International Journal of Scientific Research and Management (IJSRM)
||Volume||10||Issue||06||Pages||B-2022-199-202||2022||
Website: www.ijsrm.in ISSN (e): 2321-3418
DOI: 10.18535/ijsrm/v10i6.b1

Biodegradation of Textile Effluent using Plants and Algae

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Abstract
Increasing globalization causes different environmental pollution. Out of pollution caused by various industries such as textile, dyeing and printing, paper, pulp, plastics, food, cosmetics and pharmaceuticals. Textile effluent causes one of the major environmental problems. The effluent from textile industries poses a threat to the environment, due to the presence of various pollutants. Different types of dyes used in the textile industry usually have a synthetic origin and complex aromatic molecular structures which make them more stable and more difficult to degrade. The complex textile effluent can be biodegraded by algae (bioremediation) and various plants (phyto remediation) reduce the complex pollutants into detoxified smaller compounds.

Keywords: Effluent, Degradation, Algae, Phyto-Remediation.

Introduction

The process of converting raw fibers into finished apparel and non-apparel textile products comprises a diverse and fragmented group of establishments that produce textile related products (fiber, yarn and fabrics) for further processing into apparels [Allegre *et al*., 2006]. The water requirement for textile processing is large and varies, which depends on the factors like source of water and its availability, the quantity and quality of fabrics produced, types of processing and its sequence. For the production of one meter of finished cloth the water consumption is in the range of 12-65 liters. [Bharathi and Ramesh, 2013] [Kant, 2012].The textile indusrties consumes more water and also generates very large volumes of contaminated waste water nothing but the effluent which consists lots of waste materials such as knits, cotton, dust, colour dye, yarn, threads and other textile wastes. Among the various wastes the colouring dye are the most serious to the environment. The dye molecules are complex in structure and difficult to degrade. Several methods are available to degrade the dye molecules present in the effluent such as physical, chemical and biological methods [Krishnakumari and Thangavel, 2017]. This article mainly focus on degrading such tough dye molecules by biological methods using plants and algae.

Remediation of Textile Dyes and Effluent

In order to reduce the risk of environment pollution from effluents, it is necessary to treat them before discharging it into the environment [Ghaly *et al*., 2014]. The effluents are diverse in chemical nature and hence are difficult to treat by conventional procedures [Kamat and Kamat, 2015]. In fact, treatment like chlorination have been found to be inappropriate as they release mutagenic products from relatively less harmful dyes conventional treatment methods are not effective for most of the synthetic dyestuffs due to complex poly aromatic structure and recalcitrant nature of dyes. [Krishnakumari and Thangavel, 2017; Rahman *et al*., 2013]

Broadly, methods fall under following three categories, Physical method, Chemical method and Biological method [Joshi *et al*., 2004]. The physical and chemical methods have their own advantages and disadvantages [Bharathi and Ramesh, 2013] [Jolly and Islam, 2009] [Ahmad *et al*., 2012]. Among these methods the biological methods have gained much attraction towards remediation of textile effluent because of its advantages over the pollution [Ashfaq and Khatoon, 2014]

Advantages of Biological Remediation

- Bacteria, fungi, algae and plants are effectively can transform various toxic chemicals present in the textile effluent into less harmful forms, known as detoxification.
- Environmental friendly
- Low cost effective with wide attention
- Microbes can tolerate high concentration of toxicants
- Microbes can operate in a wide pH range, moderate temperature
- Efficient in removing colour, BOD, COD.
- Efficient in removing dyes from large volumes at a low cost
- Producing less quantity of sludge
- Yielding end products that are non-toxic or have complete mineralization
- Require less water consumption compared to physic-chemical methods

Effluent Biodegradation by Algae

Photosynthetic organisms, such as cyano bacteria or algae, have ubiquitous distribution and are observed in many habitats around the world, and are receiving increasing attention in the field of wastewater decolorization [Ansari *et al*., 2014]. A survey of the literature suggests that algae are capable of degrading azo dyes through an induced form of an azo-reductase. [Selim *et al*., 2015] [Ahmad *et al*., 2012] [Allegre *et al*., 2006]. The degradation by algae is by three different mechanisms,

(a) Assimilative utilization of chromophores for the production of algal biomass,CO_2 and water
(b) Transformation of coloured dye molecules to colourless one.
(c) Adsorption of chromophores on algal biomass.

