GREENBLUE®

FEATURE:
WORN AGAIN

Chemical Recycling
Making Fiber-to-Fiber Recycling
a Reality for Polyester Textiles

Worn Again: A Solution for PET/Cotton Blended Fabrics

Worn Again has been working on the problem of reusing end-of-use textiles since Cyndi Rhoades founded the company in 2005. For the first seven years, Worn Again dedicated its efforts to repurposing end-of-use textiles into handbags, sneakers and other accessories using exotic materials like prison blankets, military parachutes and decommissioned hot air balloons. Realizing that a more scalable solution was needed to make a significant impact, Cyndi assembled a team to explore a recycling technology that could effectively meet brand expectations and the realities of the textile production process.

The Worn Again team conducted extensive research to characterize the various types of polyethylene terephthalate (PET) and cotton fabric waste streams that will constitute the feedstocks for their future business. Their findings are that 45-50% of excess textiles go to the reusable or "wearables" clothing market, 40-45% go to recycled markets – typically downcycled into lower value end products, and about 5% go to landfill or incineration. One reason that Worn Again developed a process to recycle pure PET and PET-cotton/cellulosic blends was because their analysis showed that only a small fraction of the textile waste

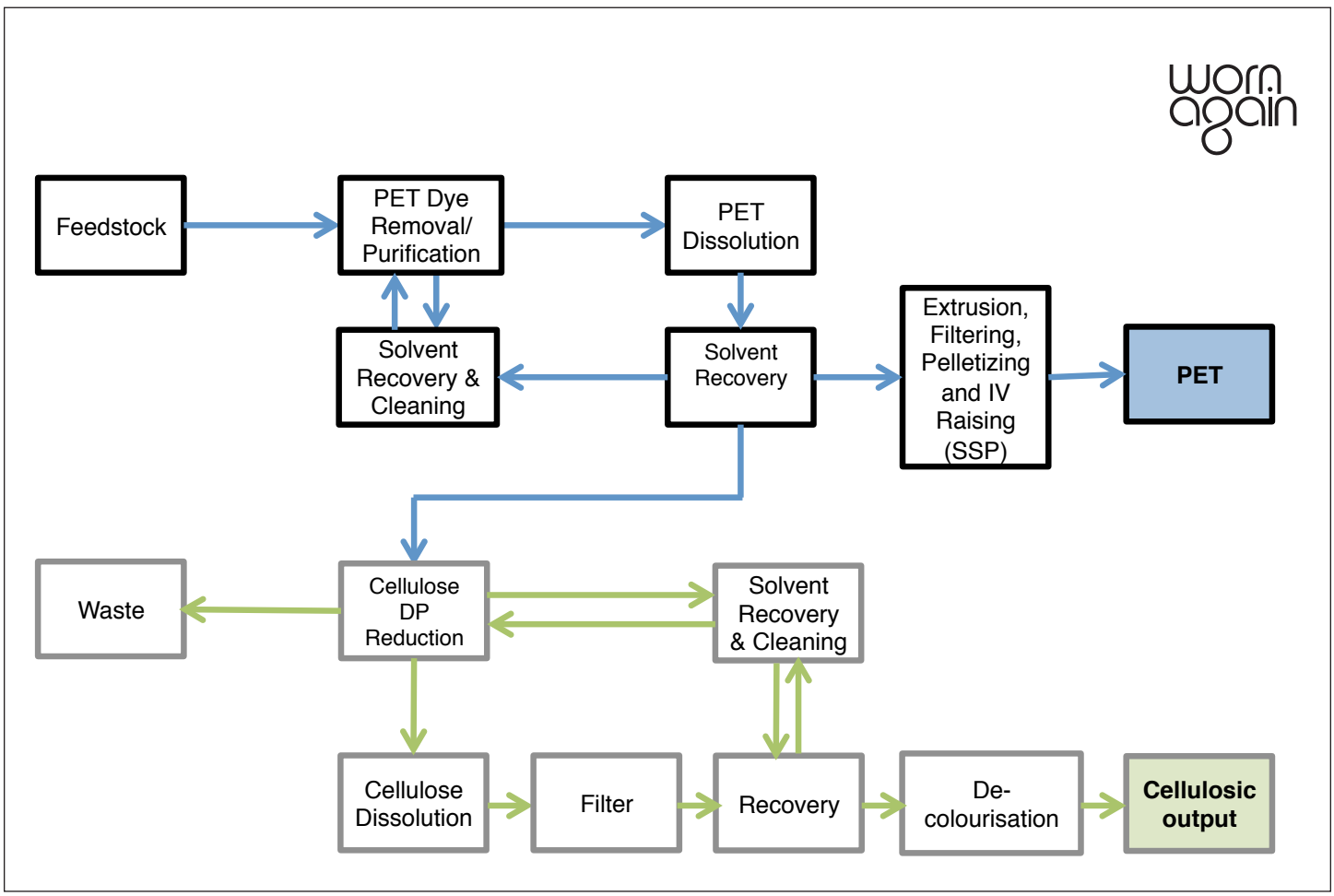
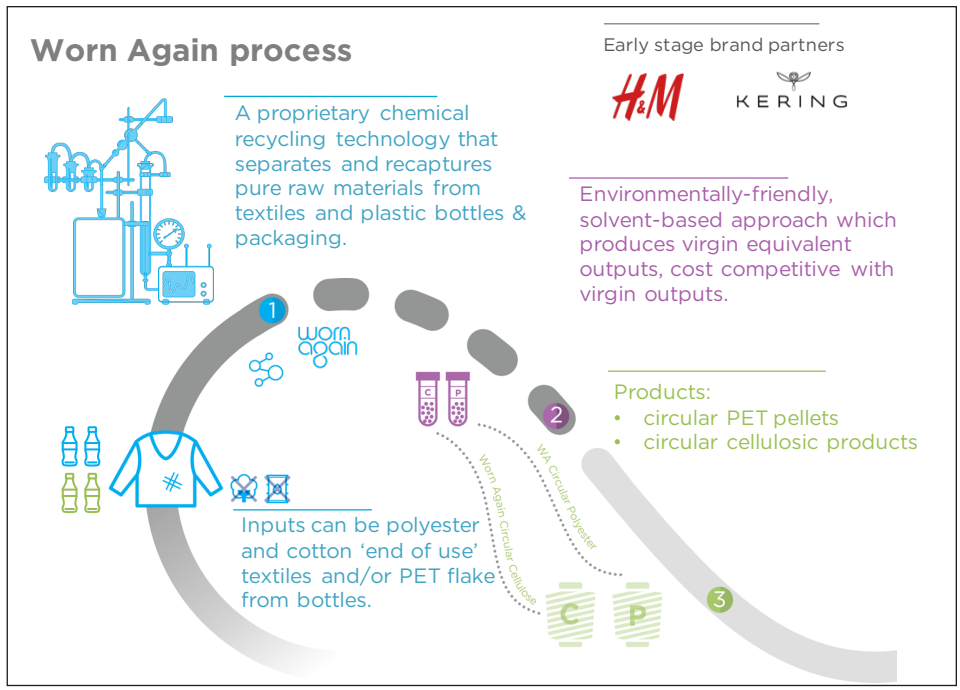


