Research and Innovations for Recycling Textile Wastes

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ABSTRACT

Sustainable production is essential. The exploitation of textile waste in research is top notch given the present industry trends. The fashion business is becoming more focused on creating products that have little negative impact on society. Several new rules relating to environmentally friendly production methods have been well received by export and import. This article focuses on the important steps taken by the fashion industry to improve the world for both the present and the next generations. The threat of disposing of textile waste is explored with the practical recycling possibilities.

Keywords: textile waste management, upcycling, downcycling, technical textiles, waste management, textile waste recycling

1. INTRODUCTION

The science of appearance is fashion. A life cycle evaluation label has just been added to apparel, transforming materials



into more than just a trend. Manufacturers consider their societal responsibilities, and consumers view clothes as a second skin. Remarkably, a survey found that only 15% of the textiles that one person uses in his lifetime—which can total up to 32 kilograms—are recycled. Consumers' increased purchasing power has increased the amount of "excessive apparel" that people throughout the world are tossing in landfills. According to studies, about 30% of municipal solid trash in wealthy nations is made up of textile waste. [1,2]

Fig. 1: Dumping of Textile wastes as landfills

This deposit in landfill can cause serious threat to the humans and surrounding environment. The textiles when disposed on the land, try to age and decompose. Growth in population, has tapped most of our natural resources and it is impossible to supply to the entire globe, using naturally derived textile fibers. Thus, man-made Petro-chemical based synthetics evolved. These do not degrade easily. Decomposing of such materials release toxic greenhouse gases and are also polluting the water bodies directly and indirectly. Scientists are finding prospective in moon and other planets after tapping of majority of earths resources. Now, land space is reduced and valued than ever before. In this scenario, it is important for textile industry to shift to better waste management practices. It will impossible for waste impossible for dumping on landfills.

2. Degradability of textile fibers- a concern:

The campaign of shopping and discounts by various fashion brands, has eventually led to purchase of clothing more than what a person needs. This has both positive in terms of GDP and country's economy and negative growth with a view of pollution. This is because, every textile material has an end after which it will be discarded. When the fiber is

100% natural it might decompose in few years, but as said before it is impossible. Demand for clothing is estimated to be 99 million tons per annum which cannot be met completely by natural fibers. [3] The rising needs of people from a fabric is high, that blends and mixtures of textiles are unavoidable. The blends are mostly petrochemical derived synthetics, which is harmful once disposed in the ecosystem. To sum up: fibers are of two types: namely naturally derived and synthetic origin. Textile materials made from natural fibers are bio-degradable whereas synthetics pose a threat of not being compostable. [4]

3. Shift towards sustainability:

In the current scenario, every segment of textile industry starting from fiber cultivation/production to shipping along with the life cycle assessment is drawn with sustainability as focal point. Globalisation has caused exchange of textiles, and export norms are an important factor in todays business. In case of quality certification or ISO, the complete product life cycle is assessed and then certified. Here, the recycling strategies, are explored some of which are addressed in this paper.

Observing the source of textile pollution, it is understandable that fabric when categorised as not wearable, is either thrown away or discarded in the landfills. Some countries have agencies that collect the old textiles and supply them to orphanage and third world countries. Good will is one such charity house that works making one person's waste to another man's wealth, the protocol is given as in the figure below. [5-7]



Fig. 2: Work chart of the Charity organisation - Goodwill

4. Market potential for recycled clothing:

Many such organisations work globally. Apparel houses also show interest in buying clothing and recycling them into newer products. Increasing awareness among consumers has been once driving force for making greener products. The advertisement and marketing strategy has also shifted to eco-friendliness. [8] Recycled products are not seen down by the todays consumers. Recent study has identified positive mindset in purchasing recycled textile materials that are eco-friendly and safe for skin. The study also unveils this is seen more in men, rather than women. It could be because men look more into content and women incline towards fashion [9]. For example: Eco-spun (Welspun Inc.,) is the brand that sells recycled fabrics made from recycled plastic bottles. This is a significant work, since every year 9 million plastic-based wastes are disposed in the landfill and such a significant work in recycling those wastes can be an incredible option for recycled textiles category. It is also reported that two hundred PET bottles can cover up a normal sized sofa. [10] The possible market for recycled clothing can be vast and long standing.



