American Journal of Environmental Science and Engineering
2017; 1(3): 64-67
http://www.sciencepublishinggroup.com/j/ajese
doi: 10.11648/j.ajese.20170103.11

Review Article

Health and Environmental Impacts of Dyes: Mini Review

Mohamed A. Hassaan*, Ahmed El Nemr

Marine Environment Division, National Institute of Oceanography and Fisheries, Alexandria, Egypt

Email address:
mhss95@mail.com (M. A. Hassaan)
*Corresponding author

To cite this article:
Mohamed A. Hassaan, Ahmed El Nemr. Health and Environmental Impacts of Dyes: Mini Review. *American Journal of Environmental Science and Engineering*. Vol. 1, No. 3, 2017, pp. 64-67. doi: 10.11648/j.ajese.20170103.11

Received: March 10, 2017; **Accepted**: April 8, 2017; **Published**: May 18, 2017

Abstract: The textile industry is one of the important industries which generates large amount of industrial effluents each year causing the main source of water pollution which is not only harmful for aquatic life but also mutagenic to human. The aim of this work is to give an overview on the health and environmental impact of dyes as pollutants as well as; the most recent treatment techniques of textile effluents wastewater.

Keywords: Dyes Production, Textile Industry, Environmental Impacts, Health Impacts, Treatment Techniques

1. Introduction

The dye manufacturing industry represents a relatively small part of the overall chemical industries. In the world-wide production of dyes is nearly 800,000 tons per year. About 10-15% of synthetic dyes are lost during different processes of textile industry. Synthetic dyes are valuable in numerous industries such as textile, paper printing, food, pharmaceutical, leather and cosmetics. It is classified into acid, reactive, direct, basic, vat, disperse, metal complex, mordant and sulphur dyes. There are more than 10,000 dyes used in textile Manufacturing alone nearly 70% being azo dyes which is complex in structure and synthetic in nature [1-5]. A major source of colour release into the environment is associated with the incomplete exhaustion of dyes onto textile fibre from an aqueous dyeing process and the need to reduce the amount of residual dye in textile effluent has become a major concern in recent years. [1-5].

2. Health and Environmental Impact of Dyes

There is no proof to suggest that most of the dyestuffs at present used in textile dyeing and finishing are risky to human health at the levels of exposure that workers generally face in the factories. However, with long-term or accidental over exposure, there can be likely health hazards and all dyes and chemicals must consequently be treated with care. The most common hazard of reactive dyes is respiratory problems due to the inhalation of dye particles. Sometimes they can affect a person's immune system and in extreme cases this can mean that when the person next inhales the dye their body can react dramatically. This is called respiratory sensitization and symptoms include itching, watery eyes, sneezing and symptoms of asthma such as coughing and wheezing [1].

Perhaps the most predominant health problems related to dyeing and finishing processes arise from exposure to chemicals acting as irritants. These may cause skin irritation, itchy or blocked noses, sneezing and sore eyes. They include formaldehyde-based resins, ammonia, acetic acid, some shrink-resist chemicals, some optical whiteners, soda ash, caustic soda and bleach. Certain reactive, vat and disperse dyes are also recognized as skin sensitive [2].

Textile industries produce large amounts of liquid wastes. These textile effluents contain organic and inorganic compounds [3]. During the dyeing processes, not all dyes that are applied to the fabrics are fixed on them and there is always a portion of these dyes that remains unfixed to the fabrics and gets washed out. These unfixed dyes are found to be in high concentrations in textile effluents [4].

The amount of water consumed and released also varies depending on the type of fabrics produced [5]. Almost 0.08 –

0.15 m^3 of water is used to produce 1 kg of fabrics. It is estimated that about 1,000 – 3,000 m^3 of water is let out after processing about 12 – 20 tons of textiles per day [6]. These effluents are rich in dyes and chemicals, some of which are non-biodegradable and carcinogenic and pose a major threat to health and the environment. Several primary, secondary and tertiary treatment processes like flocculation, trickling filters and electrodialysis have been used to treat these effluents.

