

Textile dyeing is one of the oldest art forms in existence, dating back to at least the Neolithic period. Since that time, dyeing methods have become infinitely more sophisticated, allowing us to create an astounding array of hues using both [natural pigments from plants, insects, and clays](#) and [artificial dyes concocted in the most high-tech labs](#). However, some of the most revolutionary advancements in dyeing are just now beginning to enter the marketplace. In response to growing concerns about the environmental impact of traditional, water-heavy dyeing processes that create [extraordinary amounts of pollution](#), ColorZen and DyeCoo have introduced ways of dyeing fabrics using little or no water while drastically reducing energy consumption and minimizing use of toxic chemicals. Although still in their infancy, these exciting dye technologies could be the way of the future and fundamentally change the way the textile industry—which currently has “one of the largest water footprints on the planet”—functions.¹

ColorZen

ColorZen uses a proprietary cationic pre-treatment process that alters cotton fabrics on a molecular level to make them highly accommodating of reactive dyes through enhanced ionic activity, significantly reducing water use and eliminating the need for salts and alkalis. Michael Harari, president of ColorZen, says, “Our technology reduces water consumption by 90% and can dye the same amount of cotton in less than one-third the amount of time.”² Although cationic technology is not new, ColorZen’s unique approach is allowing this advanced, eco-friendly dye technology to be used in cost-effective, large-scale production for the first time.

DyeCoo

DyeCoo, a Dutch company, takes environmentally-friendly dye technology to the next level by using carbon dioxide as a dyeing medium for polyester fabrics, eliminating the need for water altogether. “When pressurized, CO₂ becomes supercritical, a phase between liquid and gas. In this state, CO₂ has a very high solvent power, allowing the dye to dissolve easily. Thanks to the high permeability, the dyes are transported easily and deeply into fibres, creating vibrant colors.”³ Not only is the technology waterless, it also cuts energy and chemical use and half and even the carbon dioxide is reclaimed and recycled. The long-term environmental protection and cost savings afforded by dye method make investment in pricey DyeCoo machines worth it, according to Yeh Group, which has spent millions developing the first commercial-scale DyeCoo dyeing system to produce clothing for Adidas, Mizuno, Peak Performance, and Kjus.⁴ Adidas estimates that DyeCoo integration saved over 100 million liters of water in 2014 alone. Although currently DyeCoo is only used to dye polyester, researchers are investigating the potential of the technology for both synthetic and natural fabrics.

Spectrophotometric Evaluation of Dye Technologies

Regardless of the environmental advantages of dye technologies, they must create pleasing, accurate, and consistent coloration of textiles to have any chance at succeeding commercially and being integrated in textile production in a meaningful way. The advanced color measurement abilities of spectrophotometric instrumentation allow researchers and manufacturers to easily evaluate color consistency both within a roll and between rolls to ensure that the shade and levelness produced meets expectations and can be predictably reproduced by new dye methods. Spectrophotometers are uniquely suited to provide meaningful, [repeatable color measurements in all types of fabrics, regardless of material, weave, or finish](#).

Objective spectral data can be used to advance dye technologies themselves by providing critical information about areas of weakness and strength in the dyeing process. The impact of variables such as pre-treatment, dye chemistry, dye application, and fabric type, can be assessed with extraordinary detail to understand how each component of the dyeing process influences color fixation, intensity, and consistency, giving you the information you need to optimize fixation, yield, levelness, and overall quality. For example, through spectral analysis DyeCoo found that “without pre-treatment the dyeing in supercritical carbon dioxide with the reactive dyestuff is ineffective even when prolonged dyeing times are employed.”⁵ Additionally, spectrally evaluating the impact of dye chemistry revealed that difluorotriazinyl derivatised dye results in significantly stronger coloration than dichlorotriazinyl derivatised

dye. As such, spectrophotometric instruments are playing a critical role in the development of eco-friendly dye technologies and are an invaluable resource as manufacturers seek to replace water-dependent dye methods with low-use or waterless alternatives.

Full article with photos available here:

<https://www.hunterlab.com/blog/color-in-textiles/spectrophotometry-is-refining-ecofriendly-dye-technologies-and-protecting-water-supply/>