Research Article
Volume 12:9, 2022

Journal of Textile Science & Engineering

ISSN: 2165-8064 Open Access

Sustainable Fashion through Recycling and Upcycling

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Abstract

Textile enterprise has protracted records of being thrifty with its resources; a massive share of useless waste remains produced every year. Commercially, fabric waste era is encouraged with the aid of using the manufacturing of fabric goods. The textile Industry makes use of first rate portions of non-renewable resources, comprising petroleum, extracted to manufacture garments which are used simplest for a moderate time frame and undergoes landfill or incineration. Wet processing approach that contain dyeing, finishing, printing, etc. initiate toxic emissions. Spinning of yarns and weaving/knitting of fabric most usually rely upon fossil power use, inflicting emissions consisting of CO and greenhouse emissions. Water use, toxic chemical compounds and waste are the principle environmental problems confronted with the aid of using the fabric enterprise. In this paper, it's far cautioned the opportunity approaches for land fill and incineration primarily based totally on upcycling and recycling of the fabric products.

Keywords: Land fill • Incineration • Recycle • Upcycle • Cotton • Polyester

Introduction

Textiles and clothing are an integral part of day to day life and an important part of the global economy. The industry is presently worth roughly US $3 trillion and comprises the fabrication and sale of natural and synthetic fibres employed in many correlated industries. The global textile market is loaded with various types of textile fibres [1].

Currently, the utilization of synthetic polymers has rapid growth due to its favorable properties. Presently, textile industry requires magnificent transformation to reduce green house gases discharges, most likely including more upcycling and recycling which could alter the Fashion environment. Globally, 85% of discarded textiles are doomed for the landfill or incineration (Figure 1) [2].

Meterials and Methods

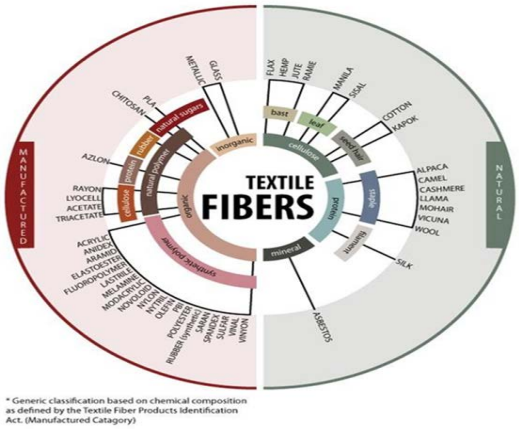

Figure 1. Types of Textile Fibres.

In fact, about 15% of textile waste is recycled or upcycled. Textile recycling frequently refers to the reprocessing of Pre or post

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Received: 28 July, 2022, Manuscript No. JTESE-22-70628; **Editor assigned:** 01 August, 2022, PreQC No. JTESE-22-70628 (PQ); **Reviewed:** 16 August, 2022, QC No. JTESE-22-70628; **Revised:** 27 September, 2022, Manuscript No. JTESE-22-70628 (R); **Published:** 05 October, 2022, DOI: 10.37421/2165-8064.2022.12.502

consumer discarded textile materials to be used as new textile or non-textile products [3].

Types of textile waste

Pre-consumer waste: Pre-consumer waste consists of textiles and by-products from the cotton industry that are recycled and employed in automobiles, aerospace, housing, furniture, mattresses, furniture, paper, clothing and other industries. These are the fragment generated as a outcome from yarn and fabric manufacture, together with the post-industrial scrap textiles from other industries (Figure 2) [4].

Figure 2. Pre-consumer waste.

Post-consumer waste: Post-consumer waste is termed as any kind of clothing or household textiles made from manufactured textiles that the owner no longer needs and wants to dispose of these items are discarded due to wear, damage, growth, or unfashionable (Figure 3). (Shirt, Pant, Jeans, Sari, Salwar, Kameez, Furnishing items etc.)

Figure 3. Post-consumer waste.

Waste management in textile industry incineration

It is a technique of burning the solid waste. Textile waste such as small, shredded, loose fibres are incinerated. However, Incinerator chimneys expel organic substances such as dioxins, heavy metals, acidic gases and dust particles that are conceivably harmful equally to humans and the environment. Moreover, there is trouble in disposal of residual ash that contains a concentrated smoke from industrial waste toxic substance (Figures 4 and 5) [5].

Figure 4. Waste management in textile industry incineration.

Land fills

It is considered to be the final substitute in an integrated waste management system. Textile trash in landfill imparts the formation of leachate as it decomposes, which has the possibility to contaminate both surface and groundwater sources. Additional outcome of decomposition in landfill is methane gas; those are major greenhouse gas and a substantial contributor to global warming. The decomposition of organic fibres and yarn such as wool produces enormous quantity of ammonia together with methane. Ammonia is extremely toxic equally for terrestrial and aquatic environments. It results in increased nitrogen content in drinking water that has effect on humans [6].

Figure 5. Land fills.

Recycling and Up cycling of Textile Products

Recycling: The process of procuring fibre, yarn, or fabric and manipulating them into useable components is known as textile recycling. Textile waste is collected from various sources and sorted and treated according to its condition, composition, and resale value [7].

Up cycling: Up cycling is a technique in which waste or worthless materials are converted into new materials of equivalent or improved quality or a increased environmental shield.

Textile recycling process

The recycling of resources can be broadly divided into thermal, material and chemical sectors.

- Thermal recycling recovers heat energy originated from the incineration of fiber wastes as thermal or electrical energy.
- Material recycling recovers polymers from fibers or plastics, and at present, the idea of transforming Polyethylene Terephthalate (PET) into fibers is most economical and widely used for practical applications.
- Chemical recycling recovers monomers from waste fibers by polymer decomposition. Impurities can be easily removed from recovered monomers, so their quality will be made exactly equal to virgin monomers (Figure 6).

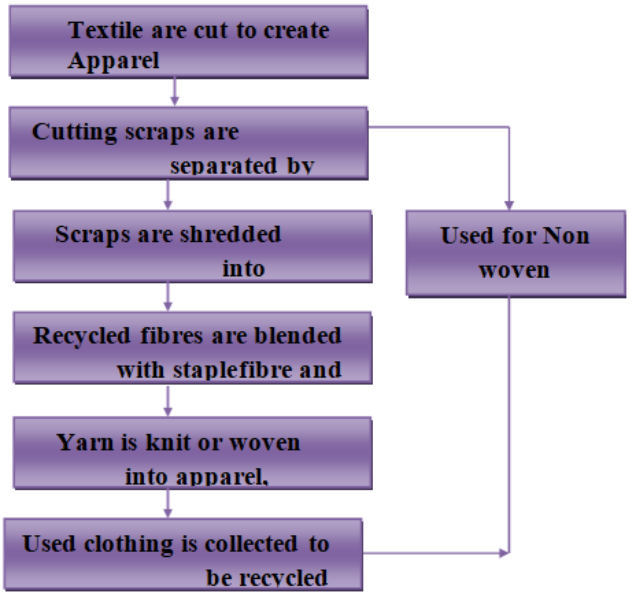

Figure 6. Recycling technology.

Recycling of non-woven

Non woven recycling process for reclaimed fibres: Non-woven discarded, are cut into pieces. They are employed as the stuffing material for upholstery. The following figure describes the basic cutting machine principle (Figure 7) [8].

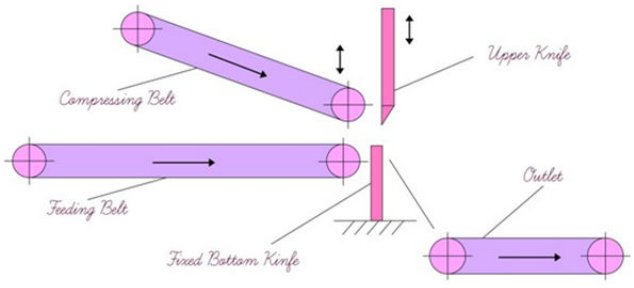

Figure 7. Basic cutting machine principle.

Re-granulation from non-woven textiles

The non woven waste from thermoplastic fibres such as polyethylene, polypropylene, polyamide, polyester etc. are processed to generate granules that are used to produce fibres.

They can be used as heavy-insulation layers or as a powdery binder agent to substitute Phenolic resin when producing thermally bonded nonwovens and mats (Figure 8).

