A New Method for Recycling Textiles and Polyesters to produce high quality reusable cotton, chemicals, silver and other products

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Historically, research has been ongoing in many countries to develop technology to recovery from the millions of tons of discarded textiles reusable cotton and chemicals. It is estimated that 85% of the millions of tons of textiles discarded in countries annually are composed of cotton and polyesters[1]. The June 27, 2016 C&EN article entitled "Can everything old be made new again?" described ongoing efforts by companies to develop methods to reuse discarded textiles. Cotton production is very costly as it requires vast amounts of fertilizers, insecticides and water. Methods now employed to recover cotton from textiles involve the use of selected solvents which requires its recovery from solution free of other soluble materials. Some of the solvents used to recover cotton are highly toxic and most are very costly.

In 2015 after more than three years of research a new chemical method (2016 patent pending) was developed that removes dyes, separates cotton from other fabrics and depolymerize polyesters within 10-30 minutes at low temperatures of 90-120° C. The low temperature processing conditions are required to prevent loss of cotton physical strength properties. The low cost reusable reagent employed in this method contains a very high concentration of water, base and catalyst. Current methods employed to depolymerize polyesters require high temperatures of 180-200° C, special catalysts and lengthy processing times. These processing conditions will destroy the reuse physical strength properties of cotton.

Applications of the new method

A major problem in the textile industry is the widespread use of bleaching agents, solvents and other chemicals to remove dyes which are often disposal of into the environment. This new method as presented in Figures 1, 2 and 3 removes dyes from large pieces of fabrics in minutes. Chemically released dyes are retained in the reagent and can be recovered for reuse or chemically decomposed of in the reagent. This method can be engineered to operate as batch or a continuous feed system to process tonnage of shredded fabrics to recover cotton along with the complete depolymerization of polyesters to produce monomers and oligomers. Also, X-ray films and polyesters coated with silver or other metals generally require high temperatures and special chemical reagents to remove metals for recovery[2]. Figure 4 presents pictures of an X-ray film before and after treatment for total removal of silver in 20 minutes at temperatures of 100-110° C.

Figures 1 Pictures of cotton and cotton-polyesters that were chemically treated to remove dyes, PET from blended fabrics and depolymerization within 20 minutes at 110° C.

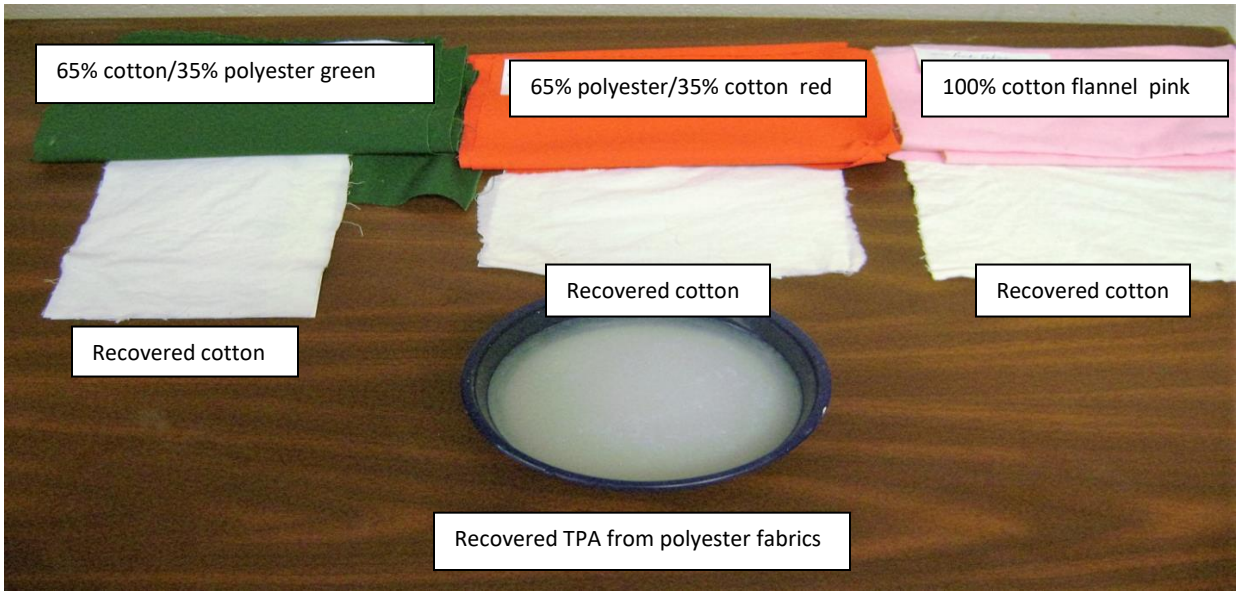
Picture 1 - Top row is 100% cotton and bottom row is cotton-polyester

Picture 2 – Fabrics are placed into the reactor containing preheated reagent

Picture 3 Fabrics are removed from reactor dried after squeezing out reagent and rinsed with water.

Picture 4 - Fabrics after drying

Figure 2 Removal of dyes from a 100% cotton fabric and two samples of fabrics with different concentrations of cotton and polyester



The dyes in these fabrics were completely removed along with PET within 20 minutes in the reagent at temperatures of 100-110° C. Samples were retested to confirm that PET was completely removed. The Terephthalic acid resulting from the depolymerization of PET is shown below in the dish.

