The Application of Medical Fiber on Medical Textile

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Abstract: The basic properties of some medical fiber and the application of some medical fiber on medical textile are introduced, the continuous development of the medical fiber on the application of medical textile is also mentioned, and the innovation should be done.

Keywords: medical fiber; properties; application

1. Introduction

With the increasing need and dependence of fiber material and production from modern medicine, medical fiber is developing into an emergent industry. The medical fiber material and product may use in making the medical instruments, meanwhile can serve as the substitute of human organs or organism organization, in this way the organ failure and organization flaw can be treated. Take America as an example, the operations on organization and organ repair reach to nearly eight million cases every year, the annual cost surpasses forty billion US dollars, equals to half of the medical care cost, the fiber material and product cost occupy a quarter of the total cost. Meanwhile, because of the close contact between the fiber product and human body also the treatment function, therefore, the medical fiber material and the product must have some certain function and biological compatibility, biological degradability, sterilization. Thus it may be known, this is a high value—added industry and great potential market. Currently, there are various kind of medical fiber in and out of home including human substitute material and medical health material. The heart membrane petal tendon, the ligament, the sanitary napkin and so on are typical example of such material. The basic properties of some medical fiber and the application on medical textile are introduced in the paper.

2. The properties of medical fiber

2.1. Alginate fiber

The alginic acid is a natural polysaccharide which withdraws from the brown alga, also a kind of linear copolymer which is formed by β-D - mannuronic acid (M) and α-L - gulose aldehydic acid (G)’s 1,4 linkages. Because of the originate differences, the monomer G and M’s relative scale and rank order differences, the different physical mechanical properties are caused. Compared with viscose, the dry strength of sea alginic acid calcium textile fiber is comparable, but lower wet strength, higher break elongation ratio, from table 1 the water content change along with the sea alginic acid calcium textile fiber is seen. The sea alginic acid calcium textile fiber may formed by the basic aqueous spinning craft. The concentrated sea alginic acid solution is squeezed through screw stock and sent to the acidic coagulating bath, the alginic acid calcium textile fiber which can’t dissolve the water is formed through the ionic exchange of sea alginic acid sodium and the calcium ion, then laundering, stretching, drying process have been done, at last, the bandage that is used to dress a wound is made through the non—woven production technique.

Sea alginic acid sodium powder $\rightarrow$ the concentrated sea alginic acid solution $\rightarrow$ aqueous spinning craft $\rightarrow$ laundering $\rightarrow$ stretching $\rightarrow$ drying $\rightarrow$ sea alginic acid calcium textile fiber $\rightarrow$ bandage

<table>
<thead>
<tr>
<th>Environment condition</th>
<th>Strength (cN/dtex)</th>
<th>Break elongation ratio(%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dry state</td>
<td>1.94</td>
<td>10</td>
</tr>
<tr>
<td>65% relative humidity</td>
<td>1.01</td>
<td>14</td>
</tr>
<tr>
<td>100% relative humidity(Saturated)</td>
<td>0.26</td>
<td>26</td>
</tr>
</tbody>
</table>

The sea alginic acid calcium textile fiber which has relative higher content of G is difficult with swelling, while the increase of the sea alginic acid sodium content among fiber can improve the absorbent rate of the fiber, thus, a kind of technique had been developed, the partial calcium ions is replaced by the hydrogen ions through laundering the sea alginic acid calcium textile fiber by use of hydrochloric acid. Then the hydrogen ions are replaced by the sodium ion through the sodium carbonate or sodium hydroxide processing. After such processes, the sea alginic acid calcium/sea alginic acid sodium textile fiber is obtained, and the sea alginic acid sodium which has water-soluble property makes the material has higher absorbent abilities than the sea alginic acid calcium textile fiber bandage.

