless steel fibers increased, the bending stiffness also increased, and the fabric’s hand feel became less soft. This is because the stiffness of stainless steel fiber was high, and increasing the content of stainless steel fibers increased the bending stiffness of the blended yarn and fabric. Considering the wear of the welding-protective suit, a fabric that is too soft will likely stick to the body and be unsuitable as work clothing. It must also have a certain degree of stiffness, but not be so stiff that it is uncomfortable. Therefore, in terms of fabric stiffness, the blended fabrics with intermediate stainless steel fiber contents of 10 and 20% were chosen.

3.3. Analysis of fabric breathability

Figure 5 shows that under the same pressure differential and fabric density, as the stainless steel fiber content increased, the air permeability of the blended fabric increased. This was because stainless steel has a relatively high specific gravity and produced thinner fibers. Therefore, under the same linear density, the yarn twist was smaller, making the yarn and fabric fluffier and more porous. The surface of stainless steel fibers was smoother, which was more conducive to air circulation; hence, the breathability of the fabric increased with the stainless steel fiber content. The air permeability of these four proportions of fabrics all exceeded 200 mm/s, indicating that they all had good breathability, especially fabrics with stainless steel fiber contents of 10, 20, and 30%.

3.4. Analysis of fabric moisture permeability performance

Figure 6 shows that the blended fabric with 10% stainless steel fiber had the highest moisture permeability, which was related to the fluffiness of the yarn structure and the moisture absorption of the yarn material. This fabric also had a greater moisture permeability than the 100% Lyocell fiber fabric because the stainless steel fibers reduced the yarn twist, making the yarn fluffier and the fabric pores larger. The moisture permeability of blended fabrics with 20 and 30% stainless steel fiber was inferior to that of the fabric with 10% stainless steel fiber. This was because, when using fluffy stainless steel-blended yarn, the moisture permeability depended on the content of Lyocell fibers with good moisture absorption. When the stainless steel fiber content increased, the content of Lyocell fibers decreased and the moisture permeability of the fabric also decreased. Fabrics with better moisture permeability make it easier for workers’ sweat to be expelled during work, providing greater comfort [31]. In terms of moisture permeability, the blended fabric with 10% stainless steel had the highest moisture permeability.

Figure 4. Stiffness performance of stainless steel fiber-blended fabric.

Figure 5. Air permeability of stainless steel fiber-blended fabrics.
3.5. **Longitudinal mechanical properties of the fabric under single stretching**

By analyzing the longitudinal mechanical properties of the weft-knitted fabric as a representative in Figure 7, upon increasing the stainless steel fiber content, the elongation at break and breaking strength of the stainless steel fiber-blended fabric slightly decreased. This was due to the high rigidity of stainless steel fiber, smooth surface, and poor cohesion, which all led to a low breaking strength of the blended yarn, which ultimately gave the blended fabric a low strength. Similarly, the elongation at break of the stainless steel fiber-blended yarn decreased upon increasing the stainless steel fiber content. Therefore, elongation at break of the blended fabric also decreased. The blended yarn with 10% stainless steel fiber had a better tensile breaking strength and elongation at break than other proportions of blended fabric and was only weaker than the 100% Lyocell fiber fabric. Generally, fabric with superior mechanical properties has better durability and can be used to produce protective clothing with greater durability.

3.6. **Fabric flame retardancy**

The flame retardant performance of the blended fabrics with four different proportions of stainless steel fiber content meets the requirements of GB 8965.1-2020 “Protective Clothing – Flame Retardant Clothing.” As shown in Table 4, upon increasing the stainless steel fiber content, the continued burning time did not change, and all were 0. The smoldering time also did not change (all were 0), indicating a significant flame-retardant effect on the fabric. The damage length of the blended fabrics with four stainless steel content ratios was almost the same, and all were between 1 and 2. Because the standard damage length was ≤100, a value in the range of 1–2 was much smaller than the standard requirement, indicating that the flame retardant fully entered the interior of the fabric and adhered to fibers during finishing, providing an excellent overall flame-retardant effect.

Figure 8a–d shows the SEM images of blended fabrics with stainless steel fiber contents of 0, 10, 20, and 30% after flame-retardant finishing, respectively. This figure shows that...
as the stainless steel content increased, a powdery substance adhered to the surface of the fabric fibers, which was determined to be the nitrogen–phosphorus flame retardant [32]. More of this powdery substance adhered to the surface of the Lyocell fiber, while less was adhered to the stainless steel fiber, suggesting that the flame retardant was more likely to combine with the Lyocell fiber.

3.7. Significance assessment

Using SPSS software to analyze the test data above, with stainless steel fiber content as the independent variable and other test data as dependent variables, the significance of the data was analyzed, and Table 5 was created. According to Table 5, except for the flammability test data and moisture absorption data with values >0.05, all other significance test values are less than 0.05. The variation in stainless steel fiber content has a significant impact on properties such as mechanical performance, bending rigidity, and air permeability, excluding moisture permeability and flame retardancy. The influence on flame retardancy is not significant, possibly due to the small difference in flammability test values, which is attributed to the excellent flame retardancy achieved. The reason for the non-significant impact of stainless steel fiber content on moisture absorption may be related not only to the material itself but also to the capillary pores of the fabric and yarn. When the stainless steel fiber content is high, moisture absorption decreases, but the capillary effect caused by the pores in the fabric and yarn also increases, resulting in a non-significant overall impact.


A radar chart was created based on the main performance of the fabric, where the data columns with the poorest performance are labeled as 1, followed by 2, 3, and 4, with 4 representing the best performance. The flame retardancy performance is consistently rated as 4. The cost of pure cotton fabric, which is the lowest, is labeled as 1, while the fabric with the highest cost, containing 30% stainless steel, is labeled.
as 4. The radar chart is presented in Figure 9. Among fabrics with various ratios, pure cotton fabric was initially excluded from consideration due to its lack of stainless steel fibers, making it susceptible to melting and penetration from welding spatter. As depicted in Figure 9, it illustrates the radar chart of fabric performance, and the blended fabric with 10% stainless steel fibers was the top choice among the remaining ratios and showed the best softness, moisture permeability, tensile strength, third-best breathability, and flame retardancy comparable to fabrics with other ratios. It also showed the lowest raw material cost and led in five-out-of-six selection criteria. Taking into account all of these factors and the performance parameters, this study proposes that the blended fabric with 10% stainless steel fiber was the best choice and shows promising application prospects for use in welding clothes.

4. Conclusion

In this study, blending was used to prepare stainless steel fiber/Lyocell fiber-blended yarn by mixing and spinning in various ratios. Weft knitting was used to form the blended yarns into fabrics with a single-sided plain knit structure. A phosphorus–nitrogen flame retardant was then used to produce flame-retardant-blended fabrics. Because of the high rigidity of stainless steel fibers and their poor cohesion when blended with other fibers, a higher content of stainless steel fibers resulted in a lower average twist and tensile strength of the stainless steel fiber/Lyocell fiber-blended yarn. The rigidity of the stainless steel fibers increased the fabric stiffness and decreased the softness as their content increased. Poor cohesion of the stainless steel fibers produced fluffy yarns, and as their content increased, the air permeability of the blended fabrics was improved.

Stainless steel fibers were not moisture-absorbing, while Lyocell fibers showed good moisture absorption. As the stainless steel fiber content increased, the moisture permeability of the blended fabrics decreased. As the stainless steel fiber content increased, the tensile strength and elongation at break of the blended yarns decreased, which also decreased the tensile strength and elongation at break of the blended fabrics. The flame retardancy was good for the four different ratios of stainless steel-blended fabrics after flame-retardant finishing. Stainless steel fibers have inherent high-temperature resistance and anti-melting properties, but, due to comfort considerations, Lyocell fiber should be the main component of clothing. Because stainless steel fiber is much more expensive than Lyocell fiber, the stainless steel fiber content should not be too high. The blended fabric with 10% stainless steel fiber was the best choice and shows promising application prospects for use in welding clothes.

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