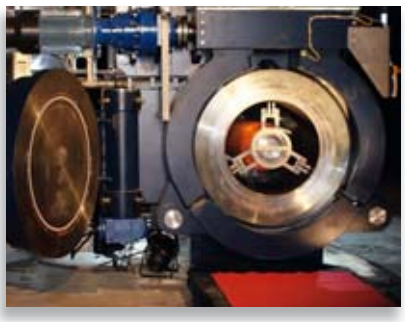
DyeCoo: waterless dyeing

Launch of the first commercial dyeing machine that uses supercritical carbon dioxide instead of water



The textile industry is believed to be one of the biggest consumers of water. In conventional textile dyeing, large amounts of water are used both in terms of intake of fresh water and disposal of wastewater. On average, an estimated 100–150 litres of water is needed to process 1 kg of textile material, with some 28 billion kilos of textiles being dyed annually. Water is used as a solvent in many pretreatment and finishing processes, such as washing, scouring, bleaching and dyeing. Hence, the elimination of process-water and chemicals would be a real breakthrough for the textile dyeing industry, and it seems this has now come to fruition, with the launch of the world's first ever industrial dyeing machines that uses super carbon dioxide (CO_2) as a replacement for water.

The manufacturer behind this system is the Dutch company, DyeCoo Textile Systems BV. Years of extensive research and development has gone into producing the novel, completely water-free dyeing process which has considerable lower operational costs compared to conventional dyeing processes.

Award-winning process

From an environmental point of view, the new dyeing machine is revolutionary. The machine was unveiled this summer and is so new it has yet to be given a name, although the technology behind the process was unveiled to the world last year when DyeCoo won the Herman Wijffels Innovation Award for the best innovative eco-based product for 2009/2010. Reinier Mommaal of DyeCoo explains that the idea for water-free dyeing is nothing new. 'The principle of dyeing with CO_2 was invented in Germany twenty-five years ago. Developing a well-functioning machine, however, turned out to be too expensive.' DyeCoo Textile Systems' parent company, Feyecon, began tackling this issue ten years ago in partnership with the Delft University of Technology and Stork. This ultimately resulted in DyeCoo (which was formed in 2008), which literally means dyeing with CO_2.

'The benefits are huge,' continues Reinier Mommaal. 'There is no water consumption, no use of chemicals, no drying and it is twice as fast. This also makes it attractive in terms of energy. It is consequently not surprising that people from around the world have shown interest in this new machine.' The disperse dyes used in the process were specially produced in cooperation with another Dutch company, Triade, responsible for the production and distribution of the CO_2 dyes, with Setex (Germany) responsible for the control system.

Production machine

The final partner of DyeCoo to make history is Tong Siang Co. Ltd (Thailand), part of the Yeh Group. The polyester textile producer will become the first textile mill to implement the commercial-scale supercritical fluid CO_2 machine into production, branding the process as DryDye. Supercritical fluid CO_2 enables polyester to be dyed with modified disperse dyes. It causes the polymer fibre to swell, allowing the disperse dye to diffuse and penetrate the pore and capillary structure of the fibres. The viscosity of the dye solution is lower, making the circulation of the dye solutions easier and less energy intensive. This deep penetration also provides effective coloration of polymers. Furthermore, dyeing and removing excess dye can be carried out in the same vessel; and residue dye is minimal and may be extracted and recycled. Currently, the process is limited to dyeing of scoured polyester fabric run in batches of 100–150 kg, although DyeCoo and its partners are developing reactive dyes for cellulosics to be available for use in this process in the not too distant future.

www.dyecoo.com

Dyeing with CO_2

"When carbon dioxide is heated to above 31°C and pressurised to above 74 bar, it becomes supercritical, a state of matter that can be seen as an expanded liquid, or a heavily compressed gas. In short, above the critical point, carbon dioxide has properties of both a liquid and a gas. In this way supercritical CO_2, has liquid-like densities, which is advantageous for dissolving hydrophobic dyes, and gas-like low viscosities and diffusion properties, which can lead to shorter dyeing times compared to water. Compared to water dyeing, the extraction of spinning oils, the dyeing and the removal of excess dye can all be carried out in one plant in the carbon dioxide dyeing process which involves only changing the temperature and pressure conditions; drying is not required because at the end of the process CO_2 is released in the gaseous state. The CO_2 can be recycled easily, up to 90% after precipitation of the extracted matter in a separator." To read more about supercritical fluid dyeing technology, read the paper by Bach *et al.* published in the SDC review journal in 2002 online at: www.wileyonlinelibrary.com/journal/cote.