INNOVATIVE FABRICS & GARMENTS FOR THE WORLD'S BEST BRANDS

DryDye™ Fabrics – Exclusively from the Yeh Group.

THE PROBLEM

The textile industry is believed to be one of the biggest consumers of water. Conventional textile dyeing uses large amounts of fresh water and which then is disposed as waste water containing dyestuff chemicals.

On average, an estimated 100 - 150 liters of water are needed to process 1 kg of textile material. Water is used as a solvent in many pre-treatment and finishing processes, such as washing, scouring, bleaching, dyeing, rinsing and finishing. The contaminated water must then be handled and treated prior to disposal or recycling.

Water scarcity and increased environmental awareness are world-wide concerns causing a sharp rise in prices for intake and disposal of water. (1)

THE SOLUTION

Currently being readied for commercial introduction in the fourth quarter of 2010, the Yeh Group will be the first textile mill to implement a new process developed by DyeCoo Textile Systems. The Yeh Group is pioneering this revolutionary new process and, consequently, has exclusive rights. The Yeh Group is branding fabrics using this process as DryDye™ fabrics. Elimination of the water process and chemicals is a real and significant breakthrough for the textile dyeing industry.

This new process utilizes supercritical fluid carbon dioxide (CO_2) for dyeing textile-materials. It is a completely waterless dyeing process using only nominal amounts of recycled CO_2.

DryDye™ fabrics dyed with this unique waterless process will have the same quality of dyeing as current, conventionally-dyed fabrics.

The Yeh Group is an innovative, environmentally responsible producer of quality fabrics and garments to premium brands in the sports and intimate wear markets. By pioneering and implementing this new waterless dyeing process, the Yeh Group will eliminate their annual use of millions of liters of fresh water in dyeing fabrics.

DryDye™ fabrics will be available to consumers in early-2011 through select brand customers of the Yeh Group.

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Technical Details About Supercritical Fluid Dyeing

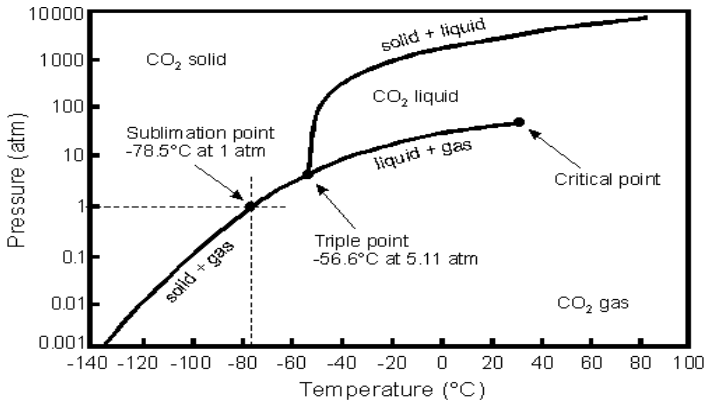
Instead of current aqueous dyeing systems, DryDye™ fabrics will be dyed using supercritical carbon dioxide.

For the past three decades, supercritical fluids have been used in various extraction processes. These have included the extraction of natural substances for the production of pharmaceuticals, cosmetics and spices.

Supercritical fluids are highly compressed gases which have unique properties of both liquid and gas and, because of this, have advantages for textile processing. Supercritical CO_2 may act as both a solvent as well as a solute, ideal for the textile dyeing process in which disperse dyes (without additives, dispersing agents, etc.) are used. Supercritical fluids have higher diffusion coefficients and lower viscosities than liquids, as well as the absence of surface tension, allowing better penetration into materials.

The three main stages of matter at ordinary temperatures and pressures are gas, liquid and solid. The molecules in a solid are so close together that the forces between them hold them in a given shape. When more energy is added, these forces are overcome and the substance becomes a liquid. Add more and it becomes a gas.

When both the temperature and pressure get high enough, liquid and gas phases become indistinguishable and the phase is called a supercritical fluid.



Pressure-Temperature phase diagram for CO_2.