Composite recycling

Fiber reinforced composite materials have tremendous potential in the construction, transportation and wind energy. Mostly it will be glass fibre reinforced polyester and carbon fibre reinforced epoxy, and referred to as GFRP/CFRP (Glass/ Carbon Fibre Reinforced Polymers). There are also thermoset composites using aramid, natural and other fibres, but volumes are currently small in comparison with glass and carbon.

Figure 8. Composite recycling machine and Composite recycling.

Recycling methods for composites pyrolysis

Most of the CFRP recycling projects employ pyrolysis process, where the materials other than carbon are burned off. The Carbon fibres retain 90% of their original mechanical properties. Recycled Carbon Fibre (RCF) is commercialized by this process (Figure 9).

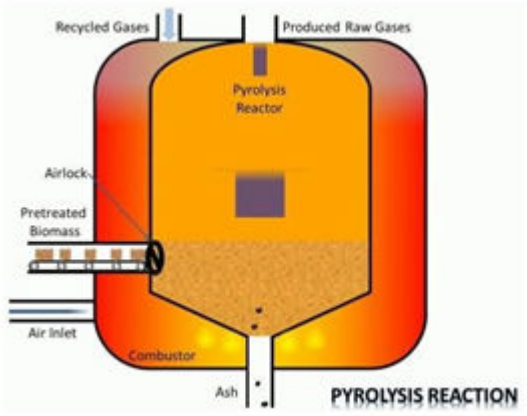

Figure 9. Recycling methods for composites pyrolysis.

Fluidised bed

Nottingham university developed this process which involves feeding of scrap composite pellets, diminished to about 25 mm, into sand bed. The sand is fluidized with a stream of hot air at 450°C-5500°C. The polymer breaks down and vaporizes, releasing the fibres and filler. The fluidized bed process has a specific advantage that it is very tolerant of mixed and contaminated articles (Figure 10).

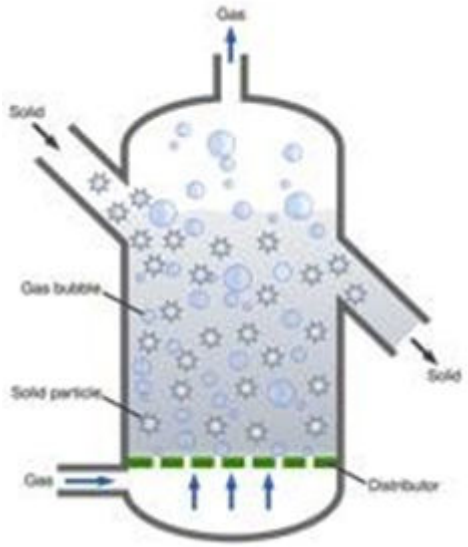

Figure 10. Fluidised bed.

Results and Discussion

Recycling of garments

Conversion to new products: Conversion to new products is done by breakdown of fabric to fibre (Figure 11).

Figure 11. Breakdown of fabric to fiber.

Breakdown of fabric to fiber: Shoddy (from knits) and Mungo (cloth garment recycling made from recycled woven garments) are terms for the breakdown of fabric to fiber through cutting, shredding, carding, and other processes (Figure 12).

Figure 12. Low-end blankets

The value added products are re-engineered from the fiber. The value added goods comprise stuffing, automotive constituents, and carpet pad, building materials such as insulation and roofing felt, and low-end blankets (Figure 13).

Wiping and polishing cloths

Figure 13. Wiping and polishing cloths.

Clothing that has seen the end of its useful life as such may be turned into wiping cloths or in industries as polishing cloths. T-shirts are a primary source for this category because the cotton fiber makes an absorbent rag and polishing cloth.

Textile recycling offers the following environmental benefits

- Decreases landfill space requirements, as synthetic fiber do not decompose and the natural fibers release greenhouse gasses.
- Reduced consumption of virgin fibers.
- Energy and water consumption is decreased.
- Avoids Pollution.
- Lessened demand for dyes.

Upcycling

Upcycling is the process of creating something new and better from old items. The aim of upcycling is to prevent the squander of eventually useful materials by using the existing ones. In developed countries, upcycling is given pronounced importance, which reflects an interest for eco-friendly products (Figure 14).