However these treatments are not found effective against the removal of all dyes and chemicals used [7, 8]. The effluents do not only contain high concentration of dyes used in the industry, but also contain the chemicals used in the various processing stages. Some trace metals such as Cr, As, Cu and Zn are present in these effluents and are capable of causing several health problems including haemorrhage, ulceration of skin, nausea, severe irritation of skin and dermatitis. Textile effluents are also found to contain other organic and microbial impurities [9, 10].

The usage of cotton has been increasing constantly throughout the past century [11]. Cotton fibres are mainly dyed using azo dyes which are one of the largest groups of synthetic colorants used in the industry [12]. Azo dyes are difficult to degrade by the current conventional treatment processes. They are characterized by the presence of the nitrogen-nitrogen bond (-N=N-) in the center and hence they are highly electron deficient [13].

These azo dyes are found to be complex in nature and have been found to show carcinogenic evidences on reductive cleavage. These dyes are capable of altering the physical and chemical properties of soil, deteriorating water bodies and causing harm to the flora and fauna in the environment [14-21]. It was observed that the toxic nature of dyes causes death to the soil microorganisms which in turn affect the agricultural productivity [22].

The presence of very small amount of Azo dyes in water (<1ppm) are highly visible [23]. This affects aesthetic merit, transparency and water-gas solubility. Reducing light penetration through water decreases photosynthetic activity, causing oxygen deficiency and de-regulating the biological cycles of aquatic biota [24]. Many Azo dyes are also highly poisonous to the ecosystem and mutagens, meaning they can have acute to chronic effects upon organisms, depending on exposure time and Azo dye concentration.

1,4-diamino benezene is an aromatic amine whose parent azo dyes can cause skin irritation, contact dermatitis, chemosis, lacrimation, exopthamlmose, permanent blindness, rhabdomyolysis, acute tubular necrosis supervene, vomiting gastritis, hypertension, vertigo and, upon ingestion, oedema of the face, neck, pharynx, tongue and larynx along with respiratory distress [25]. Aromatic amines can be mobilised by water or sweat, which encourage their absorption through the skin and other exposed areas, such as the mouth. Absorption by ingestion is faster and so potentially more dangerous, as more dye can be absorbed in a smaller time frame [26]. Water soluble Azo dyes become dangerous when metabolized by liver enzymes.

3. AOPs of Wastewater Treatment

The necessity to restore water for new uses makes purification of wastewater almost crucial to attain a preferred degree of quality. To this end, other suitable wastewater treatment technologies have to be studied. Hence, removing the dye contents from effluents before disposal is paramount. There are several techniques for the treatment of effluents, such as incineration, biological treatment, absorption onto solid matrices, etc. However, these techniques have their drawbacks, such as the formation of dioxins and furans, caused by incomplete combustion during incineration; long periods for biological treatment to have an effect, as also the adsorptive process, that is based on the phase transfer of contaminants without actually destroying them [27, 28]. An important class of technologies named Advanced Oxidation Processes (AOPs) has emerged as suitable for accelerating the oxidation and destruction of a wide range of organic contaminants in polluted water [29]. Advanced oxidation processes (AOPs) were developed to generate hydroxyl free radicals using different oxidants under different combinations and these radicals were found to destroy components that are not destroyed under conventional oxidation processes [6, 30].

AOP using ozone (O_3), ultra violet (UV), TiO_2, fenton, photo-fenton, hydrogen peroxides (H_2O_2) and ultrasonic (US) can be used to treat dyes. The main advantage of AOPs over the other treatment processes is its pronounced destructive nature which results in the mineralization of organic contaminants present in wastewater [6]. Also, AOPs are considered as a low or non-waste generation technology, which destroys the complex structures using short lived chemical species with a high oxidation power. The hydroxyl radical (.OH) is the main oxidative power of AOPs [30, 31]. The .OH radicals can be generated by chemical, electrical, mechanical or radiation energy. Therefore, AOPs are classified under chemical, catalytic, photochemical, photocatalytic, mechanical and electrical processes [32].

