



Advances in Sustainable Dyeing Methods, Machinery, and Processes



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Advances in Sustainable Dyeing Methods, Machinery, and Processes

Need for Sustainable Dyeing Methods



EPA Definition

Sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs.

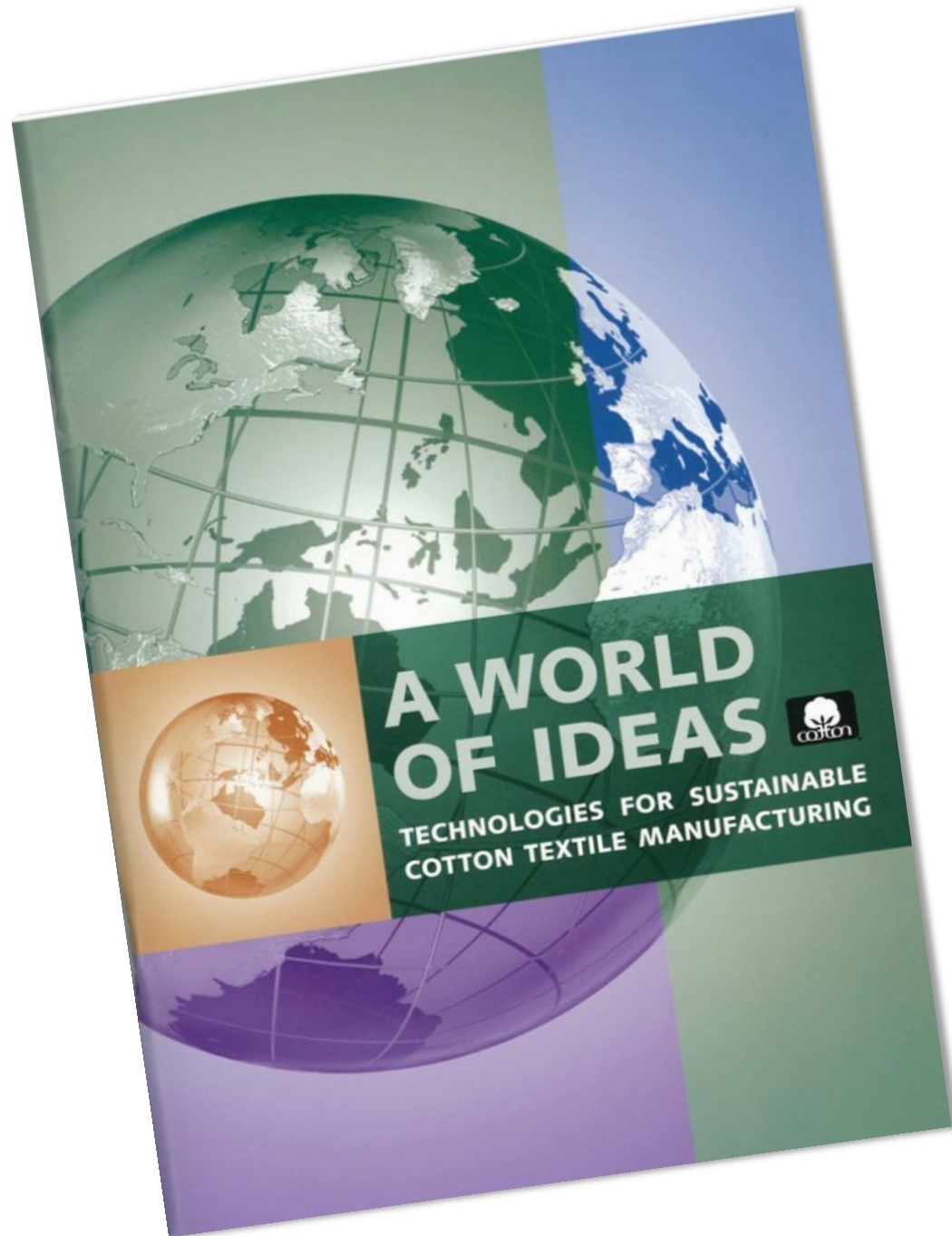
Photo courtesy of Seametrics.com

Life Cycle Assessment Overview





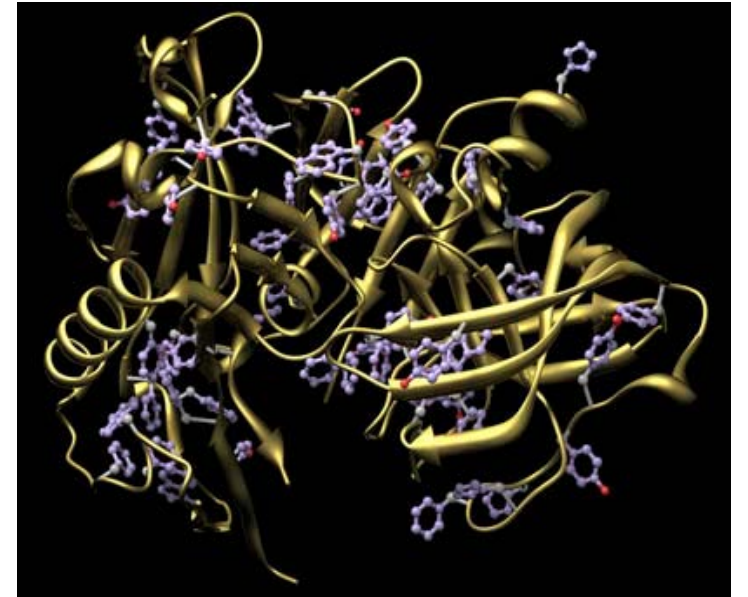
Sustainable Dyeing Processes



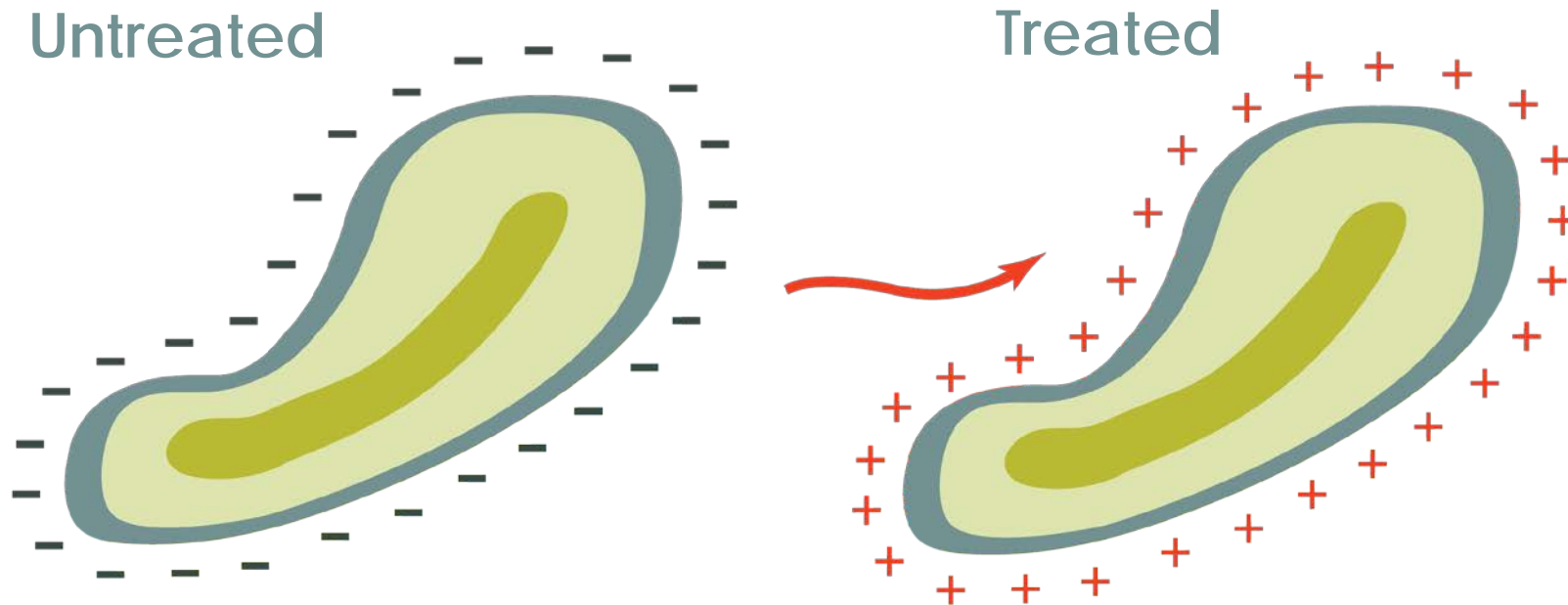
Many of the technologies needed to significantly reduce the environmental footprint in textile manufacturing already exist.

Environmentally Friendlier Preparation for Dyeing Enzyme Applications

- Specialized proteins found in all living organisms and serve as natural catalysts for biochemical reactions.
- Safe and easy to use.
- **Attack** and degrade *specific* substrates under mild conditions.
- Can replace *harsh* solvents and other organic compounds.
- Amylase, Cellulase, Pectinase, Laccase, Catalayse

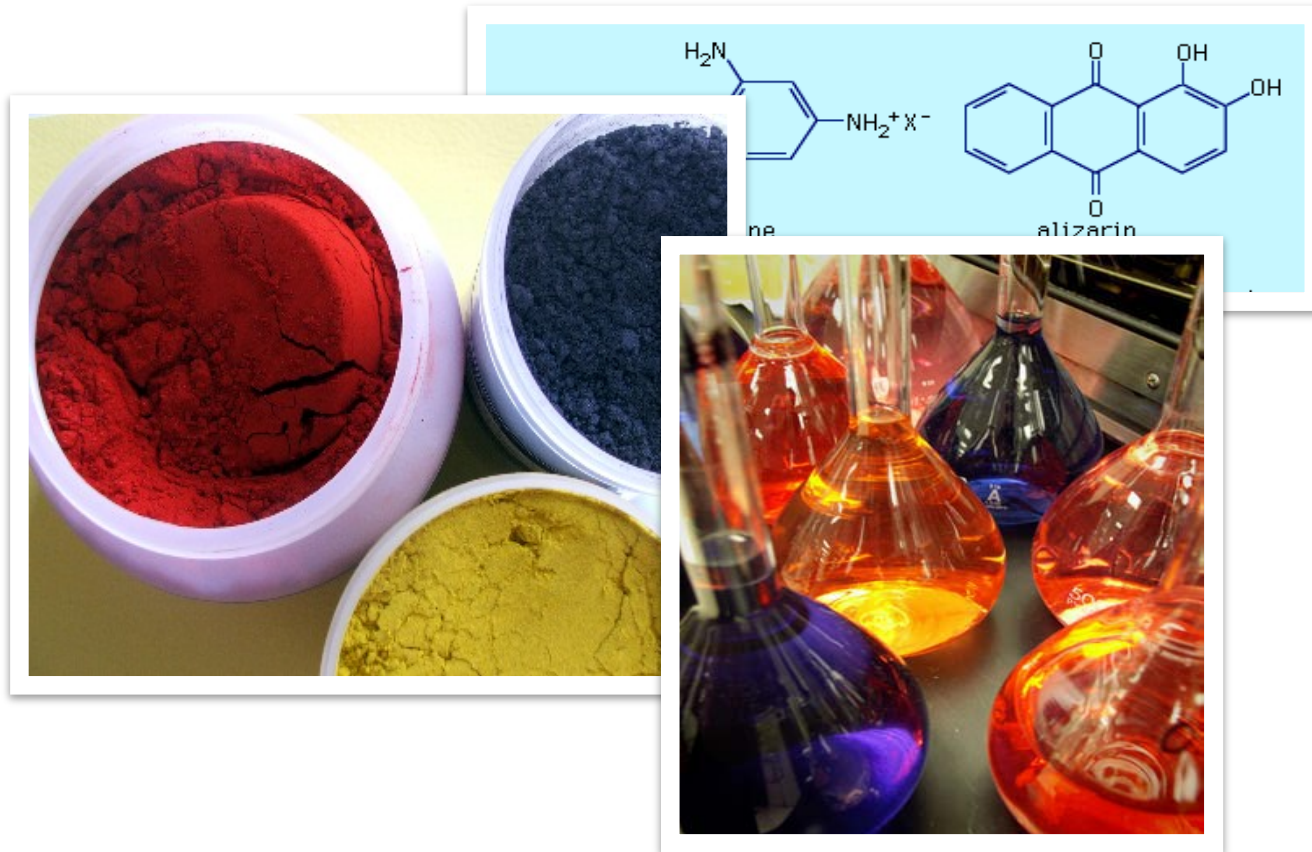


Environmentally Friendlier Preparation for Dyeing Cationic Cotton



Environmentally Friendlier Dyes

High Fixation – Low Impact Reactive Dyes









- Higher Fixation Rates (as high as 90% or greater)
- Multiple anchor groups (reactive groups) within molecule
- Greater efficiency – more depth with less dye and less salt
- Lower dye temperatures (as low as 40°C)
- Lower Liquor Ratios (less than 6:1 L/R)
- Lower rinse and soap-off temperatures
- Fewer Rinses (reduced water consumption)
- Compared to conventional reactive dyes, use less water, energy, and time.

Environmentally Friendlier Dyes

High Fixation – Low Impact Reactive Dyes



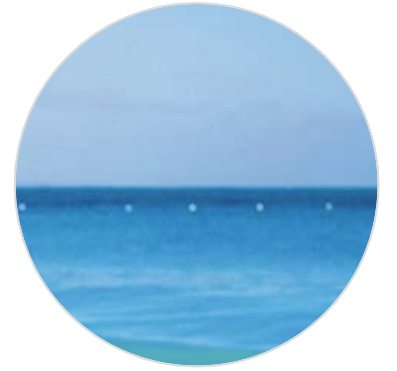
- Avitera® SE (Huntsman)
 - Poly-reactive dyes
 - 93 % fixation, leaving only 7% unfixed dye to remove
 - Lower washing off temperatures
 - Compared to conventional reactive dyes, use less water, energy, and time.

Conventional Dyes	 Water 60 – 80 l/kg	 Steam / CO ₂ 6.5 / 2.2 kg	 Time 7 h
AVITERA® SE Dyes	 Water 18 – 20 l/kg	 Steam / CO ₂ 1.7 / 0.7 kg	 Time 4 h

Photos courtesy of Huntsman

Environmentally Friendlier Dyes

High Fixation – Low Impact Reactive Dyes

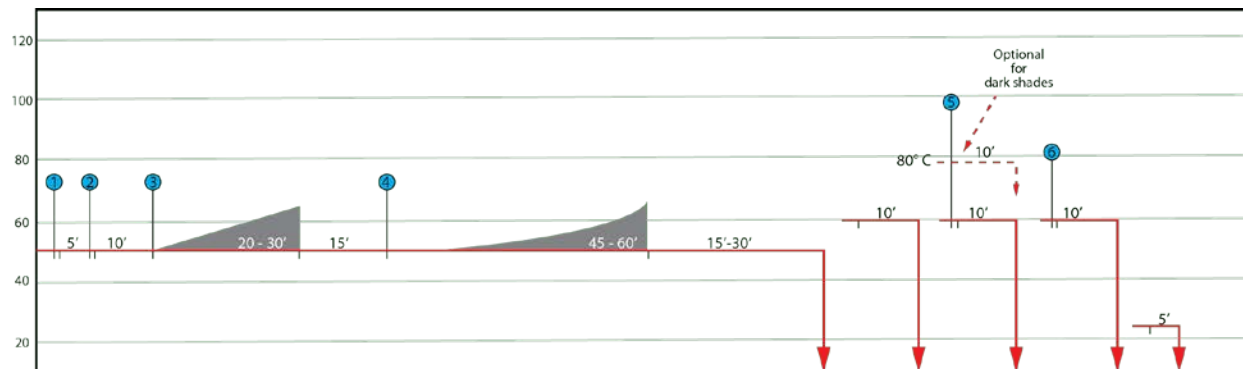


Photos courtesy of CHT/Bezema

- Bezaktiv GO (CHT/Bezema)
 - Third part of the 4 Success process
 - Fixation rate as high as 90%
 - Lower Dyeing Temperature
 - 40°C
 - Lower Rinse Temperatures
 - Cotoblanc SEL (40°C)
 - Lower Liquor Ratios
 - Minimum consumption of water, energy, and salt
 - Short process times in exhaust and CPB processes

Environmentally Friendlier Dyes

High Fixation – Low Impact Reactive Dyes



Photos courtesy of DyStar

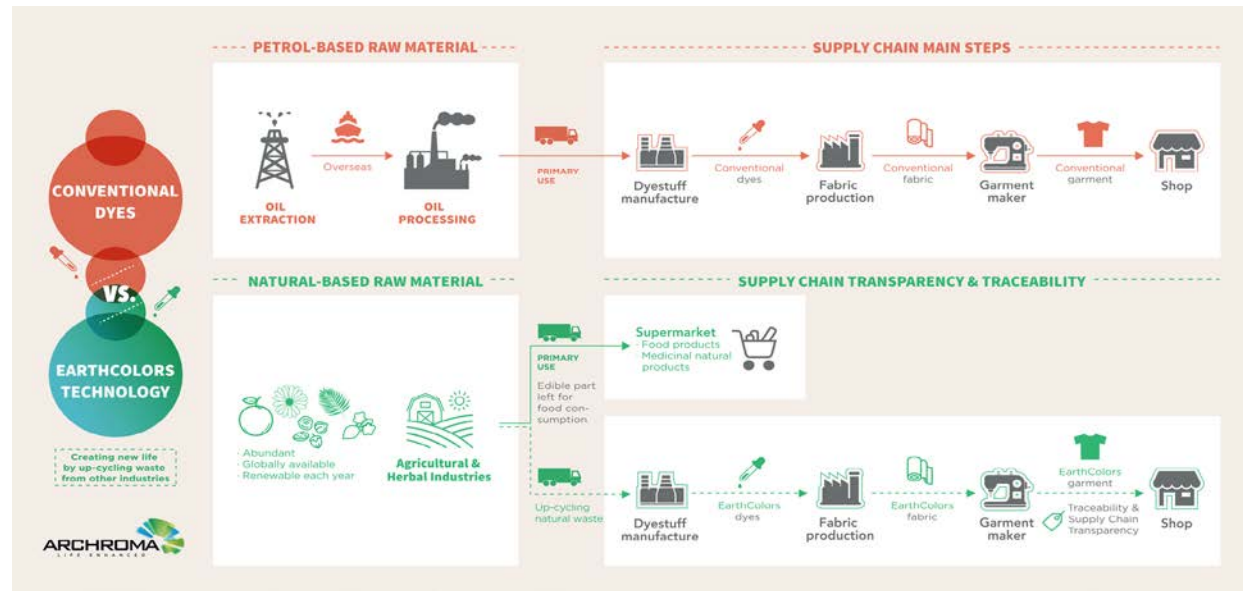
- Cadira[®] Reactive (DyStar)
 - Uses select Levafix[®] and Remazol[®] reactive dyes
 - Higher fixation yield
 - Good wash off properties
 - Optimized dye process
 - Lower Dyeing Temp. (50°C)
 - Lower Liquor Ratio (5:1)
 - Special Wash off Process
 - Sera[®] Fast C-RD
 - Soap-off Rinse at 60°C
 - Shorter process times

Environmentally Friendlier Dyes

Sustainably Produced Dyes



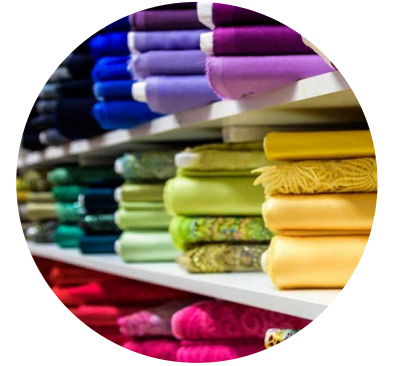
- **EARTHCOLORS[®]** (Archroma)
 - Fully traceable biosynthetic dyes derived from natural waste products of the agricultural and herbal industries
 - Transformed natural waste based colorants synthesized using up to 100% of raw materials from natural waste such as non-edible shells of nuts, leaves, and cotton gin waste.
 - Traceable with NFC technology.