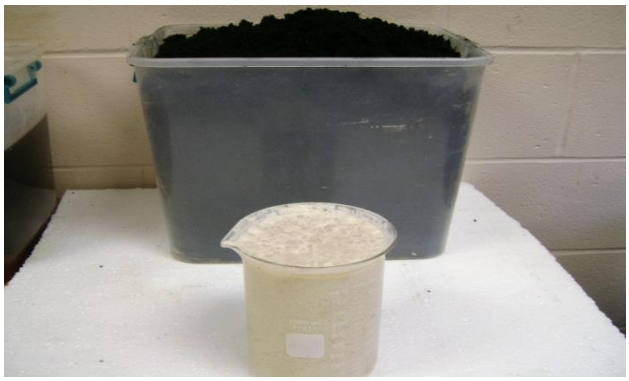
Figure 3 – Chemical Processing of a Polyester Fabric

The polyester fabric was shredded to 3/8 inches as shown in the first container and placed in the reactor where the reagent had been preheated to 120° C. The shredded fabric was processed at this temperature for 30 minutes. The fabric was completely depolymerized and contents placed in the second container which reveals the deposit of some of the sodium Terephthalate and reagent discoloration from released fabric dyes. The solid sodium Terephthalate is shown in the third container. The solid sodium Terephthalate was treated with stoichiometric amounts of acid for 30 minutes to produce TPA as shown in the picture.

Polyester blend material before processing

Chemically treated PET taken from reactor

Disodium Terephthalate recovered from the reagent



Terephthalic (TPA) acid produced after treatment with stoichiometric amounts of acid.

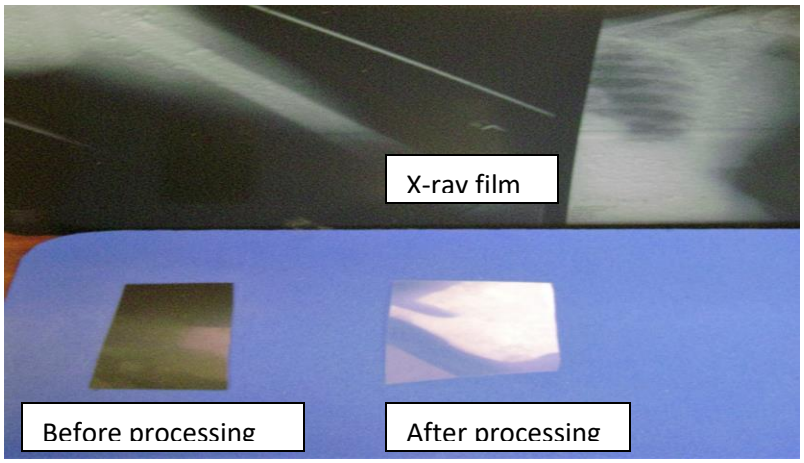
Conceptual Continuous Textile Recycling System

The process chemistry can be employed in engineered closed–looped systems to effectively recycle waste textiles, phthalates plasticizers and other composites. The implementation of continuous processing systems will greatly advance the recycling of the millions of tons of waste disposed of annually.

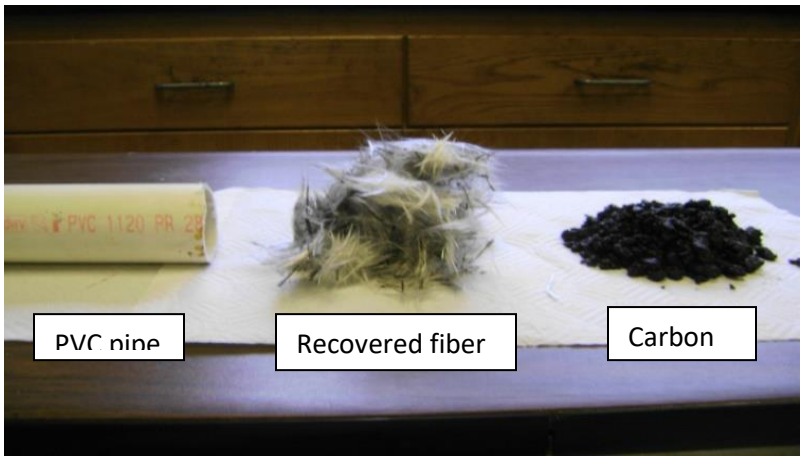
Recycling of Other Waste Materials

The methods commonly employed to recover silver and other metals from coated polymeric materials usually require lengthy processing times, high temperatures, and special chemical reactions[2]. Silver and other metals can be recovered by this method from X-ray films, other metal-bearing polymeric materials in 10-20 minutes and at low temperature about 110° C. This method has also been demonstrated as shown below to rapidly recover products from composites. Polyesters and x-ray films can be recovered as a solid or chemically converted to oligomers and monomers. Silver removal and its recovery is shown in Figure 4. Also, the chemical processing of the composite, PVC, and the products recovered is shown in Figure 4.

Figure 4– Figure 4 - Recovery of silver, other metals present in X-ray films, polyesters, and other polymeric materials



Silver recovered from coated polyester and X-Ray film as shown



Conclusion

Reportedly there are millions of tons of textiles that are now being disposed of annually that contains valuable reusable products. New technology developments are required to be operated simply, low cost, and in an environmentally acceptable manner to advance textile recycling nationally and internationally. The new method described herein can play an important role in advancing the recycling of textiles and composites that are now disposed of in landfills. For more information regarding this chemical method, contact

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Footnotes:

1. "The **circular** economy, design thinking and education for sustainability"; lec.sagepub.com (Google)
2. Patent US5238543 – Recovery of Silver From Photographic Films