Life recycle models of abandoned textiles

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Life recycle models of some abandoned natural fibers and synthetic fibers including cotton, flax, silk and polypropylene were designed in this paper on the basis of the process of their producing, which was the production →consumption →collection and classification →recycling →returning to market of the abandoned textiles. These abandoned textiles were divided into "unused" and "consumed" abandoned textiles. The life recycle models were designed in this paper, which offer the academic guidance to reasonable and effective recycling of abandoned textiles. The models are good to improve the economic benefits of the whole textile industry and effective approaches to reduce environment pollution. Furthermore, the models meet the demand of new trade protectionism and remit the resource restraint.
Key words: *abandoned textiles, life recycle models, recycle, design*

1. Instruction

As the improvement of our daily life and the shorter life span of textiles, a large quantity of useless abandoned textiles exist in lots of textile and garment factories as well as in our daily life which result in abandoned textiles and environment pollution. Also it may easily cause fire which is a huge hidden trouble. How to recycle these abandoned textiles is a emergency problem. If these abandoned textiles were recycled scientifically, it would create huge economic and social benefits and our precious resources would be saved. Life recycle models of some abandoned natural fibers and synthetic fibers including cotton, flax, silk and PP were designed in this paper on the basis of the process of their producing, which was the production →consumption →collection and classification →recycling →returning to market.

A characteristic Germany unbenefit social medium system called DSD was used in the collection of the abandoned textiles. It mainly run in two ways: one was collection on the street, the other was cross-recycle system [1].Since 1990s, the level of machinery equipment coordinating with abandoned textiles recycling has been increasingly improved and the categories are getting abundant. The main recycling objects are technological textiles and abandoned carpets [2]. The first automatic separation machine was invented by an Europe company to classify the abandoned carpets to be recycled [3]. And the new technology made abandoned textiles recycling in more ways and made the life recycle models more branches [4-6]. As to silk, Xinyuan Cocoon and Silk Group Co.Ltd established a life recycle model that mainly involved the development of the abandoned sideline products when producing [7]. Abandoned silk could be recycled to make silk paper. And there were great improvements in stretching and bending properties after silk was composited with PBS polybutylene succinate, (thermoplastic aliphatic polyesters) [8].

Abandoned flax was recycled to make paper and composite materials which were made from abandoned flax and polyolefin polymer [9-11]. The production, recycling and disposing of PP [12-13] all were the basises of establishing models.

Suzhou was taken to be the example to discuss the way to recycle abandoned textiles [14] as well as the model established by Cangnan county to make the abandoned cotton be the regeneration fiber and enter the market again [15]. Generally, there were two ways to recycle jean on the basis of color [16], then the distinguished jean could participate in production again with cotton. The use of regeneration fiber in uniform was also discussed based upon the research in schools and companies in Fushan county [17].

Life recycle models of abandoned textiles were designed based on the existing literature to explore the production of abandoned textiles and the relevant recycle methods.

2. Life recycle model of abandoned cotton

The main sources of abandoned cotton fibers are listed as followings: spinning; processing of garments and textiles; abandoned garments and textiles. There are several recycle methods according to the source, for instant, a specialized enterprise could be set up which can cooperate with abandoned textiles producing factories such as spinning mills, weaving mills, garment factories thus forming a fixed collecting method. In order to recycle consumed abandoned textiles, a network should be founded due to their dispersing, low quantity, complication and other uncertainty factors. These abandoned textiles should be classified by color, fiber status, fabric texture and so on, then these classified abandoned textiles will be provided to recycle institution as demanded.

There are several relevant collection lines in each recycle institution making different abandoned cotton disposed in the right way.

- Some abandoned cottons are made into spinnable reprocessing fibers, then these fibers could be made into new apparel fabrics by spinning and weaving. There are two steps in this technological process. First, abandoned cotton are made into reprocessing fibers after being incised, tore and openinged. Second, the reprocessing fibers are made into yarns by rotor-spinnable, ring spinnable, friction spinnable or parallel spinnable and the like. Some yarns being treated on the earlier stage can be woven into new apparel fabrics directly, such as jean.
- Other abandoned cottons are made into unspinnable reprocessing fibers which can be made into non-woven fabrics by widely applied non-woven technology. Besides, being filler or being one of the sources of activated carbon which involves in other industry is also a novel method. The life recycle model based on the source, recycle method and usage of abandoned cotton fibers mentioned above is shown shematically in the Fig.1.

3. Life recycle model of abandoned flax

The number of abandoned flax is increasing as flax industry develops. At the moment, most of abandoned flax are buried or burnt or disposed by other traditional methods which not only are hidden troubles but also result in environment pollution. A more economic and environmentally friendly way is discussed in this paper and an intact industry chain is expected to be formed in flax industry.