The sea alginate can usually be used as frozen mastic or thickening agent in food industry, textile industry and
pharmaceutical industry, also be used as division of socks’ after—woven processing and paper industry. The new use of alginic acid is used as wound bandage or paste, and great success was gained in recent years. Along with the establishment of “cured in wet condition” concept in recent years, the ideal conditions of curing wound is regarded as wet condition, in such condition the paste can be moved easily from the wound. The alginate fiber has the unique ionic exchange performance which may interact with the wound percolate and form the moist gelatin, in such way, the wound can be cured and the bandage can be removed easily, the bandage which has higher content of alginate fiber can be washed by heat salt fluid or removed all, and the newly recovered frail organization of the wound surface can’t be affected, hence, it becomes one of the ideal wound wrap article. The main mechanism is that the alginate fiber exists in the form of calcium salt, the calcium ion of the fiber can exchange the ion with the sodium ion on the wound percolate, the calcium ion enters the wound, so part of the fiber change into sea alginic acid sodium, because of the water—solvent property, the fiber happens huge swelling and forms into gelatin, such kind of ionic exchange create a moist environment for the wound cicatrization. Because of the comprehensive properties, it becomes one of the most popular materials to cure the wound.

2.2. Chitin fiber

The chitin is one of the richest natural organic matters in nature, the chitin is the linear polymer which is formed by 2- acetyl amino - 2- deaeration - β-D – glucose in the form of β-1, 4 glucoside, and it widely exists in crustacean animals such as shrimp, crab and so on. Statistics indicated that the biosynthesis chitin can reach to billions tons every year, it is a rich natural resource.

The raw material which is chosen to make chitin fiber is mainly from the abandoned shrimp and crab chitin. The pigment, protein are removed firstly and the chitin powder which has 0.2% of ash is obtained, then treat the powder with the toluene sulfonic acid’s isopropyl alcohol solution, and dissolve the powder in dimethyl acetamide which has few LiCl, at last, the relative high strength and elongation chitin fiber has been got through the normal wet technique or dry technique. The technical process is as follows:

Shrimp, crab →chitin powder →toluene sulfonic acid’s isopropyl alcohol solution → LiCl dimethyl acetamide → wet spinning →dry spinning →chitin fiber

Because of the strong reactivity, non-toxic property, tasteless, anti-alkali, anti-corrosive, biodegradation, good biological activity, biological compatibility, binding property, softness, antibacterial property and so on, the chitin fiber can be used as the suture line, the artificial skin and the wound wrap material. The relative high strength and elongation ratio chitin fiber can be gotten through the normal wet spinning and dry spinning; different kind of forms can be gotten such as yarn, weave fabric, knitted fabric, non—woven fabric and so on.

2.3 Chitosan fiber

Chitosan is the deacetylation derivatives of chi-tin, because of the primary amino in chitosan, so the reactivity and dissolved performance are better than chitin, and also be regard as the most important and widely used derivatives. Almost all the chitosan can dissolve in or-ganic and inorganic acid peroxide solution, also the cellulose has similar structure with chitin and chitosan, if the C—2 position’s —OH in cellulose is replaced by acetyl amino group (—NHCOC3H7), then the chitin is formed, if is replaced by —NH2, then chitosan is formed. Because of the strong reactivity, non-toxic property, tasteless, anti-alkali, anti-corrosive, biodegradation, good biological activity, biological compatibility, binding property, soft-n Chitosan is the deacetylation derivatives of chitin, because of the primary amino in chitosan, so the reactivity and dissolved performance are better than chitin, also be regard as the most important and widely used derivatives. Almost all the chitosan can dissolve in organic and inorganic acid peroxide solution, also the cellulose has similar structure with chitin and chitosan, if the C—2 position’s —OH in cellulose is replaced by acetyl amino group (—NHCOC3H7), then the chitin is formed, if is replaced by —NH2, then chitosan is formed. Because of the strong reactivity, non-toxic property, tasteless, anti-alkali, anti-corrosive, biodegradation, good biological activity, biological compatibility, binding property, softness, antibacterial property and so on, so it arouses great interest.

2.4 polylactic acid fiber

Because petroleum isn’t used in polylactic acid, and the abandoned garbage can degrade easily in human body, soil, and sea water, so the earth environment can’t be polluted, it’s a kind of new synthetic earth—friendly fiber.

