As the pressure mounts to reduce the clothing industry's impact on the environment, solutions, new and not-so new, are emerging to turn the tide on the wasteful use of water. Many stages of fibre and textile manufacturing, dyeing and finishing require large quantities of the natural resource.

Against the flow



Pakistan-based denim fabric manufacturer Artistic Milliners has paired a black solution-dyed Cordura nylon by Invista with two other dope-dyed yarns, Eco Colour Tencel by Lenzing and T400 Lycra to make Cordura SuperCharged Noir fabrics.

Lenzing Tencel

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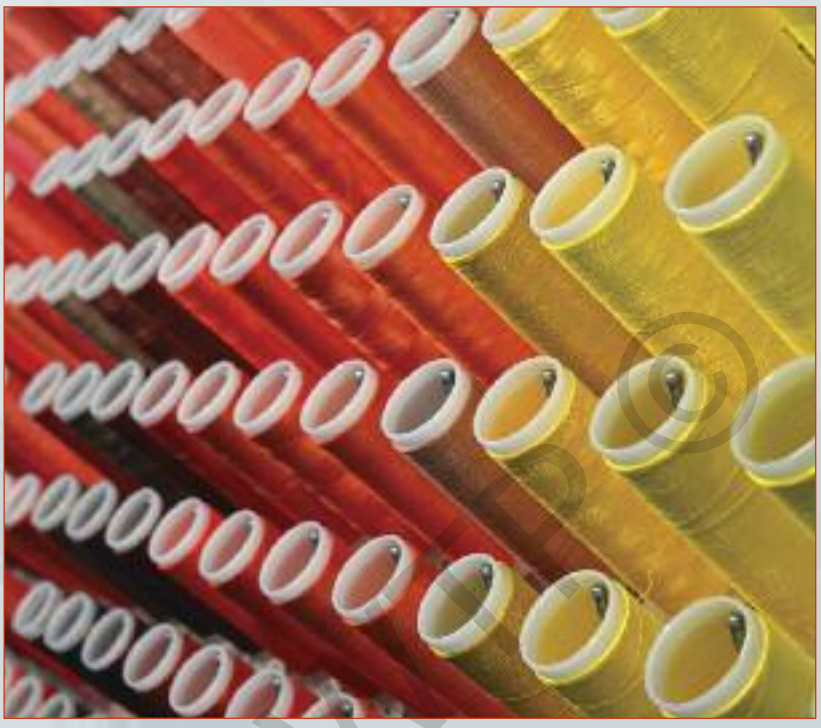
The textile and clothing industry is said to be the world's second largest user of water and responsible for 20% of global wastewater. These data, released by the UN Economic Commission for Europe (UNECE) this year, are yet another reminder of this industry's toll on nature.

For once, signs of change are coming from China. Announced in 2015, the country's Water Ten Plan set down new rules to reduce water pollution and specifically targeted 19 industries, requiring them to upgrade their facilities to comply with the stricter standards or risk being shut down. Chemicals, chemical fibres, dyes production and textile dyeing and finishing are some of the categories linked to textile and clothing manufacturing on China's black list. As promised, the administration is now closing down facilities that fail to meet the new standards. Dye houses are being closed in several Asian countries, Mats Anderson, e.dye's deputy managing director for supply chain, tells *WSA*. "We are seeing a drastic change in mentalities; we are going from being the worst with regards to pollution to being among the best," he says. A supplier of masterbatches for solution-dyed polyester and recycled polyester yarns founded in 2014, e.dye is based in Shanghai and Mr Anderson says the authorities support the company in its efforts to help the industry reduce its water usage.

In the process of dope- or solution-dyeing, pigmented chips are added to white or colourless polymer chips before melting and extrusion. The result is a synthetic yarn whose colour is "locked in" with no need for dyeing at later stages of the manufacturing process. This method can be used for synthetic and man-made cellulosic yarns, such as viscose, modal or lyocell. It leads to significant savings in energy and water use compared to cone dyeing or fabric dyeing. In its 2017 Sustainability Report, Austrian cellulosic fibre manufacturer Lenzing dedicates a section to its Modal Eco Colour dope-dyed fibres indicating that it uses up to 50% less energy and water compared to conventionally dyed fabrics (from cradle to finished fabric).