Flax is sent to spinning mill after being reaped and degummed. Thus, raw material factory treating and flax spinning mill are the production of abandoned flax. In terms of raw material treating factory and flax spinning mill, abandoned flax are anxious to be disposed even if they will cost them some money. Centralized sources and low price, and perhaps generating profits, are extremely attractive to collection institute and recycle institute. However, recycle institute can cooperate with factories directly making collection institute less important because of centralized sources.

Abandoned flax are first used to make paper because the market demand is huge and the technology is relevant mature. However, with high degree of market saturation and low economic profits and heavy pollution now, the papermaking industry has already shrinked for a certain extent, thus finding a new way to dispose these abandoned flax is extremely urgent. Being made into composite materials with polyolefin polymer

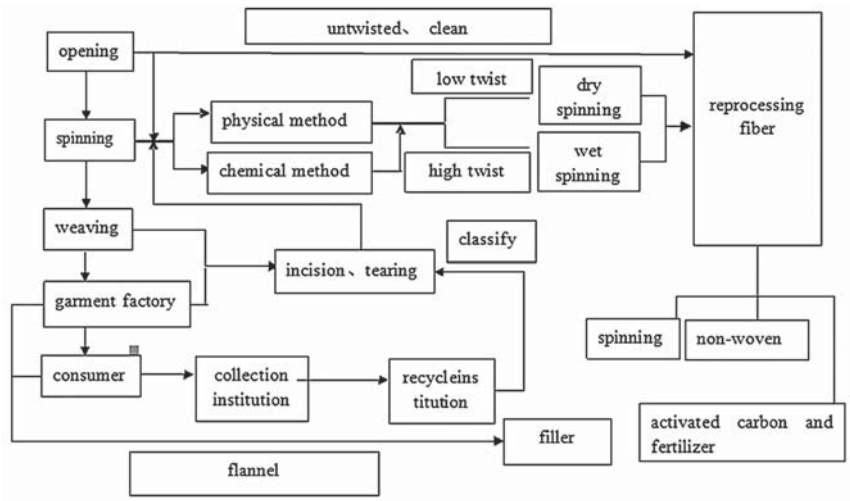

Fig.1 Life recycle model of abandoned cotton fibers

materials seems to be an appropriate way to solve this problem, and the technology is diverse, simply and popular. The products have been sold as Plastic-wood composite materials all over the world for the last two decades and their market prospects are pretty well. Recently, the timber has been in great demand and the price has been risen a lot because of each country's protection policy for forest resource, for example, Russia where we import timber has decreased their export of timber to protect their forest resource. So composite materials made of abandoned flax fibers and polyolefin polymer materials not only can fill in the vacancy of the Plastic-wood product market, but also can bring prodigious economic profits and social profits. Life recycle model of abandoned flax is shown in diagram at Fig.2.

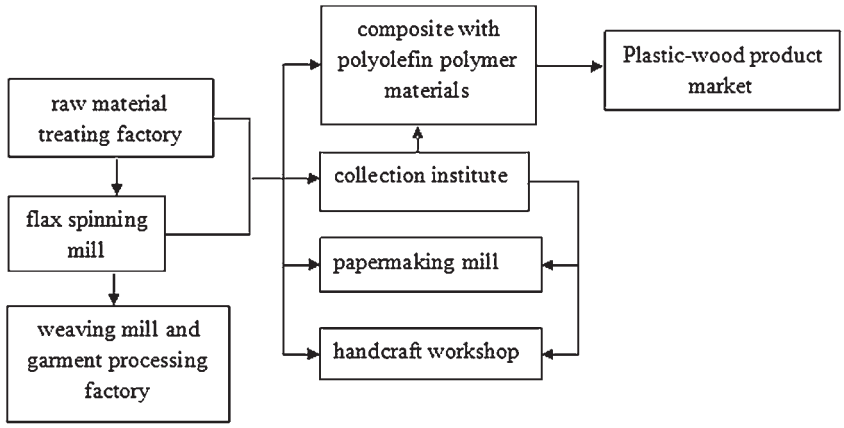

Fig.2 Life recycle model of abandoned flax fibers

4. Life recycle model of abandoned silk

Cocoon fiber usually called silk is a kind of continuous filament formed by liquidsilk solidification which is secreted when matured silkworm cocooning. Silk like wool is one of the earliest used animal fibers. Due to it being widely used and its high price, recycling abandoned silk is of great importance.

There are several sources that can produce abandoned silk:

- Abandoned silk can be produced by silk reeling process. Frison, broken filament and waste silk can be made into spinnable silk. High quality silk quilt can be made by double cocoon and silkworm pupa can be further treated. Shorter silk can be used in papermaking industry;
- Abandoned silk can be produced by silk cloth process. The leftover materials can be made into silk rug. The sericin can be applied to producing cosmetic. Life recycle model based on the source, recycle method and usage of abandoned silk is shown in diagram at Fig.3.