Figure 14. Facts about upcycling.

Several luxury fashion brands are focusing on reusing and bringing sustainability into the garment industry, damaged buttons, broken beads, waste rags and so on are woven into a wearable design (Figures 15 and 16).

Figure 15. Old kameez upcycled to a frock.

Figure 16. Discarded shirt used as cushion cover, T-shirt used as bag and various applications of sweater.

Upcycling by colour extraction and re-dyeing

By upcycling textile waste and extracting the colour, the textiles have increased in circular life cycle. Cotton and polyester fibres are the most consumed fibres in the world.

Coloring is a method of enhancing a textile material to develop an additional attraction. There are several ways to dye a material in the state of fibre, yarn and fabric. Water soluble matter are called dyes another insoluble matter is called pigment. Auxiliary chemicals are used while dyeing the fabric. Wet processing for dyeing involves the following methods (Figure 17).

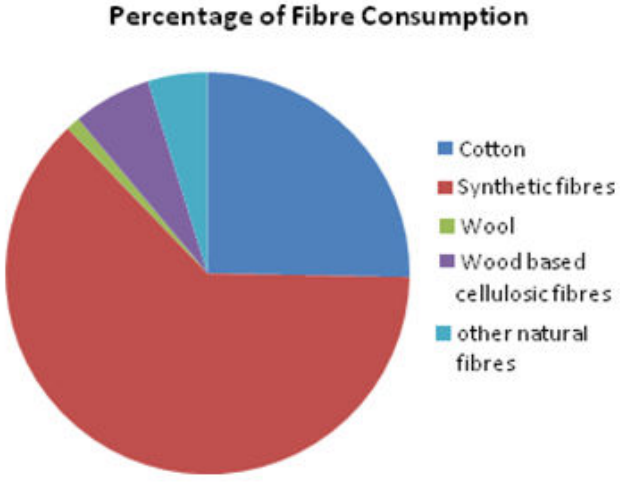

Figure 17. Percentage of fibre consumption.

Various steps in wet processing

To upcycle a textile, it must be as similar to the original fibre as possible. Therefore it is important to remove dye, pigment and finishing products before upcycling (Figure 18).

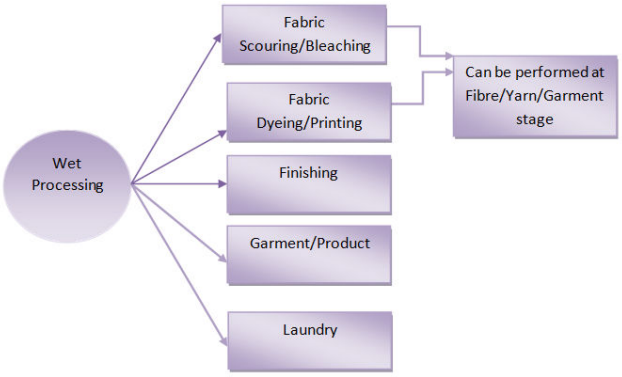

Figure 18. Various steps in wet processing.

Dyeing of cotton: When colouring the cellulose fiber a reactive or direct dye bath is used. The colours are water soluble, therefore a help chemical is used. Salt will make the reactive or direct colour create a covalent bond to the cotton fiber.

Removing of colour from cotton: Removing of dye and finish from cotton includes 3 steps. The first step is made in an alkaline condition and the second with an acidic condition. These two processes are made to remove the reactive dye. Final process is wrinkle free finish that is offered to prevent wrinkles (Figure 19).

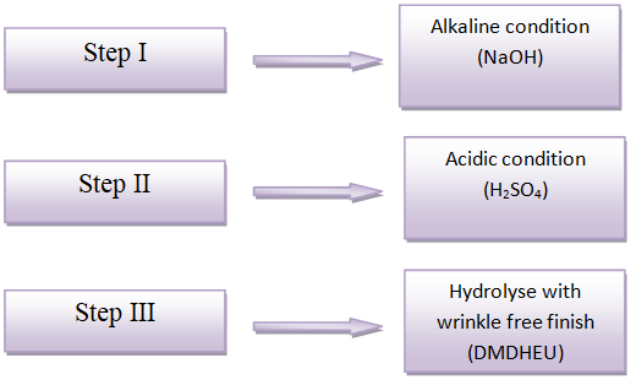

Figure 19. Steps in removal of colour from cotton.

