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International Journal of Current Research
Vol. 9, Issue, 01, pp.44619-44622, January, 2017

INTERNATIONAL JOURNAL OF CURRENT RESEARCH

ISSN: 0975-833X

RESEARCH ARTICLE

DYE REMOVAL STUDIES WITH IONIC LIQUIDS 1-ETHYL-3-METHYL IMIDAZOLIUM LACTATE & 2-HYDROXYETHYL-TRIMETHYL AMMONIUM L+LACTATE

[1]Priyanka Yadav, [1]Jyoti Dahiya, [1]Kanishk Bhardwaj, [1]Ravleen Kaur, [2]Ranjana Saxsena, [3]Hema Banati, *,[1]Aruna Chhikara and *,[1]Amita Malik

[1]Department of Chemistry, Dyal Singh College, University of Delhi, Lodhi Road, New Delhi 110003, India
[2]Department of Zoology, Dyal Singh College, University of Delhi, Lodhi Road, New Delhi 110003, India
[3]Department of Computer Science, Dyal Singh College, University of Delhi, Lodhi Road, New Delhi 110003, India

ARTICLE INFO

Article History:
Received 19th October, 2016
Received in revised form
23rd November, 2016
Accepted 10th December, 2016
Published online 31st January, 2017

Key words:
Ionic liquid, Dye, extraction.

ABSTRACT

Textile industries are major source of water pollution, dyestuffs have proven to be problematic as these are most difficult to treat and recover the dye. These dye effluents are discharged in millions of gallons from different textile mills world over. These are known to affect the environment adversely reducing the dissolved oxygen thus affecting the aquatic life. Conventional treatment techniques involve physical, chemical and biological methodologies. These are not full-proof and thus new techniques are required to improve the efficiency of dye removal. Ionic liquids have been reported to be novel solvents for carrying out liquid –liquid extractions. The asymmetric cations with different combinations of anions can be explored for the removal of dye from the generated textile effluents. These could provide possible solutions to overcome this problem of textile industry.

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Citation: Priyanka Yadav, Jyoti Dahiya, Kanishk Bhardwaj, Ravleen Kaur, Aruna Chikkara, Amita Malik, Ranjana Saxena and Hema Banati, 2017. "Dye removal studies with ionic liquids 1-ethyl-3-methyl imidazolium lactate &2-hydroxyethyl-trimethyl ammonium l+lactate", *International Journal of Current Research*, 9, (01), 44619-44622.

INTRODUCTION

To meet the demands of a growing population, textile mills are increasing in size and number thus producing more dye-containing wastewaters. As of 2012, more than 100,000 different dyes existed worldwide, and between 700,000 and 1,000,000 tons were produced each year. The textile industry utilizes about 90% of all dyes, while there maining 10% are used in food, printing, and plastics. Approximately 280,000 tons of textile dyes are discharged through wastewater on a yearly basis worldwide. Textile industry has been the major cause of water pollution both in terms of quantity generated and difficulty of treatment. The dyes used are responsible for the increase in the COD levels of waste water and decrease in the dissolved oxygen levels thus affecting the aquatic life. Research on treatment of dye containing effluent has always been the topic of interest. New methodologies have been worked upon to develop full-proof technology for removal of dye and generate treated waters for use. (Pang and Abdullah, 2013; Wang *et al*., 2011) Various methods used to remove dyes from textile effluents include micellar enhanced ultrafiltration (Ahmad *et al*., 2006), oxidation processes using different oxidizing agents (Neamtu *et al*., 2004), electrochemical degradation (Martı'nez-Huitle and Brillas, 2009), ozone based processes (Zhang *et al*., 2009), photocatalytic degradation (Bali, 2004; Siboni *et al*., 2011; Li *et al*., 2001; Nagel-Hassemer *et al*., 2012), electrocoagulation (Purkait *et al*., 2003), nanofiltration (NF) (Zhong *et al*., 2012; Patel *et al*., 2012), adsorption on various surface which include agricultural solid waste (Namasivayam and Kavitha, 2002), different minerals like bentonites (Arvanitoyannis *et al*., 1989), activated carbon from different sources (Kannan and Sundaram,2001; Mezohegyi *et al*., 2012), and biological treatments (Khataee *et al*., 2010; Oller *et al*., 2011). The physical methods are non-effective and thus require secondary treatment coupled with them as they merely transfer the pollutants from one medium to another (Bes-Pia *et al*., 2003); chemical methods generate lots of sludge which involves additional cost of disposal; they are generally used in high dosage and thus not economically viable; (Kurbus *et al*., 2005). Ultrafiltration (UF) and nanofiltration (NF) have been reported for complete removal of all classes of dye, but certain limitations like membrane fouling have been reported. Due to low biodegradability of dyes, the conventional biological wastewater treatment processes like activated sludge are not very efficient in treating wastewater from textile industry (Muthuraman and Palanivelu, 2005). There are numerous technologies available, which are presently being applied for the extracting dye from waste water. Use

Corresponding author: Amita Malik and Aruna Chhikara,
Department of Chemistry, Dyal Singh College, University of Delhi, Lodhi Road, New Delhi 110003, India.