Dyed in the yarn

Solution dyeing is not a new technology, but the process is being reinvented by companies such as e.dye and Spindye. The main innovations introduced are a wider array of colours and lower minimum quantities. E.dye's palette contains 3,800 hues. The company has developed a system to identify and compare shades based on a set of variables including cast, saturation and lightness. Once a colour platform has been created, it will supply the pigmented masterbatch chips for polyester or recycled polyester extrusion. The ability to produce a shade consistently across various materials, the ribbed collar and knit body of a polo shirt for instance, or canvas and webbing for bags, is seen as one of the process' key advantages. "There is no need to develop a colour recipe for each type of fabric and there will be no difference in colour between the salesman samples and bulk production," says e.dye's global sales and marketing director, Michael Murphy. Solution dyeing produces yarns that have a higher colour-fastness compared to piece-dyed fabrics, the company states. This includes resistance to UV light, washing, bleeding (when a colour runs in a wet or humid environment) and crocking (when the dye of a dry fabric rubs off).



In the past, dope-dyed yarns were often shunned by brands because they were available in only a small range of colours. This is what e.dye, based in China, is seeking to change with its 3,800 possible shades.

e.dye

E.dye has had an Environmental Product Declaration (EPD) done on a typical baselayer knit fabric made with an e.dyed yarn. Results show great savings in water (100%), energy (48%) and carbon footprint (60%) as well as a 90% reduction in chemical usage.

Companies looking to use e.dye's Waterless Colour System are motivated by the higher performance of the yarns and their lower environmental footprint as well as for industrial and supply chain reasons, says Mr Anderson: "Dope-dyed polyester yarns have improved physical properties, as conventional dyeing processes tend to damage the yarn." Some of the company's clients need high colour consistency or high UV resistance as the car industry does, he adds.

SpinDye, a Swedish start-up, is also betting that its selection of 1,950 different shades will inspire more brands to shift to dope-dyed yarns. The concept launched in 2017 won a

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Italian warp knitter Eurojersey has partnered with WWF Italia and the Italian National Research Council (CNR) to pursue its efforts to reduce water usage, gain more insight into water pollution and raise awareness.

Eurojersey

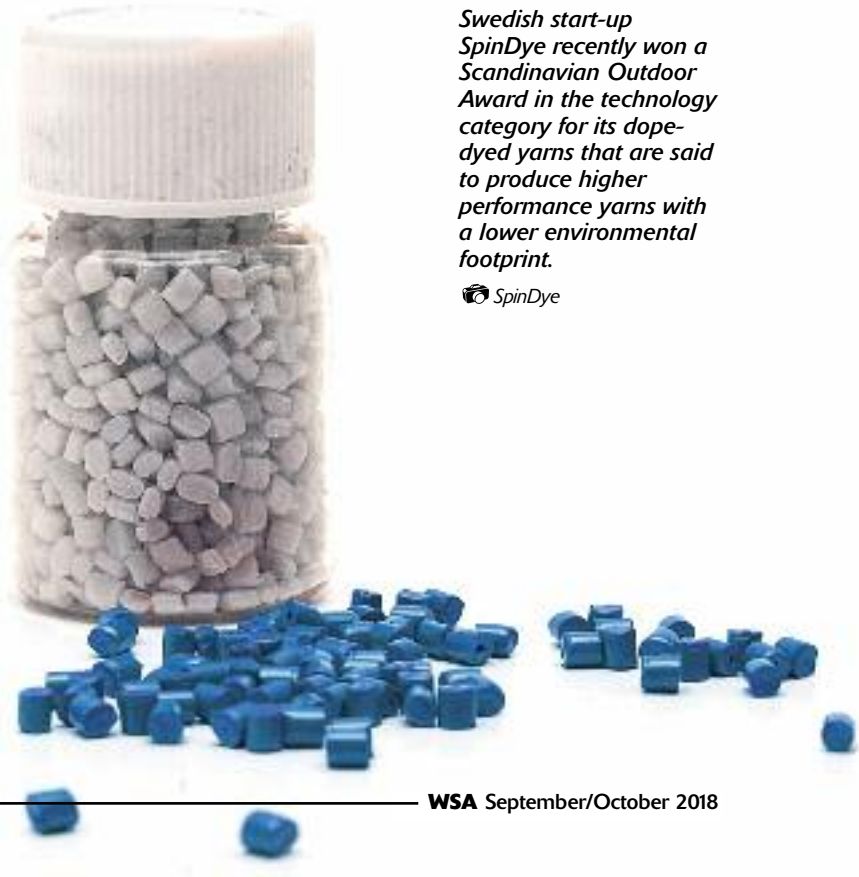
Scandinavian Outdoor Award in the technology category at the OutDoor show this past summer. The jury was impressed by its ability to reduce water usage by 75% and chemicals by 90% compared to traditional dyeing processes. When Fjallraven launched a recycled polyester version of its famous Kanken bag it chose to use solution-dyed yarns made from SpinDye's wide assortment of colours to manufacture the backpack's canvas and webbing.