5. Life recycle model of abandoned polypropylene

Synthetic fiber is a kind of polymer whose monomer is made from petroleum, coal, natural gas and some agriculture and sideline products. As one of three materials, the number of synthetic fiber is extremely increasing, and owing to its undegradation, abandoned synthetic fiber has caused a lot of environmental problems which has been the focus for years. Polypropylene (PP) as one kind of synthetic fiber has been widely used and the main products of PP are shown in Tab.1.

According to the products and application areas of PP, the main sources of PP are industrial abandoned textiles (constructive fabric and carpet and so on) and living abandoned textiles (flexible freight bags and the like). Industrial abandoned textiles are centralized and can be disposed together by using units such as construction site, therefore, abandoned PP is easy to collect. But for living abandoned textiles, there are several uncertain factors, and it needed to be classified to be convenient for collecting.

Tab.1 Products and applications areas of PP

Products	Application area
Carpet	Interior decoration
Constructional fabric	Construction site
Non-woven(diaper)	Hospital-welfare house
Flexible freight bags	All factories
Thin film	All packing

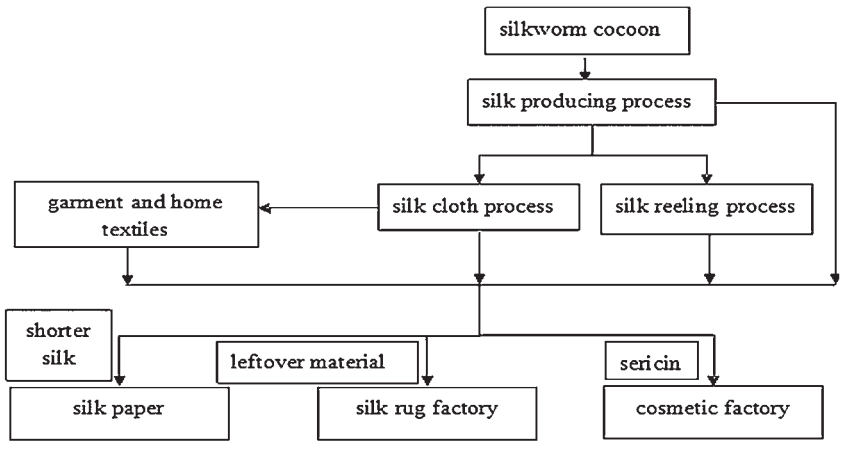

Fig.3 Life cycle mode of abandoned silk

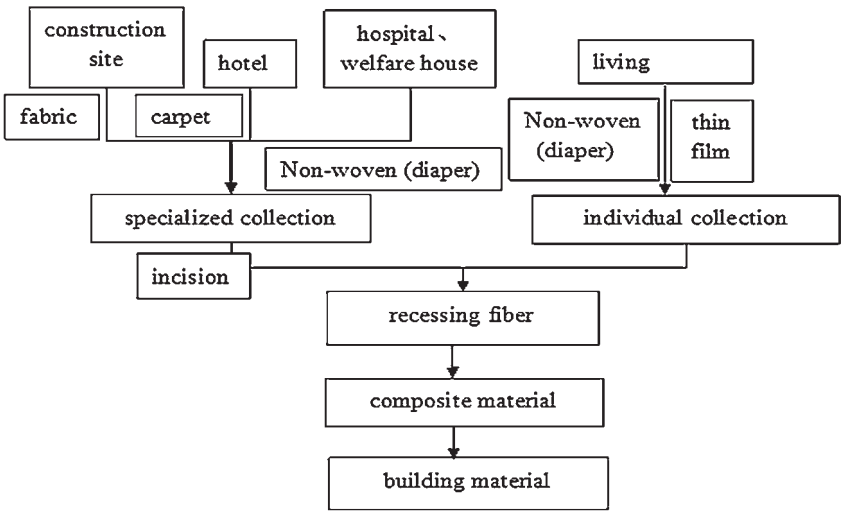

Fig.4 Life recycle model of abandoned PP

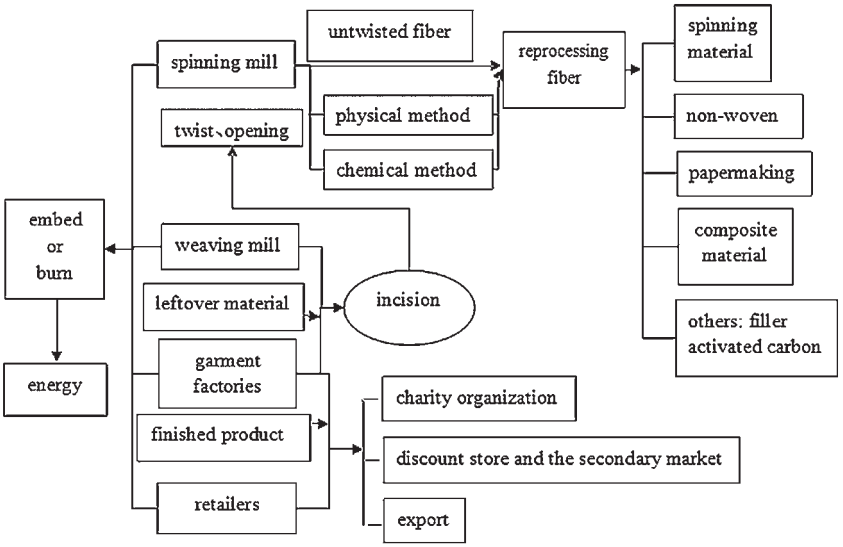

Fig.5 Life recycle model of unused abandoned textiles

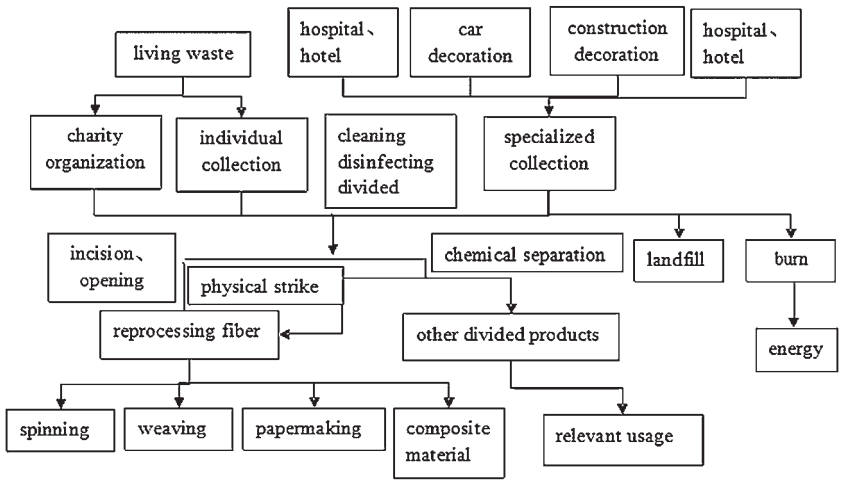

Fig.6 Life recycle model of consumed abandoned textiles

For the moment, burning is the main method to recycle PP because of its high combustion value. But with the technology improving and abandoned PP modified technology innovation, there is a great application prospect in building materials. At the same time, building material market does be helpful to collect abandoned PP. Life recycle model is shown in Fig.4.

From the above, life recycle model of abandoned textiles designed in this paper gives expression to the source, collection, recycle and usage of abandoned textiles:

Source - According to different sources, abandoned textiles can be divided into unused abandoned textiles (leftover materials etc.) and consumed abandoned textiles (used by consumer). Unused abandoned textiles can be subdivided into semi-manufactures abandoned textiles (produced when processing) and finished product abandoned textiles (unsalable textile).