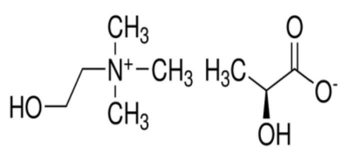
ionic liquids has not been widely used by many dye-consuming industries as only few researches have been carried out to provide sufficient proof on the effectiveness as well as versatility of ionic liquids for the purpose of dye removal. Based on the tailoring ability of ILs, either for the solvation of a wide array of compounds or for the extraction of the most diverse biomolecules from aqueous media (Taziki *et al*., 2012), the use of IL-based aqueous two phase systems to extract and remove dyes typically discharged by the textile industry is described in this work envisaging their potential application in the treatment of aqueous effluents. Recent publications reported the possibility of exploiting ILs in the extraction of dyes from water-rich phases (Gharehbaghi and Shemirani, 2012; Chen *et al*., 2013). Nevertheless, in these studies (Gharehbaghi and Shemirani, 2012; Chen *et al*., 2013), hydrophobic ILs, i.e. non water-miscible ILs at temperatures close to room temperature, were employed.

A number of studies have been conducted that examined the use of ionic liquids in the extraction of various dyes (Visser *et al*., 2000; Vijayaraghavan *et al*., 2006; Ali *et al*., 2006; Pei, 2007; Liand Xin, 2008; Fan *et al*., 2011). For these extractions to be viable, the dye components obviously must partition into the ionic liquid or organic layer, thus vacating the wastewater (aqueous layer). No mechanism of extraction was formally determined, but curiously, the researchers concluded that hydrophobicity of an ionic liquid has no effect on extraction efficiency. This seemingly contradicting study was conducted by Pei *et al*. in 2007. In this work, four different ionic liquids were used, including C4 mim PF6, 1-hexyl-3-methylimidazolium hexafluorophosphate (C6mimPF6), 1-hexyl-3-methylimidazolium tetrafluoroborate (C6mimBF4), and 1-octyl-3-methylimidazolium hexafluorophosphate (C8mimPF6). The anionic dyes used were methyl Orange, eosin yellow, and Orange G, and the extractions were performed over a wide range of pH values. It was observed that the ILs possessing longer alkyl chains were more efficient at extraction. Not much work has been reported on disperse dyes and direct dyes. In this paper the efficiency of removal has been compared with of two different classes of dye and two different ionic liquids. The cations of the ionic liquids are different and the anion is the same.

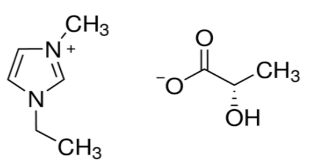
Experimental

A) Ionic liquids were procured from Sigma Aldrich. The ionic liquids used for the study are:

1. 2-Hydroxyethyl-trimethyl ammonium L+ lactate

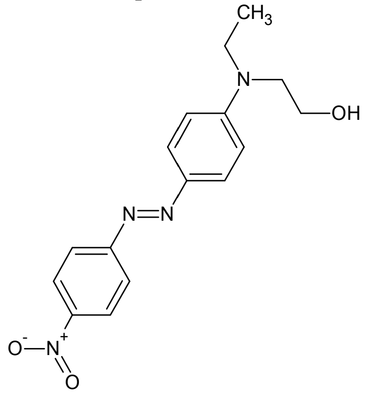


2. 1-Ethyl-3-methyl imidazolium lactate

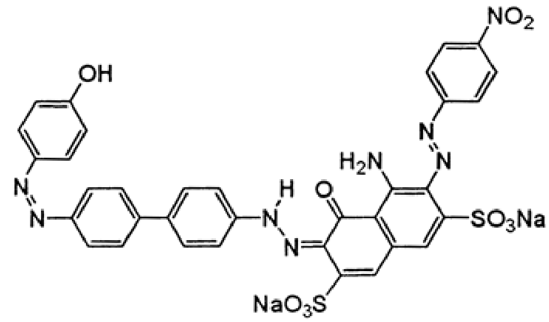


b) Dyes used for the study are: Disperse dye red-1and Direct dye Green-6

Disperse Red -1



Direct Green-6



The concentrations of dye and ionic liquid used for the study are 500mg/liter (500ppm) and 0.1% ionic liquid, respectively. The absorbance spectra for the dyes were noted using a Colorimeter- Systronics at different wavelengths to determine the λmax for the dye. Standard curves were plotted by taking the absorbance at the λmax for the different concentrations of the dye. The standard curve were used to determine the different concentration of the dye after treatment with the ionic liquid. The studies have been carried at different phase ratios of dye and ionic liquid. The ionic liquid volumes have been increased keeping the dye constant. The ratios of ionic liquid used for the study varied from 10 to 100 ml. The % efficiency of removal was calculated using the formula

$$\% efficiency = 1 \quad \frac{Cf}{Co}$$

Where, *Co* is initial concentration of the dye and *Cf* is the final concentration in ppm.

RESULTS AND DISCUSSION

The results of % removal of dyes with different ionic liquids are tabulated in Table-1. The %removal of disperse dye is lower in case of 2-Hydroxyethyl-trimethyl ammoniums L+ lactatewith higher volumes of ionic liquid while using lesser volume of ionic liquid, the % removal is much better as given in column three of Table1. However in case of direct dye, better removal has been observed with higher volumes of ionic liquid. And at lower ratios much less removal has been observed. The cation part of ionic liquid has a hydroxyl group which is probably causing different types of interactions with the dye. The interactions possible in case of direct dye are more as compared to the disperse dye. The disperse dye has a hydrophobic chain which may be responsible for such results. However, in case 1-ethyl-3-methylimidazolium-L(+)-lactate the cation part of the ionic liquid has no such polar groups.

Table 1. % Removal of dyes using different ionic liquids

No	Phase ratios (Dye:IL*)	2-Hydroxyethyl-trimethyl ammonium L+ lactate - (HL) (% