

Waste Management Technologies in Textile Industry

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Abstract

This paper is a collective review on the different methods available to recycle textile wastes namely composting, paper making, techniques adopted by fashion brands to recycle old clothing. Special focus is given to technical textiles, composites and non-woven sectors that involve product development using upcycled wastes. This can be an eye opener to researchers and industrialist's world-wide to indulge in more research activities and serve in reducing the landfill pollution

Keywords: Textile waste management; Upcycling; Downcycling; Technical textiles; Waste management; Textile waste recycling

Introduction

Every year a minimum of hundred new textile products evolve with sustainability as a focal point. In an era of increased purchasing power among consumers more textiles are dumped after their life cycle, this alarming pollution of landfill is reminded to be escalating every year. This deposit in landfill can cause serious effect to the humans and ecology. On disposing the materials try decompose and some become successful and others end as a harmful deposit without being degraded. 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 earth's 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 [1,2].

Escalated Textile Production

Every textile material has an end after which it will be discarded. When the fibre is 100% natural it might decompose in few years, but multiplied population in the last decade has made the scientists to find new sources. The growing population demands more clothing which is estimated to be 99 million tonnes per annum which cannot be met completely by natural fibres [3]. The rising need 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: fibres are of two types: namely naturally derived and synthetic origin. Textile materials made from natural fibres are bio-degradable whereas synthetics pose a threat of not being compostable [4].

Shift Towards Sustainability

Every segment of textile industry from fibre cultivation/production to shipping and life cycle assessment is focused on sustainability. In case of quality certification or ISO, the complete product life cycle is assessed and then certified. Once the fabric is found not wearable, it is either thrown away or discarded in 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 [5-7].

Recycling Textiles Wastes into Clothing

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 not down by the 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]. International fashion brands have now moved into use of recycled fibres in their products.

Apparel lines

Eco-spun (Welspun Inc.) is the brand that sells recycled fabrics made from recycled plastic bottles. 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. Two hundred PET bottles can cover up a normal sized sofa [10]. Eco-fi manufactures textiles made from 100% recycled PET fibres 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 fibre is made by upcycling wastes from ocean. This special initiative in 2017, converts the plastics into textile fibre.

Safeleigh was launched by Leigh fibres recently that use the cut scarp of protective clothing like fire men garment, bullet proof vest and mix with aramid (natural FR fibre) to create a clothing line that has flame retardancy as a natural character [11]. Fibres 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 dandelions' roots is some of newly derived fibres that help in reducing the carbon foot print in textile.

K-sorb (Eco-sorb international) manufactures regenerated textiles which are used in industries, sludge stabilisation and various

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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 fibres are made by importing textile wastes around the globe, melting and make needle punched non-wovens. This is one of the very popular brands that caters to various field of technical textiles like filtration, insulation, automobile, packaging and invisible textiles.

Brands with sustainability

Patagonia has developed methods to recycle old PET bottles. These recycled fibres are available in clothing lines of Armani Jeans, Eco-simple, Marks and Spencer. There are few more companies that are launching their labels using PET bottle recycling. Levi Strauss uses eight plastic bottles to make one pair 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 fibre for clothing. Parley has collected the ocean waste and made a swimwear for their customers. H&M is one of the leading stores, 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.

Textile Waste Recycling Options

Composting

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 fibres 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 composts 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 water bodies [16].

It is seen that natural fibres 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 fibres 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 fibres 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 compost to ensure safe disposal [20,21].

Regeneration

Reclaimed/recycled fibres 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 fibre is regenerated from a natural source by heat and chemicals. For examples, Tencel, Lyocell, Seacell are some of the popular brands that made textile fibres 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].

Non-woven technology

The textile production technique that uses very short fibres and bonding them with heat, resin, chemical and ironing; creating a textile like material is called non-woven. The recycled fibres may be heterogenous and hence a systematic fibre length and fabric formation is not possible, and non-woven can be resourceful. In this technology, composites, which uses fibre 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.

Composite technology is also advancing with the FRP (fibre reinforced polymers) that find their origin from recycled materials. Most of the thermoplastic fibres like polyester, polyamide will be melted and converted into granules for recycled fibre production. Natural fibres are also used in making composites. Pine apple fibres are used as reinforcement purpose. Coir, Basalt, kenaf, hemp, bamboo, flax, jute, sisal, arecanut and banana are some of the popular non-conventional fibre 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].

Technical textiles

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 fibre 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 fibres are also used in automobile interiors, agro-textiles, reinforcement in geotextiles, acoustics, textiles for building construction purpose, upholstery, package textiles and food packing materials.

Paper making alternatives

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 an upcoming industry that finds old fabrics are an excellent binding 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 are as high as 25%. Such recycled fibres 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.

Conclusion

A recent report published by the US government unveils that fifty on eighty garments are found to have NPE (Nonylphenol Ethoxylates), which is a harmful chemical that can be possibly released during washing, resulting in creating a toxin when mixed with water bodies. It is one among the many compounds commonly found in textile materials and proved to be dangerous. Pollution and harmful effects of textiles are ever increasing [31-33]. It is critical to focus on waste management in textiles much equal to inventing new products and technologies. Sustainability is the key to run a business in the modern era, especially if the company is into exporting. Discarded waste fabrics are now seen as a new resource and a wealth potential.

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