ISSN: 0975-766X
CODEN: IJPTFI
Available Online through *Research Article*
www.ijptonline.com

BOOM OF WATERLESS DYEING IN CHINA – AN OVERVIEW

E.Priyadarshini*[1], E.Sharon Preethi[2]
[1]Sathyabama University, [2]Anna University.
Email: priyaeb@gmail.com

Received on 06-08-2016 *Accepted on 10-09-2016*

Abstract

Dyeing fabrics is the ecological problem faced by the fashion industry. It is one of the most water-intense parts of the supply chain and pollutes of the water which is involved in the process. The cost of waste water treatment will cause a prominent problem in the future as it does today. In China waters, seventy two toxic chemicals originates solely from the textile dyeing industry. Waterless dyeing companies say their technologies have resulted in a significant reduction in water use and pollution in China. China's textile dyeing industry has caused the opening of clothing factories by major international corporations in the last decade. That shift also outsourced the water pollution problem. In this paper, a comparative study has been done between routine dyeing and waterless dyeing in China and the various textile manufacturers equipping waterless dyeing in China.

Keywords: Super Critical carbon, Drydye, Zero liquid discharge.

1. Introduction

Every year, the global industry uses about trillions of liters of fresh water along with an enormous amount of chemicals. The wastewater from the industry which is often untreated is dumped, into rivers that bring its toxic content to the sea spreading it around the globe. The textile dyeing sector in China produces and then discharges about 40 percent of all the dyeing chemicals which is used worldwide. To overcome this, new waterless dyeing technologies have been developed to reduce the vast quantities of pollution generated by textile dyeing. In recent times, three companies have each developed waterless dyeing technology. Two of them are AirDye and Color Zen which are American enterprises and the third one is a Dutch company, DyeCoo being used by one of its partners, Adidas. Although the three processes are very different from each other, the results are much the same. The use of water is cut to near-zero, sharply diminishing pollution. The amount of chemicals is reduced, while faster dyeing

cycles lead to a major drop in energy consumption. Despite these benefits, major questions remain as to whether these new technologies will enable the textile industry to reduce pollution.

Water has been used in dyeing the fabric for centuries, and textile firms have been reluctant in changing its views. New waterless dyeing machines also are expensive to install and the technologies can only be used only on certain kinds of cloth, such as polyester.

2. Waterless Dyeing

When carbon dioxide is heated to above 31°C and pressurised to above 74 bar, it becomes supercritical, a state of matter that is an expanded liquid, or it may be a heavily compressed gas. In other words, carbon dioxide has properties of both a liquid and a gas when it is above the critical point. Hence Supercritical CO_2, has liquid-like densities, which is beneficial in 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 be done in one plant in the carbon dioxide dyeing process involving only changes in the temperature and pressure conditions; At the end of the process CO_2 is released in the gaseous state for which drying is not required.. The carbon- di- oxide which is obtained can then be recycled easily, after precipitation up to 90% of the extracted matter in a separator.

3. China's textile dyeing industry

China’s textile dyeing industry has been booming in last decades as various major international corporations opened clothing factories there. This shift has taken care of the water pollution problem. Since the price of clothing imported to the United States in the last decades had dropped 25%, the textile mills of Asia slashed costs by discharging untreated waste water into rivers. This in turn resulted in severe land and water pollution in and around textile industries. Apart from dye houses, the industrial belt along major Chinese rivers like the Yangtze and the Pearl includes petroleum refineries, chemical plants, metal smelters, nuclear fuel processing plants, and electric equipment producers.

4. Hazardous Pollutants in textile dyeing

The need to reform the textile-dyeing industry is urgent, especially in China, Bangladesh, India, Vietnam, and Thailand. China’s textile industry discharges about 2.5 trillion liters of wastewater into its rivers annually. Among these wastes are many hazardous chemicals — tributyltin (TBT), pentabromodiphenyl ether (PBDE), phthalates, perfluorooctane sulphonate (PFOS), and aniline — that are banned or strictly regulated in other countries because

they are toxic, persistent, bio-accumulative, hormone disruptive, and can cause cancer. The dyeing industry makes the cloth beautiful but in turn makes the clean water black.

5. Super Critical Carbon

A supercritical fluid can be defined as a substance above its critical temperature and pressure. Under this conditions the fluid has unique properties, in that it does not condense or evaporate to form a liquid or a gas. It has been observed that the supercritical state exists at temperature and pressure conditions above the so-called critical point. As the critical point of a substance is approached, its isothermal compressibility tends to infinity. Correspondingly, the specific volume or density of the substance changes dramatically. In the critical region, a substance that is a gas at normal conditions exhibits liquid-like density and an increased solvent capacity. This behaviour occurs because increase in density decreases mean intermolecular distance resulting in an increase in the number of interactions between the solvent and solute. Even though liquid like densities are observed for supercritical fluids, other properties are similar to those of gases.