IMAGE COURTESY OF WORN AGAIN, 2017

stream not absorbed by the used clothing industry is made of 100% PET. The significant majority is PET blends, with over 35% made up of PET/cotton blends.

Worn Again's Chief Scientific Officer, Dr. Adam Walker, has been conducting research since 2006 for using solvents to recycle a wide variety of polymers such as polyethylene (PE), polypropylene (PP), polystyrene (PS), polycarbonate (PC), polyvinyl chloride (PVC) and acrylonitrile butadiene styrene (ABS). Dr. Walker described Worn Again's process to separate and recover PET and cotton or other cellulosics as a logical extension of his earlier research. In a process called "dissolution", solvents are used to dissolve the PET material, removing dyes, catalysts and other organic additives. Other chemistries are used to cleave the chemical bonds to remove dyes from cellulosic fibers. Insoluble additives such as titanium dioxide or antimony trioxide are released as fine powders and are removed by filtration. The unique process does not actually change the material at the chemical level and is able to separate the PET and cotton/cellulose in one process, requiring less energy than reduction to monomers to repolymerize into new resin.

The Worn Again process produces two primary products: 1) 100% PET resin chips and 2) a cellulosic pulp, similar to dissolved wood pulp, which can be regenerated into a cellulosic fiber. Unique to Worn Again's technology as compared to the other chemical recycling technologies featured in this report,



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is that it does not depolymerize the PET into monomers or oligomers, but rather solvents dissolve the polymer, filtering out insoluble impurities. The solvent is then removed to regenerate the purified polymer to meet performance requirements of fiber producers.

The ideal feedstock is comprised of at least 80% PET or cotton or some combination of both and will tolerate 20% other materials. Contamination rates higher than 20% erode efficiency and economic profitability, so similar to the other technologies described in this report, Worn Again will have to implement fairly stringent quality control on its feedstocks to make sure that contamination rates stay within the bounds of what is economically feasible to process.

The company is also doing novel research to develop methods for refining process by-products (dyes, surface finishes, backing materials, processing chemicals and non-target fibers) into potentially useful end products as opposed to sending these materials to incinerators or landfills. For example, Worn Again has run trials with a Dutch company that uses waste dye mixtures to produce a uniform black dye for dyeing yarns or fabrics as first quality goods. The company will also be experimenting with purifying elastane fractions (from PET/elastane blends) to see if there are potentially valuable end uses for these materials. At a minimum, Worn Again staff would like to find a way to valorize these chemical by-products to produce energy for their own plant operations as opposed to exporting them to waste-to-energy facilities, incinerators or landfills.

Worn Again will offer licenses to commercial recyclers once it has completed its research for scaling its operations in the coming years.