Photos courtesy of Archroma

Environmentally Friendlier Dyes

Sustainably Produced Dyes



Photos courtesy of DyStar

- Levafix[®] ECO (DyStar)
 - A new range of reactive dyes based on chemistry which is free of p-CA and other regulatory controlled amines.
 - Enhanced fastness properties leading to improved sustainability.
 - The shade range can be extended by the use of additional existing p-CA-free Levafix[®] and Remazol[®] dyes.

Environmental Impact Measurement Tools for Measuring Sustainable Dye Methods



Photos courtesy of Archroma



ONE WAY

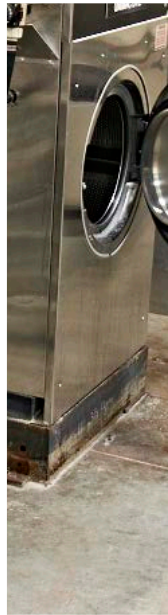
Systematic Approach to Actionable Sustainability (Archroma)

eliot™
(DyStar)



Photos courtesy of DyStar





Sustainable Dyeing Equipment

Dyeing: The Road to Sustainability

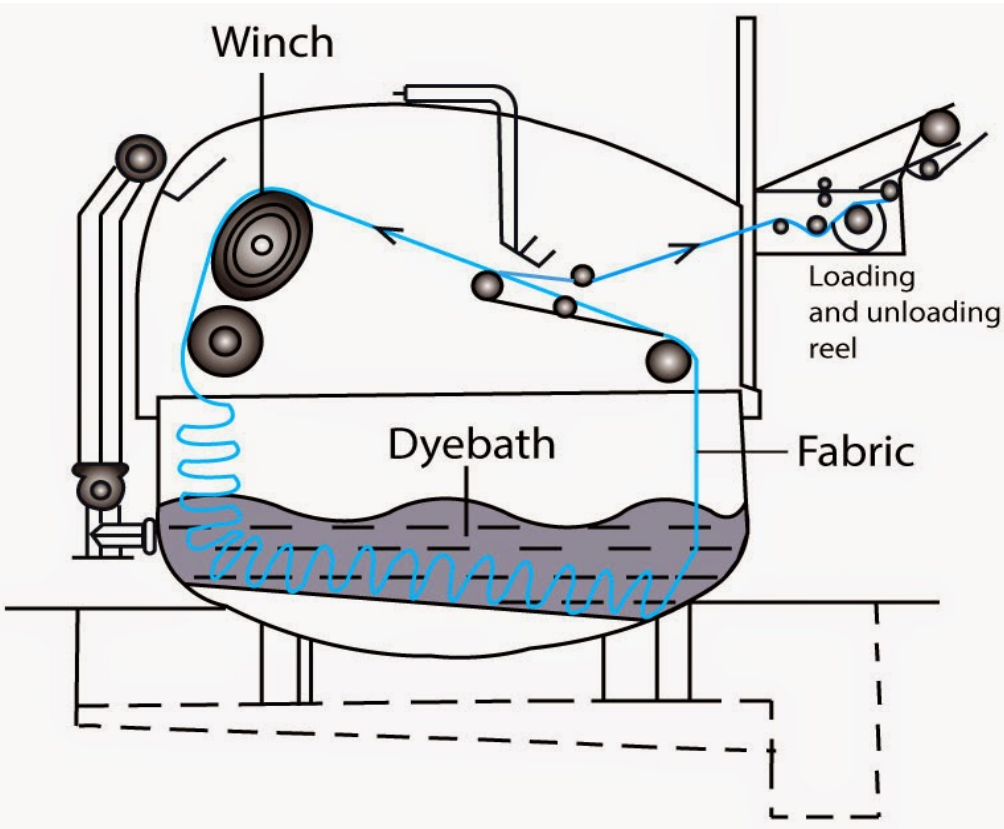
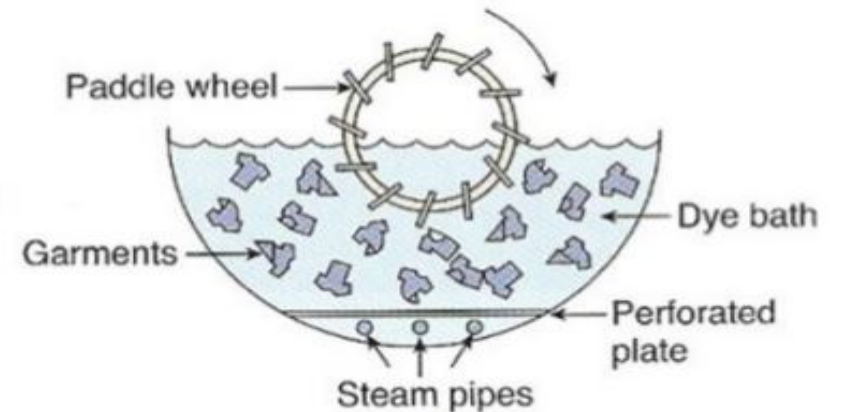
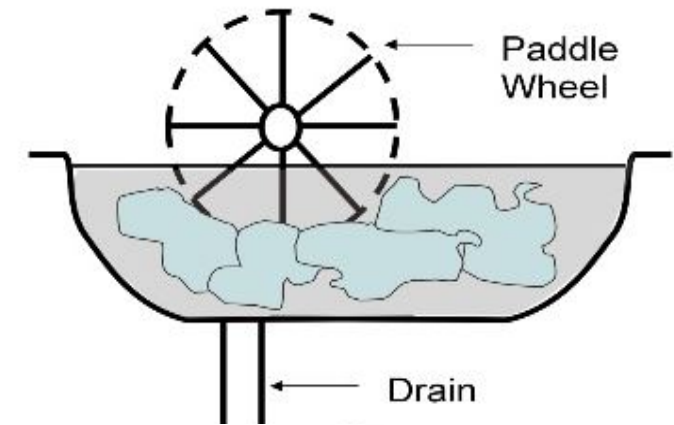


Image courtesy of TextileApex.blogspot.com

- Fabric sits in water
- 20:1 or higher liquor ratios
- High energy use
- High steam use
- Inefficient

- Gentle to fabric
- Floats in bath
- Paddle dyeing still in use



Images courtesy of Azmir Latif, MSc. Engr. (Textile)

Efficient Package Dyeing for Yarn



Image courtesy of CHTC Fong's Industries



Image courtesy of Loris Bellini

- Lower liquor ratios for cotton
 - 1:3 or 1:4
- More efficient circulation pumps draw significantly less energy
- Only require enough bath to run the pump
- Less water means less salt and auxiliaries (up to 30% reduction)
- Intelligent rinsing reduced water
- Innovative water extraction means less time and energy to dry

Low Liquor Ratio Jet Dyeing



Photo courtesy of Fong's Europe GmbH - THEN

- Soft flow for gentle fabric action
- Use air rather than water to move the fabric
- Reductions in water, salt, auxiliary chemicals and time
 - 3:1 LR for cotton
 - Faster drop/fills
- Dyeing takes place in the venturi, not in the bath

Low Liquor Beam Preparation and Dyeing

- Low liquor beam dyeing means bleaching and dyeing using less than 20 L/Kg of fabric!
 - 30-50% reduction in water use vs. typical beam dye machines
- Low steam use
- Low energy use related to pump efficiency
- Less water means less salt and alkali required for dyeing
- Preservation of surface appearance
- Virtually no stretch applied to fabric



Photo courtesy of Lab-Pro



Photo courtesy of Alliance Machines

Cold Pad Batch Dyeing

- Low water requirements
- No salt needed
- Dyeing at room temperature
- Applicable to knits and wovens
- Preserves surface appearance