The biodegradation polylactic acid fiber which is made through microorganism fermentation system by use of plant such as corn as raw material is taken by some Japanese and America companies, the biodegradation polylactic acid fiber’s strength like polyamide fiber and polyester fiber, melting point reaches to 175 ℃, work and dyeing property are relative good. Through different chemical additive, the degeneration cycle in soil and water can be controlled within 2 months or 2 years, furthermore, the biodegradation polylactic acid fiber can completely degrade into carbon dioxide and water, also the degeneration intermediate low lactic acid can promote the growth of plant. Such kind of fiber can widely used in medical suture line, implantation material of surgical operation, artificial blood vessel, disposable product like medical suture line, implantation material of surgical operation.
diaper, woman sanitary napkin. The technical process is as follows:
corn$\rightarrow$starch$\rightarrow$microorganism ferments or synthesis$\rightarrow$ lactic acid$\rightarrow$polymerization$\rightarrow$polylactic acid$\rightarrow$spinning $\rightarrow$polylactic acid fiber

2.5 PHA

The biomacromolecule material(PHA) which has developed in recent 20 years, the biomacromolecule material is a kind of inner cell polyester which synthesis by many microorganism, also a kind of natural bio-polymer material. This kind of polymer is formed by the fruitful resources of wild grass fermentation in mid-west America. Gene adding during the processing process can make the biological polyester. The strength of suture line that is made by the material is higher or lower, the elasticity or the inelasticity are the best, through controlling the gene can make the fiber have sequenced residual period. Besides, the application of PHA in fiber area makes the suture line can dissolve in a short time, at the same time, it can be used as human body or structure such as pancreas or heart. Because of the good biocompatibility, biodegradability and plastic heat processing performance, therefore, it has become the hot research point of biological materials in recent years.

2.6 Modified Lyocell textile fiber

The new solvent spinning cellulose fiber “Lyocell” is developed by England’s Courtaulds company, Austria’s Lenzing company, Germany’s Akzo company and so on, the preparation technique is simple, the alkalize, etiolution and ripening procedure isn’t necessary, the solvent is un—toxic, the technical process is closed, the recycled solvent ratio reaches above 99.5%, the product process is environment—protective. also the fiber has good handle feel, dress—comfortability, water absorbability, softness, biodegradation, relative high wet and dry strength, washing fastness, the low shrinkage ratio, the fiber can undergo chemical process in different wet and dry state, also normal dyeing and print$^{[9][10]}$.

The directly dissolved cellulose technique is generally adopted to produce Lyocell, the principle is that dissolve the cellulose in ring—shaped tertiary amine oxide N—methylmorpholine—N—oxide and water mixture under certain circumstance. In the technique, the good pretreatment PPTA mix with NMMNO and water in the continuous mixer, and the cellulose is dissolved into viscous solvent, filter the solvent then spinning, the cellulose is out in solid silk—shape, the diluted NMMNO solvent can be recycled and can realize easily,99.5% of the solvent can be recycled.

England’s Courtaulds Company has developed fiber named Hydrocel under the production technique of modified Lyocell textile fiber, this can replace alginate calcium which is used to make superior bandage to cure wound and burn $^{[11]}$. Hydrocel is the CMC production that is made by modified chemical method. Hydrocel has similar properties with alginate fiber; Hydrocel can provide a humid environment to promote the wound recovery. Besides, Hydrocel has higher water absorption than linate fiber, it can reach to 35 times of its own weight, and also the great continuous gel is formed, so it can remove all easily and easy to change the bandage.

2.7 Superld medical fiber

Superld medical fiber is made through advanced composites manufacturing technology by America Dupont non—woven material company, a special double component recipe is taken to make the new product. The new product can be used to make garment, protect medical care personnel, also the product has comfortability. This is the first medical product which has high protective and softness properties. Superld is a kind of non—woven product which is made by polyester and polypropylene, suprelld has the properties of polyester and polypropylene. Besides, the surface friction is lower than the other medical material, so the wearer can feel more comfortable and can move easier.

3. Summary

The basic properties of medical fiber and the application of medical fiber are introduced in the article, with the surging new material, new technology, new application; the medical fiber research is also developing. At the same time, with the widespread promotion of medical fiber in medical textile product area, the higher request of such material is demanded. Also for china, we need to meet the new challenge.

References