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SUPERCRITICAL CO_2 QUALIFICATIONS

Supercritical fluid CO_2 has become a mainstay in extraction processes in the food industry (decaffeination, extraction of hops) and apparel dry cleaning, where it has proven to be the best, gentlest, most thorough cleaning method now available. Carbon dioxide is also considered the best supercritical fluid for the dyeing process. It is naturally occurring, chemically inert, physiologically compatible, relatively inexpensive and readily available. Other attributes of carbon dioxide are:

- It is an inexhaustible resource.
- Its use does not release volatile organic compounds (VOCs).
- It is biodegradable as a nutrient for plants.
- There are no disposal issues. It can be recovered and reused from the dyeing process.
- It is nonflammable and non-corrosive.
- It is non-toxic and low cost.

DYEING WITH SUPERCRITICAL CO_2

Using supercritical fluid CO_2, polyester and other synthetics can be dyed with modified disperse dyes. The supercritical fluid CO_2 causes the polymer fiber to swell allowing the disperse dye to easily diffuse within the polymer, penetrating the pore and capillary structure of the fibers. The viscosity of the dye solution is lower, making the circulation of the dye solutions easier and less energy intensive. This deep penetration provides effective coloration of polymers which are characteristically hydrophobic. Dyeing and removing excess dye are processes that are done in the same vessel. Residue dye is minimal and may be extracted and recycled.

Supercritical CO_2 dyeing gives excellent results as far as dye levelness and shade development, and the physical properties of dyed yarns are equivalent to conventional methods.

Conventional textile dyeing is very water and energy intensive in pretreatment, dyeing, and post-treatment (drying). The supercritical CO_2 process involves the use of less energy than conventional processes, resulting in a potential of up to 50% lower operating costs. The only overlap is in the pre-treatment process, which is essentially the same for both.

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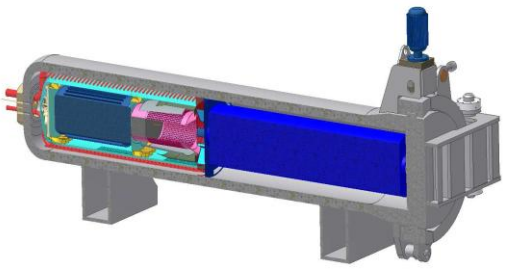
Comparative energy requirements* (kJ) (2):

	Conventional	$scCO_2$
Pretreatment	4,555	4,555
Dyeing	45,250	30,625
Post Treatment	3,800	0
Total	53,605	27,180
Energy Savings		49%

**Actual results will vary by country and by dyeing equipment.*

Equipment

Supercritical fluid dyeing equipment conforms to package dyeing regimes in which a roll of fabric is inserted into a high pressure vessel which is filled with CO_2 and pressurized up to 250 bar.



Summary of Key Advantages of Supercritical Dyeing (1)

- Elimination of water consumption
- Elimination of wastewater discharges
- Wastewater treatment process eliminated
- Elimination of drying and dryer effluent
- Reduction in energy consumption
- Reduction in air emissions
- Dyeing time significantly reduced
- Pure dyes used. Surfactants and auxiliary chemicals in dyes eliminated
- Dye utilization is very high with very little residue dye. Unused dye can be recaptured and reused
- Approximately 95% of CO_2 can be recycled
- Fewer re-dyes are required and color correction is easier compared to aqueous dyeing

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DryDye™ Fabrics are Green!

The environmental and economic advantages of dyeing with supercritical CO_2 are clear:

CONVENTIONAL DYEING	DYEING IN SUPERCRITICAL CO_2
High volumes of waste water with the residual dye chemicals, etc.	No waste water at all. Dye remains as powder. No need for dispersing, leveling agents
High-energy requirements.	Only 20% energy requirement
Dyeing/washing, drying times is 4-6 hrs per batch.	Only 2-3 hours.

REFERENCES

1. "Dyeing Textiles with Supercritical Carbon Dioxide", Kim Anderson, PhD, http://www.techexchange.com
2. http://epanote2.epa.vic.gov.au/epa/publications.nsf/2f1c2625731746aa4a256cd90001cbb5/4540f6d120c63fef4a2566ad00170d01/$file/621.pdf
3. http://www.dyespigments.com/
4. www.expresstextile.com/20050915/processworld02.shtml
5. www.nasaexplores.com/show_912_student_st.php?id=030529150856
6. "Progress in Supercritical CO_2 Dyeing", Walter Hendrix, Journal of industrial Textiles 2001:31,43
7. www.botanix.co.uk/
8. "Supercritical Fluid Technology in Textile Processing", Gerardo A. Montero, Carl B. Smith, Walter A. Hendrix, and Donald L. Butcher, North Carolina State University, College of Textiles