Photo courtesy of Erbatech, GmbH

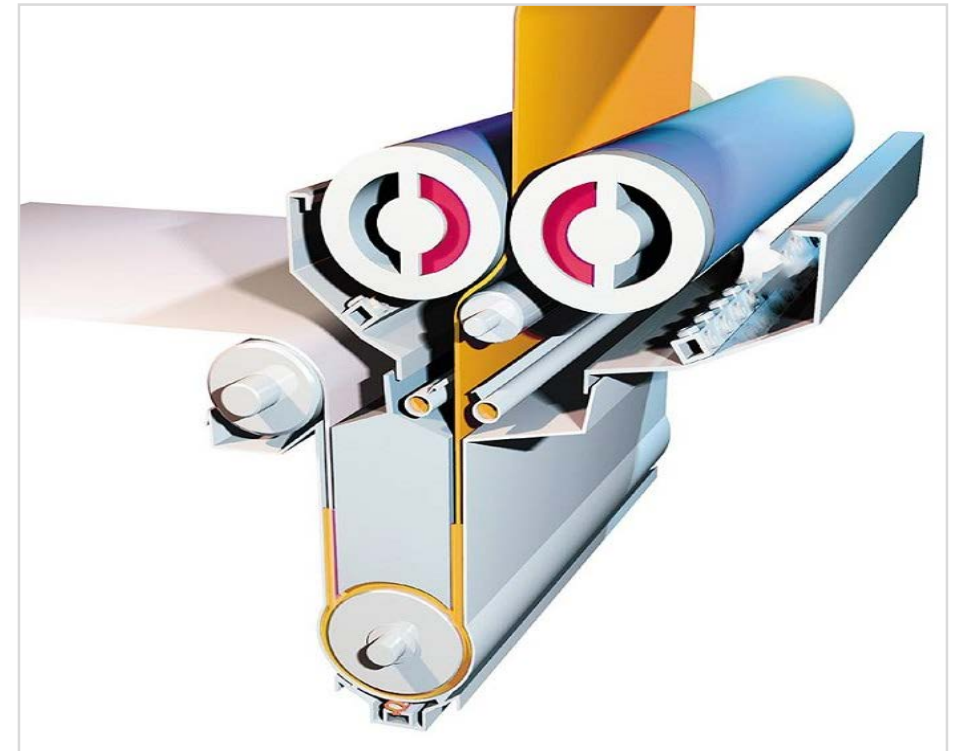
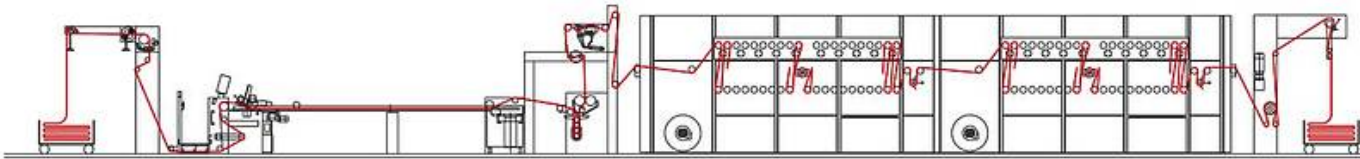
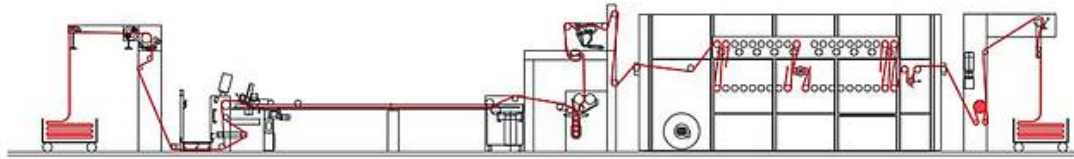
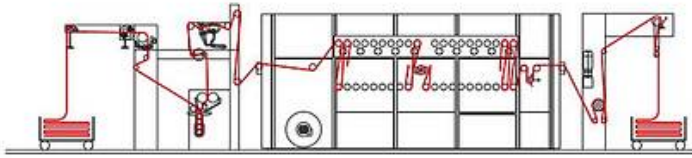


Photo courtesy of Benninger

Monforts E-Control

- Continuous dyeing of knit fabrics
- More efficient when compared to exhaust applications
- Reduction in water usage



- Alternative for cold pad/batch
- Reduction or elimination of salt
- Reduced effluent loading
- Aesthetically better fabric surface appearance

Schematic courtesy of Monforts

Foam Dyeing and Finishing

- Reduce water consumption up to 80%
- Reduce energy usage
 - Increase range speed
- Reduce chemical costs
 - Single sided application
- Increase versatility
 - Dyeing or finishing



Photos courtesy of Gaston Systems

Garment Dyeing: Tonello Core



- Versatile garment dye unit
- Completely programmable
- Able to process cotton at ultra-low liquor ratios at 1:1
- Create uniform dyeing
- Create novel effects
- Can apply both dyes and finishes
- Core unit can attach to any Tonello garment machine

Photo courtesy of Tonello Srl

Jeanologia e-Flow

- Nanobubble carriers for chemistry
- Significant savings in water, energy, and chemistry are reported
- Considerable reduction in effluent
- Can be connected to any garment washing machine
- Applicable to many fabric types including denim

“Water is over, air is the future”



Photo courtesy of Jeanologia

Sustainable Drying Technology



Photos courtesy of Monforts

- Ultra-efficient dryers
- Heat exchangers
 - Remove moisture from air
- Recirculate dry air into dryer
- Lower energy use
- Automatic cleaning
- Computer integrated airflow control

Control & Measurement Systems

- Improvements can only be made once conditions are benchmarked
 - Water meters on dye machines
 - Installation of a control system to monitor water, energy and steam use
 - Scheduling controls for machine use to minimize cleaning
 - Controls for weighing, mixing and delivery of dye and alkali to machine

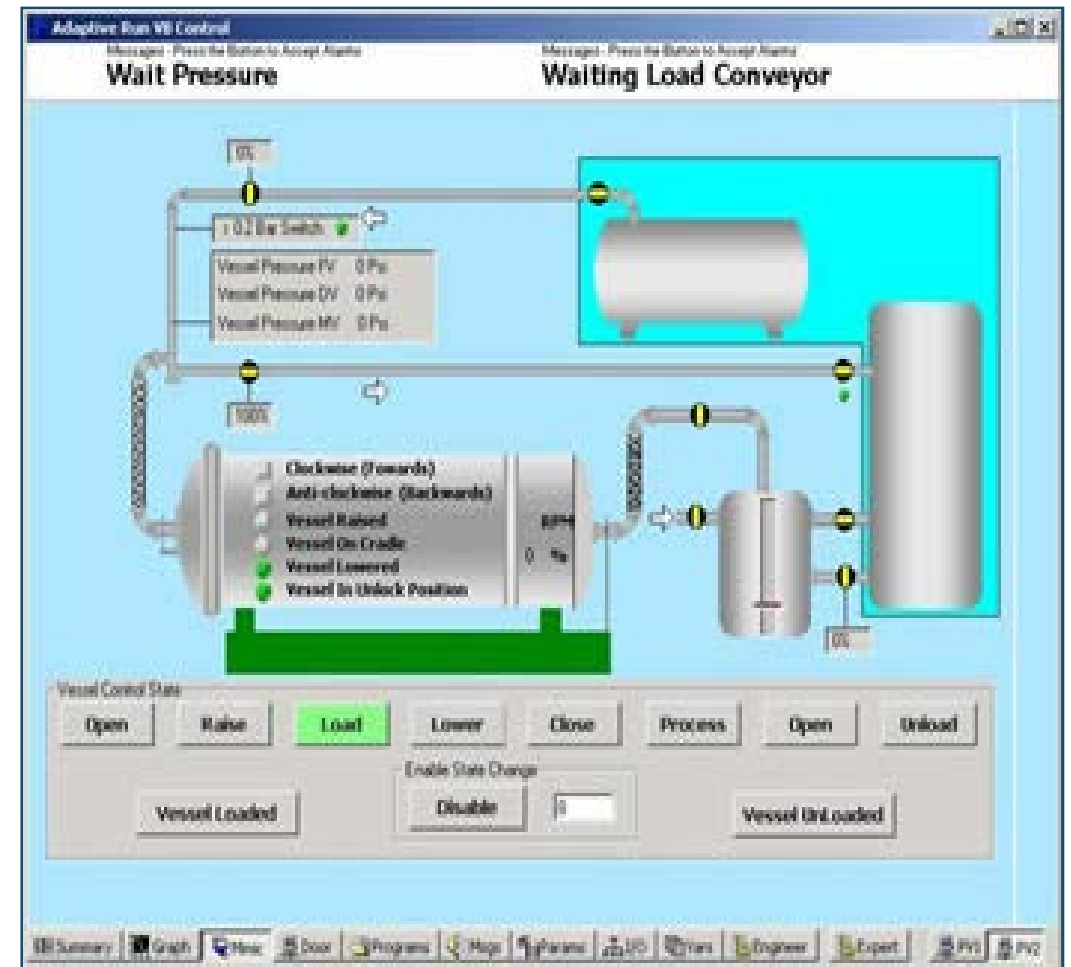
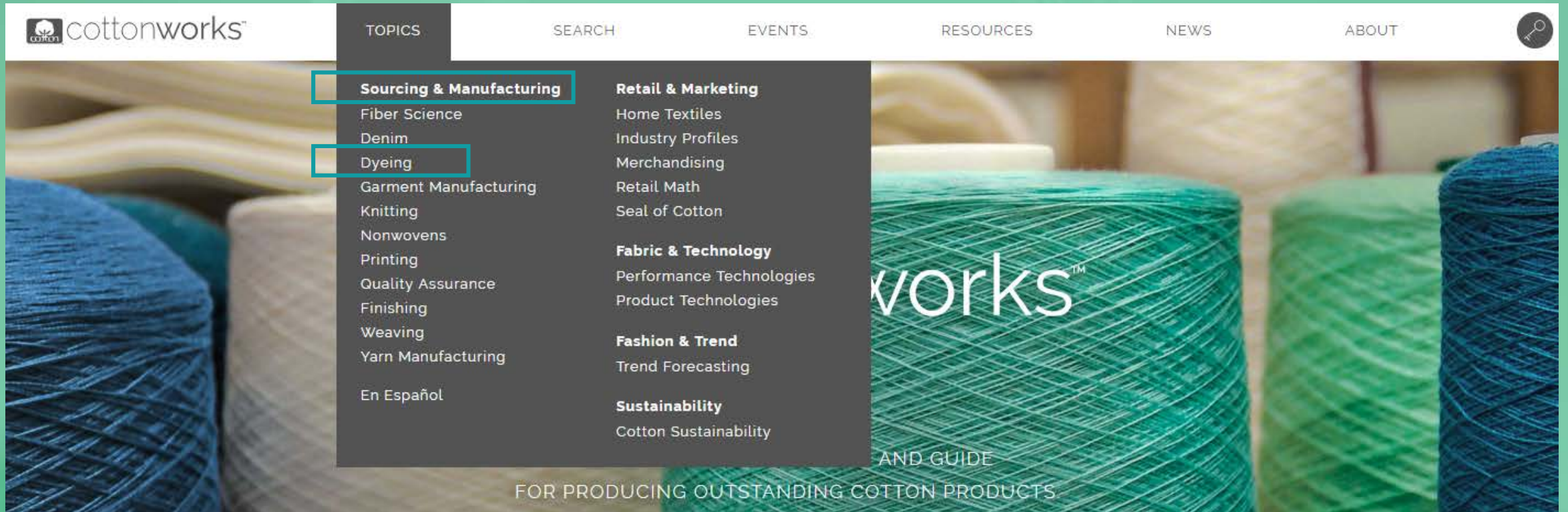


Photo courtesy of Adaptive Control Inc.



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