Fig 3: Steps in making Eco-spun fabric

5. Sustainable apparels:

Eco-fi manufactures textiles made from 100% recycled PET fibers and are used in a variety of applications like home textiles, car interiors, furnishings, upholstery and craft items. The blends with wool are also very popular in the market. Lutradur ECO, is another sustainable brand that uses disposed drinking PET bottles and manufactures yarns. One square meter of fabric is made from one two litre PET bottle. Seaqual fiber is made by upcycling wastes from ocean. This special initiative in 2017, converts the plastics into textile fiber. From then may researches come up every day to create products for packaging, home textiles, apparels, upholstery, sports and even in protective clothing. Another example is Safeleigh. It was launched by leigh fibers recently that uses the cut scarp of protective clothing like fire men garment, bullet proof vest and mix with aramid (natural FR fiber) to create a clothing line that has flame retardancy as a natural character. [11]. Fibers made from organic sources are also suitable in stay in the chain or eco-friendly textile production. The rubbers used in shoe sole, automobile, industry and sports along with the worn-out tyres are all collected and subjected into recycled rubber called Green rubber [12]. The idea being the brain child of Datuk Vinod Sekhar is now extending its application areas. Rubber from the dandelions root are some of newly derived fibers that help in reducing the carbon foot print in textile.

Many such reclaimed and recycled fibers are used globally. K-sorb (Eco-sorb international) manufactures regenerated textiles which are used in industries, sludge stabilization and various environmental remediation programme. Barnhardt a very old recycling company that supplies regenerated, reclaim and recycled cotton as homogenous blends with absorbency rate less than virgin cotton. Stein fibers are made by importing textile wastes around the globe, melting and make needle punched non-wovens. This is one of the very popular brand that caters to various field of technical textiles like filtration, insulation, automobile, packaging and invisible textiles.





6. Eco-friendly initiatives by Fashion Brands:

Patagonia has developed methods to recycle old PET bottles. These recycled fibers are available in clothing lines of Armani Jeans, Eco-simple, Marks & Spencer. There are few more companies that are launching their labels using PET bottle recycling. Levi Strauss uses eight plastic bottles to make one air of Denim pant. Nike has taken initiatives to reduce the size of the show box, monitoring the effluent discharged, recycle the cloth hangers, collect the extra clothing from public, recycle and use the yarns for make new apparels and footwear. In collaboration with NASA they have

designed various steps for clean production. Nike has designed the Team India Kit for World Cup 2015 for the Indian Cricket team using 15 bottles for the jersey and 18 bottles for the pants. This sustainability award winner has collaborated with Ocean conservation group to recycle the waste fishing nets and plastics from ocean into fiber for clothing. Parley has collected the ocean waste and made a swimwear for their customers. H&M is one of the leading store, that uses recycled PET bottles and develop fashionable clothing. BIONIC is one such made from recycled ocean waste. Repreve is another brand that markets yarns from PET bottles and reports convey that 27 bottles are used in making one graduate gown. Four million plastic bottles are testified to be recycled by this company.

7. Textile Recycling:

Exploring degradable non-conventional fibers

In the recent times, awareness on the ill effects of non-degradable synthetics has opened huge opportunities for manufactures to think of degradable/ compostable textiles. Nappy pads, wipes, mulching sheets for agro-textiles, interiors for cars are now made in a way that it will be back to nature after its life cycle. This is the era of non-wovens and disposals. It will be lucrative if researches in the industry can focus on materials with 100% natural origin that can be completely degraded when thrown on to the landfills after their life cycle. Natural and regenerated fibers can be processed in this way. Biodegradable plastics from PLA are hitting the market. PLA (Poly lactic acid) derived from Corn. The natural anti-microbial property is further enhanced and applied in medical textiles. This fabric is compostable / degradable when thrown in the landfill. [13-15] Various researches are being done to use the post-industrial waste, that is lack of chemicals into a compost and applying to the plants as bio-manure. Fortification and enrichment is possible using effective microorganisms to make the medium more nourishable to the soil, plant and waterbodies. [16]

It is seen that natural fibers when cut into smaller particles and then disposed off tend to degrade easily. The technique is much appreciated especially in interior designing and automobile sector where use of natural fibers can also reduce the weight of the automobile and ensuring better mileage. The package textiles that are mainly focusing on research and business opportunities with eco-friendly textile materials are now into making bags that are compostable. Natural fibers with least size possible and made into non-wovens can be a very effective material to be used in making carry bags, that can be a replacement of wastes. [17-19] The harmful textile effluents are also given treatment with microbes and further made into a compose to ensure safe disposal. [20,21]

Reclaiming fiber from fabric

Reclaimed / recycled fibers can be used to make wiping cloth, yarns – untwisted and re-spun into new yarn variety, mattress and wadding. Regeneration is another technique in which the fiber is regenerated from a natural source by heat and chemicals. For examples, Tencel, Lyocell, Seacell are some of the popular brands that made textile fibers from wood. The trees are cut and the wood will be chopped to small particles, which when treated with chemicals and under high temperature and pressure will be passed through spinneret and made into a filament for textiles. These are used to make fabrics with sustainable properties. [22] The textile production technique that uses very short fibers and bonding them with heat, resin, chemical and ironing; creating a textile like material is called non-woven. The recycled fibers may be heterogenous and hence a systematic fiber length and fabric formation is not possible, and non-woven can be resourceful. In this technology, composites, which uses fiber and polymer matrix bonded under heat and pressure, to form a compressed medium that can be very much suitable for agro, build, geo, acoustics and filtration textiles.

Non-woven Technology

Composite technology is also advancing with the FRP (fiber reinforced polymers) that find their origin from recycled materials. Most of the thermoplastic fibers like polyester, polyamide will be melted and converted into granules for recycled fiber production. Natural fibers are also used in making composites. Pine apple fibers is used as reinforcement purpose. Coir, Basalt, kenaf, hemp, bamboo, flax, jute, sisal, arecanut and banana are some of the popular non-conventional fiber types hitting the market. These can also be used in non-woven production to melt and hold the base matrix of textile material. Such recycled materials have good potential to be used in insulation. [23-25] In the olden days, textiles were made and then tested for their suitability for an end use and if positive will be made into the required product for a purpose. Contrastingly, based on the properties required in the end product the fiber selection, yarn properties to functional finishing is decided and executed. Technitex or technical textiles is now framed as a huge banyan tree with all the application areas being connected in the main bark. Recycled textiles are used in filtration purposes [26] Recycled fibers are also used in automobile interiors, agro-textiles, reinforcement in geotextiles, acoustics, textiles for building construction purpose, upholstery, package textiles and food packing materials.



Fig. 5: Composite - non wovens made from recycled textiles

Handmade paper

Discussing on the possibilities of recycling old textiles, it is interesting to know, that the old textiles are used in making papers. This is a conventional way of making high quality paper. It is believed that the American currency and bond papers [27]. Eco-friendly paper making industry is upcoming that finds old fabrics are an excellent biding material. Bio-mass, agro waste and old cotton textiles serve in building the matrix in the handmade paper. [28] This is extremely beneficial as it reduces the stress on deforestation. Carbon emissions due to deforestation is as high as 25%. Such recycled fibers used in making paper are further made into tea bag, carry bag, envelope, book papers. In contrast to the word upcycling, the products that are made with less value than conventional is called downcycling. [29] It uses less energy than conventional paper production. There is no use of chlorine that is harmful as an effluent. The quality of paper is also much better up to 70% that the other category papers that sum up to 35%. [30] By application of recycling technology, we can minimise the use of dye since the fabrics recycled are already dyed. There is a huge bulk of textiles from post-consumer section which has been less explored but has a huge potential for recycling and application in different forms of technical textiles.



Fig. 6: Hand-made papers made from natural fibers

8. Conclusion

According to a recent US government research, NPE (Nonylphenol Ethoxylates), a dangerous chemical that can potentially be generated during washing and result in the creation of a toxin when mixed with water bodies, is identified in 50 out of 80 clothes. It is one of the many substances that are frequently present in textile materials and has been shown to be hazardous. Textile pollution and its negative impacts are constantly rising. [31-33] The management of textile waste is as important as developing new products and technology. Especially if the organisation is engaged in exporting, sustainability is essential in today's economic world. Today, discarded waste fabrics are viewed as a new resource with great economic potential.

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