The application of SCFs, especially supercritical carbon dioxide (SC-CO_2), in the textile industry has recently become an alternative technology for developing a more environmentally friendly dyeing process. Carbon dioxide, has so far been the most widely used, because of its convenient critical point (Tc=31◦C and Pc=74 bar), cheapness, chemical stability, non-flammability, stability in radioactive applications and non-toxicity. On account of its solvating ability towards nonpolar or slightly polar organic molecules in the supercritical phase, CO_2 can be used to transport disperse dyes to polyester fibres, without having to use the traditional aqueous medium, thus avoiding pollution problems. Since polyester fibres typically have a very compact structure and high crystallinity, the choice of dyes for them is limited to the disperse dye range

6. Advantages of using waterless dyeing

DyeCoo's machines use carbon dioxide, which is heated and heavily compressed so it becomes supercritical, a state between a gas and a liquid. It then acts as a solvent and a solute at the same time. As a result, color pigments penetrate much more quickly into textile fibers and no chemicals or salts are needed. Since the dyeing time is cut in half and fabric comes dry out of the machine, energy use is reduced by 50 percent. Also there was no wastewater discharge. After each batch is dyed, only a handful of residue remains, consisting mainly of color pigments and oil About 95 percent of the carbon dioxide can be recycled and used again in the machines, said Mommaal. Using less energy and chemicals means that, in the end, the DyeCoo process brings production costs down by about 30 to 50

percent, the company says. At the moment, the Yeh Group in Thailand is using DyeCoo's machines to produce clothes for Adidas, and Far Eastern New Century in Taiwan utilizes these machines to manufacture clothes for Nike. AirDye has taken a different direction. Its cloth is no longer dipped in the traditional bath filled with water and dye, but put into printing machines. Pressure and heat are used to transfer specially formulated dyes from paper onto polyester fabric. The molecule of the dye is attached to the molecule of the fiber, which gives a more lasting color. This process is faster than the traditional one and also uses 95 % less water and 86 % less energy according to AirDye. ColorZen has developed a method that changes the molecular composition of cotton fibers, making it more receptive to dye. After treatment, the dyeing process uses 90% less water, 95 % fewer chemicals, 75 % less energy, and half as much dye as conventional processes, according to the company. The adoption of waterless dyeing technologies is facing some daunting hurdles. ColorZen has one location in China, which means that companies have to transport their fibers to this facility, have it treated, and then transported to a yarn plant to have it spun.

7. Conclusion

Waterless dyeing companies say their technologies have resulted in a significant reduction in water use and pollution. Last year, Adidas announced that by using one million yards of DryDye fabric, the company was able to save 25 million liters of water. Still, these savings are just a small fraction of the estimated annual 6 trillion liters of fresh water currently used by the global textile industry. For waterless dyeing technology to be widely adopted, the price of the dyeing machines must come down substantially One hurdle is the expense of waterless dyeing machines, which can cost up to $4 million apiece. The dye industry is typically a very low-margin industry, which is unfortunate because now the only way to make money is to abuse the environment. The strategy adopted by China can be adopted by other developing countries like India in order to overcome water pollution caused by dyeing industry. Increasing consideration of ecological consequences of industrial processes as well as legislation enforcing the avoidance of environmental problems have caused a reorientation of thinking and promoted projects for replacement of conventional technologies. Though waterless dyeing has economic threats, it is very good option compared to the regular dyeing.

8. References

1. Ozcan, A.S., Clifford, A.A., Bartle, K.D. and Lewis D.M., Dyeing of Cotton Fibres with Disperse Dyes in Supercritical Carbon Dioxide, Dyes and Pigments, Vol.36, No.2, 103-110, 1998.
2. Dyeing in Supercritical Carbon Dioxide, (http://www.geocities.com.htm).

3. Montero, G.A., Smith, C.B., Hendrix, W.A. and Butcher, D.L., Supercritical Fluid Technology in Textile Processing: An Owerview, Ind. Engineering Chemical Research, Vol.39, No.12, 4806-4812, 2000.
4. Dyeing Textiles with Supercritical Carbon Dioxide: A Non-Aqueous Dyeing System, (http://www.techexchange.com).
5. Hendrix, W.A., Progress in Supercritical CO2 Dyeing, Journal of Industrial Textiles, Vol. 31, No.1, 43-55, July 2001.
6. Devrent Nalan, Waterless Dyeing [Review], Annals of The University Of Oradea Fascicle Of Textiles, Leatherwork, pp 23-26, 2015.

Corresponding Author:
Dr.E.Priyadarshini[1]
Email: priyaeb@gmail.com