Cotton can be chemically recycled or upcycled, though the quality of fiber is significantly worse after this process. The cotton fiber will be considerably shorter and is therefore mixed together with virgin cotton to receive a better quality.

Dyeing of polyester: Polyester is the most widely used synthetic fibre. Polyester is dyed with disperse dyes which is water insoluble and the fibre does not swell in water which means high temperature is needed for colouring. The amorphous areas of the fibre molecules become larger in high temperature to allow the colour to enter the fibre. Because the dyes are fastened inside the fibre, that colour cannot be washed out.

Removal of colour from polyester: Polyester fabric is reacted with solvent bath containing 1,3 di methyl 1,2 imidozolidione abbreviated DMI. After 10 minutes, the textile and solvent bath was

filtered and rinsed. The filtered textile was poured into pure DMI and rinsed then polyester fabric was again filtered and washed in cold ethanol. The fabric pieces were filtered again and excess ethanol was squeezed out of the fabric. The result showed the possibility of decolourisation from a textile.

But experts explain the colour is strongly attached to the polyester fibre and hard to remove. Another way to remove the colour is to dissolve the fibre completely by using chemicals and it becomes liquid like solution. Centrifuged can be added and one can separate the dye stuff and liquid fibre. In the next step of the process, the solution can be spun into new fibres (Figures 20- 22).

Upcycled products

Figure 20. Faded T-Shirt, processed and bleached T-Shirt and upcycled tie and dye T-Shirt.

Figure 21. Processed cotton fabric and Fabric upcycled with Batik.

Figure 22. Faded old jean and redyed upcycled shorts.

For companies: Take back programmes, which allow customers to return used clothing in exchange for gift cards or other benefits and rewards, can be launched by brands and businesses. Clothing that hasn't been worn in a while can be refreshed and resold, while lightly used or damaged clothing can be upcycled to make new clothing. Companies can, of course, upcycle unsold stock rather than sending it to an incinerator or landfill (Figure 22).

For consumers: According to Forbes, 93 percent of consumers anticipate the companies that manufacture their favourite products to support applicable social and environmental considerations.

- Buying upcycled apparel allows environmentally conscious consumers to shop with confidence, knowing that their purchases won't contribute to environmental considerations.
- The upcycling fashion assiduity can produce trendier and further unique apparel, adding variety and furnishing consumers with fresh, new styles to love and enjoy.

For the environment: The benefits to the environment comprise the following:

- The recycling and upcycling of existent textile materials preserve natural resources. By upcycling clothing, 2,700 liters of water that is essential to fabricate just one T-shirt is saved.
- As diverse manufacturing processes are diminished, greenhouse gas emissions and chemical production are prevented.
- Upcycling keeps needless waste from landfills. This inhibits soil degradation, confines the consequences of dangerous chemicals, and reduces air pollution from waste burning.

Recent news of upcycling in india

According to the Hindustan times, Indian designers are towards upcycled clothing and have started using rejected textile materials for creating new designs and support in making the sustainable fashion uplifted.

Conclusion

Recycling and upcycling is the next frontier in environmentally responsible clothing. The concept of taking waste and reimagining, reusing and reinventing is a new fangled idea.

Numerous research projects have been performed to establish recycling processes and seek pathways of effectively using recycling material in new existing applications. Textile industry is predicted to emit about 2.1 billion metric tons of GHG by 2030.

Our Prime minister Mr. Narendra Modi says that by 2030, India will reduce emissions intensity of GHG by 45%, which is a higher goal when compared to previous year's 33% to 35%. It is clear that each and every body in India must focus on the control of GHG emissions. Initially, we may start with the upcycling of textiles and garments which is easier to be practiced at home level. Let us all join our hands together to control GHG emissions and hope for Green India (GI).

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How to cite this article: Anitha B. "Sustainable Fashion through Recycling and Upcycling ." *J Textile Sci Eng* 12 (2022): 502.