Different producing area may cause some differences in collection. Unused abandoned textiles could be collected by factories and be disposed together. However, abandoned textiles produced by consuming are hard to collect and need to establish a collection network.

Reasonable ways to recycle abandoned textiles - Abandoned textiles produced during the fiber processing could be recycled directly for further treating, however, the number of such clean and low twist fiber is very few and most of the abandoned textiles need to be openinged again. Other abandoned textiles produced in the process of garments and textiles such as threads and fabric edge and the like are needed incised and tore to make them return to fiber status.

On the whole, unused abandoned textiles could not only be sent to charity organization, but also be made into garments, housing decorations and car decorations etc. Consumed abandoned textiles in daily life could

be disposed through either physical method or chemical method to be reprocessing fibers which could be back to market not only with new properties but in a new status by spinning-non-woven-papermaking and compositing etc. Also, some old garments and textiles could enter the secondary market. Kinds of life recycle models of abandoned textiles are discussed in this paper and two types of life recycle models can be concluded: unused abandoned textiles (shown in Fig.5) and consumed abandoned textiles (shown in Fig.6).

6. Conclusion

Life recycle models of some abandoned natural fibers and synthetic fibers including cotton-flax-silk and PP were designed in this paper on the basis of the process of their producing, which was the production → consumption →collection and classification →recycling →returning to market of the abandoned textiles. These abandoned textiles were divided into "unused" and "consumed" abandoned textiles. The life recycle models were designed in this paper, which offer the academic guidance to reasonable and effective recycling of abandoned textiles. The models are good to improve the economic benefits of the whole textile industry and effective approaches to reduce environment pollution. Furthermore, the models meet the demand of new trade protectionism and remit the resource restraint.

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