Thanks to recent investments in its manufacturing facilities, Invista's Cordura nylon is now also available as a solution-dyed yarn. As part of the $65-million plan to expand and modernise its facility in Camden, South Carolina, Invista has dedicated $30 million specifically to overhaul its solution-dyed nylon 6,6 bulk continuous filament (BCF) fibre production capacity. The company says it has developed a proprietary small-lot technology with German machine manufacturer Trützschler. Though designed for Invista's carpet business, it will also offer Cordura-branded yarns for apparel applications, says Cindy McNaull, Cordura's global brand and marketing director. The new service is expected to be fully operational this autumn.

The ability of this plant to adapt quickly to small lots should give its customers more flexibility and more options. Invista is making new counts available (in addition to 500 and 1000 denier yarns), expanding the palette and lowering minimum orders, says Ms McNaull. At the Outdoor Retailer show in Denver in July, a seventh colour, Wolf Grey, was added to the first six shades. The new platform is being called TrueLock, in reference to the "locking in" of colour but also because it allows other properties to be sealed in, such as near infrared or antimicrobial functions. In the next six to 12 months, Ms McNaull expects to be able to offer 15 different shades, including a red, a (blue) black for the European market and a safety (or neon) red, orange and yellow. Custom shades can also be made.

The solution-dyed Cordura yarns require less water and energy and fewer chemicals to make while delivering higher colour-fastness. In addition to these properties that dope-dyed yarns share, Invista's nylon 6,6 is also said to have a higher stain-resistance.

Despite its clear environmental and performance benefits, solution-dyeing has yet to become widespread in clothing. Traditionally it has suffered from high minimum quantities, as the process is made for mass production, and from the limited selection of available colours. Even black, which could be considered an ideal colour for use in great quantities, is more complicated than one would expect. There is no single "true" black, but rather myriad nuances of blue, green, red blacks, and so on. European and American brands do not agree on a single standard for this shade. Another issue that could turn brands away from solution-dyeing is that it



Swedish start-up SpinDye recently won a Scandinavian Outdoor Award in the technology category for its dope-dyed yarns that are said to produce higher performance yarns with a lower environmental footprint.

SpinDye

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often requires longer lead times to produce the fabric compared to dyeing stocked greige rolls as needed.

The North Face mentions solution-dyeing as one of its moves to be more sustainable, which it says it adopted in 2014. Nike also seeks to reduce water use in its supply chain. Its 16/17 sustainability report mentions that its dyeing and finishing suppliers used 16 billion litres of water in the company's fiscal year 2016, representing some 126 litres of freshwater for every kilogram of fabric produced. Nike would like to reduce its water usage by 20%, but acknowledges that this is a challenge.

Waterless processes

There are other waterless processes being developed for textile dyeing and finishing using plasma or super critical carbon dioxide ($scCO_2$). Like solution-dyeing, these have yet to gain wide market acceptance in the active clothing industry. But one company, Green Theme International (GTI), based in Boulder, Colorado, has plans to replace the traditional wet processing of DWR finishes with a waterless process using either plasma or heat. US-brand Marmot will be introducing clothing treated by GTI in its upcoming ranges. An eco-friendly flame-resistant finish is in the works, Mike Costa, co-founder and international sales manager tells *WSA*. He points out that the machines, which have already been installed in Taiwanese companies, do not need to be located in an area that has access to water.

Dutch company Dyecoo has developed machines that dye fabrics using high-pressure carbon dioxide instead of water. This process has been tested by many brands including Nike, adidas and Swedish skiwear brand Peak Performance.

Without resorting to new machinery or processing, textile manufacturers are constantly taking measures to reduce their water and energy use as standards become stricter not only in Europe, but also, as we have seen, in China. As part of its sustainability strategy first launched in 2007, Eurojersey keeps a close watch over its water and energy use. The Italian mill based in Caronno Pertusella has recently expanded its partnership with campaign group WWF Italy, launching a new three-year programme that focuses specifically on water. Among the goals of the partnership, Eurojersey intends to measure the water footprint of its Sensitive Fabrics, promote sea-based initiatives and awareness with regards to microplastics and healthy eco-systems. The company is also collaborating with the Italian National Research Council (CNR), based in Biella, on a programme to measure microplastics released by synthetic fibre textiles during garment washing and drying. The company says its Sensitive Fabrics require little maintenance and water consumption, dry quickly and should therefore have a lower environmental impact compared to other synthetic textiles. Insight from this research project is expected to help the company improve the quality and lifecycle of its fabrics.

The measures taken to reduce water usage in the textile industry are focusing on the many wet processes used to dye and finish fabrics, as seen in the shift to waterless processes and in the radical shut down of facilities in China. This alone should send a clear signal to the sports clothing industry to take a closer look at solutions that consume little or no water. If that is not enough, then the issue of microplastic pollution might send another strong signal.