Several species of *Chlorella sp* and *Oscillatoria sp* are capable of degrading azo dyes to their aromatic amines and can further metabolize the aromatic amines into simpler organic compounds or CO_2[Mozumder and Islam, 2010]. It attributes the decolorization to biosorption followed by bioconversion and biocoagulation using algae [Joshi *et al*., 2004]. It has been reported that more than 30 azo compounds can be biodegraded and decolorized by *Chlorella pyrenoidosa, Chlorella vulgaris and Oscillateria tenuis*, with the azo dyes decomposed into simpler aromatic amines [Mozumder and Islam, 2010] [Ali *et al*., 2009]. Thus the foregoing results could mean that algae can play an important role in the removal of azo dyes and aromatic amines in stabilization ponds. This bio sorption process could be adopted as a cost effective and efficient approach for decolouration of effluents and it may be a viable alternative to more costly materials [Bayoumi *et al*., 2014] [Lavanya *et al*., 2014]

List of Algae involved in Biodegradation (Ahmad *et al*., 2012; Mozumder and Islam, 2010)

Algae such as *Chlorella pyrenoidosa, Chorella vulgaris, Oscillatoria tenuis, Gloeocapsa pleurocapsoide, Chroococcus minutes, Anabaena flos-aquae* UTCC64, *Oscillatoria angusta, Synechococcus sp*. PCC7942, *Scenedesmus bijuga, Scenedesmus obliquus, Nostoc muscourm and Phormidium autumnale* UTEX1580 are some examples which effectively involved in degradation of various dye molecules.

Effluent Biodegradation by Plants (Phyto-remediation)

It's an emerging technology with effective and inexpensive approach for the remediation of soils and ground water contaminated with heavy metals and organic pollutants [Ghaly *et al*., 2014]. The main advantages are it's an autotrophic system with a large biomass that requires little nutrient input, it's easier to manage and environmental sustainable [Idris *et al*., 2007]. The colour reduction 72-77% was observed in wetlands vegetated with cocoyam plants [Ahmad *et al*., 2012] [Mansour *et al*., 2012]. An herb *Blumea malcommi* was found to degrade textile dye (RR 5B) [Bharathi and Ramesh, 2013]. Hairy root cultures of marigold *Tagetes patula* L are effectively decolourize the dye RR198 [Jolly and Islam, 2009]. In large scale application, have to be consider, the level of pollutants tolerated by plants bio available fraction of the contaminants and evaporation of volatile organic pollutants, requiring large areas to implant the treatment. [Kamat and Kamat, 2015]

List of Plants involved in Biodegradation (Selim *et al*., 2015; Ahmad *et al*., 2012; Mozumder and Islam, 2010)

Plants such as *Brassica juncea, Ipomea palmate, Sorghum vulgare, Saccharum spontaneum, Phaseolus mungo, Medicago sativa L., Moringa oleifera, Sesbania cannabina Pers, Blumea malcolmii , Aloe barbadensis* involved in biodegradation of dye molecules.

Conclusion

The textile effluent consists of toxic compounds such as unused dye molecules, salts and solid wastes etc. which are very difficult to degrade. Among various ancient methods the biological methods were gained importance towards the environmental cleanliness and leads to the increased biodegradation rate when compared to the other methods. Especially plants and algae involved in the biodegradation of the toxic, complex compounds to non toxic, simpler molecules. The use of plants in the process of biodegradation of effluents was considered to be beneficial, low cost effective, easy to cultivate and effective degradation rate. In similar way, the cultivation of algae is a simpler method and the cell culture maintenance also easier and low cost. In recent decades the use of plants and algae in the degradation of the environmental pollution are gained importance due to their advantages and successive degradation rate.

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