4. Conclusion

It was reported that the synthetic textile dyes exhibited a great group of organic compounds that could have detrimental impacts on the environment, as well as, some of them can cause hazards to humans. The growing complication and struggles in treating textile wastes has led to a continuous examination for new approaches that are applicable and economically feasible. However, till now, there is no very highly effective technique capable of complete removal of both the color and the toxic properties of the dyes released into the environment.

References

[1] Hassaan, M. A. 2016. Advanced oxidation processes of some organic pollutants in fresh and seawater, PhD, A Thesis, Faculty of Science, Port Said University, 180 P.

[2] Health and Safety Executive, HSE (2016). Dyes and chemicals in textile finishing: An introduction. Dyeing and Finishing Information Sheet No 1- HSE information sheet. (accessed 2016.10.10).

[3] Elliott, A., Hanby, W and Malcolm, B. (1954). The near infra-red absorption spectra of natural and synthetic fibres. Br. J. Appl. Phys., (5): 377.

[4] Hassaan, M. A. and El Nemr, A., Advanced Oxidation Processes for Textile Wastewater Treatment, International Journal of Photochemistry and Photobiology. Vol. 2, No. 3, 2017, pp. 85-93.

[5] Ananthashankar, R. 2012. Treatment of textile effluent containing reactive red 120 dye using advanced oxidation, M. Sc, A Thesis, Dalhousie University, Halifax, Nova Scotia, 145 P.

[6] Kdasi, A., Idris, A., Saed, K and Guan, C. (2004). Treatment of textile wastewater by advanced oxidation processes: A review. Global Nest. Int. J., 6 (3): 222-230.

[7] Eswaramoorthi, S, Dhanapal, K. and Chauhan, D. (2008). Advanced in textile waste water treatment: The case for UV-ozonation and membrane bioreactor for common effluent treatment plants in Tirupur, Tamil Nadu, India. Environment with People's Involvement & Co-ordination in India. Coimbatore, India.

[8] Hassaan, M. A., El Nemr, A., and Madkour, F. F. (2016c). Application of Ozonation and UV assisted Ozonation for Decolorization of Direct Yellow 50 in Sea water, The Pharmaceutical and Chemical Journal, ISSN: 2349-7092, Volume 3 Issue 3 2016, Page No. 131-138.

[9] Nese, T., Sivri, N. and Toroz, I. (2007). Pollutants of textile industry wastewater and assessment of its discharge limits by water quality standards. Turkish J., 7: 97-103.

[10] "http://www.fibre2fashion.com/industry-article/4434/pollution-and-its-control-in-textile-industry" accessed on 20th March 2017.

[11] UNCTAD (2003). Major uses of cotton fibres. United Nations Conference on Trade and Development, Updated on Oct 2003.

[12] Mohan, V., Rao, C. and Karthikeyan, J. (2002). Adsorptive removal of direct azo dye from aqueous phase onto coal based sorbents: A kinetic and mechanistic study. Journal of Harzardous Materials, 90 (2): 189-204.

[13] Robert, L., Joseph, F. and Alexander, A. (2008). Fisher's contact dermatitis in: Textiles and shoes. BC Decker Inc., Ontario, p.339-401.

[14] Manu, B. (2003). Decolourization of indigo and azo dye in semicontinous reactors with long hydraulic retention time. PhD thesies submitted to IIT Bombay, India.

[15] Hassaan, M. A., El Nemr, A., and Madkour, F. F. (2017). Advanced Oxidation Processes (AOPs) for Wastewater Treatment. Lambert Academic publishing, Editor: Scole, e-book [ISBN: 978-3-330-03170-8]. pp. 202.

[16] Hassaan, M. A., El Nemr, A., and Madkour, F. F. (2016a). Testing the advanced oxidation processes on the degradation of Direct Blue 86 dye in wastewater. Egyptian Journal of Aquatic Research (2016), http://dx.doi.org/10.1016/j.ejar.2016.09.006.

[17] Hassaan, M. A., El Nemr, A., and Madkour, F. F. (2016b). Advanced oxidation processes of Mordant Violet 40 dye in freshwater and seawater. Egyptian Journal of Aquatic Research (2016), http://dx.doi.org/10.1016/j.ejar.2016.09.004.

[18] Hassaan, M. A., El Nemr, A., and Madkour, F. F. (2015). Ultraviolet assisted ozone degradation process of Acid Red 17 dye. Fifth International Conference on Aquatic Resources ICAR-15 "Challenges, Development and Sustainability".

[19] Hassaan, M. A., El Nemr, A., and Madkour, F. F. (2016d). Color removal and detoxification of chrysophenine G (Direct Yellow 12) using ultraviolet assisted ozone degradation for possible water reuse. The International Conference on Biotechnology and Environment, organized by Alexandria University, Egypt; and University of Leeds, United Kingdom held on 1-3 November 2016, Alexandria, Egypt.

[20] Hassaan, M. A., El Nemr, A., and Madkour, F. F. (2016e). Examination of advanced oxidation processes on decolorization of Direct Blue 86 dye in two different wastewaters. The International Conference on Biotechnology and Environment, organized by Alexandria University, Egypt; and University of Leeds, United Kingdom held on 1-3 November 2016, Alexandria, Egypt.

[21] Hassaan, M. A., El Nemr, A., and Madkour, F. F. (2016f). Removal of Mordant Violet 40 Dye from wastewater using UV/O3 Advanced oxidation Processes. The International Conference on Biotechnology and Environment, organized by Alexandria University, Egypt; and University of Leeds, United Kingdom held on 1-3 November 2016, Alexandria, Egypt.

[22] Savin, I. and Butnaru, R. (2008). Wastewater characteristics in textile finishing mills. Environmental Engineering and Management Journal, 7(6): 859-864.

[23] Chung, K. T. (1983) The significance of azo-reduction in the mutagenesis and carcinogenesis of azo dyes. Mutat Res. 114(3):269-81.

[24] Apostol, L. C., Pereira, L., Pereira, R., Gavrilescu, M., Alves, M.M. (2012) Biological decolorizartion of Xanthene dyes by anaerobic granular biomass. Biodegradation DOI: 10.1007/s10532-012-9548-7.

[25] Report by LGC (1999) The risk of cancer caused by textiles and leather goods coloured with azo dyes. Presented, CSTEE plenary meeting, Brussels.

[26] Puvaneswari, N., et al. (2006) Toxicity assessment and microbial degradation of azo dyes. Indian journal of experimental biology 44(8): 618.

[27] Babel S, Kurniawan TA. Low-cost adsorbents for heavy metals uptake from contaminated water: a review. Journal of Hazardous Materials. 2003; 97(1-3) 219-243.

[28] Associação Brasileira da Indústria Têxtil e de Confecção. Economia. <http://www.abit.org.br/site/navegacao.asp?id_menu=8&IDIOMA=PT> (accessed 19 August 2011).

[29] Glaze, W. H., Kang, J. W. and Chapin, D. H. (1987). The chemistry of water treatment processes involving ozone, hydrogen peroxide and ultraviolet radiation. Ozone Sci. & Eng, 9: 335-342.

[30] Arslan, I., Balcioglu, A. and Tuhkanen, T. (1999). Oxidative treatment of simulated dyehouse effluent by UV and near-UV light assisted fenton`s reagent. Chemosphere; 39(15).: 2767-2783.

[31] Kestioglu, K., Yonar, T. and Azbar, N. (2005). Feasibility of physico-chemical treatment and advanced oxidation processes (AOPs) as a means of pretreatment of olive mill effluent (OME). Process Biochemistry, 40 (7): 2409-2416.

[32] Chung, K. T., Stevens, S. E. J. and Cerniglia, C. E. (1992). The reduction of azo dyes by the intestinal microflora. Critical Reviews in Microbiology, 18: 175-97.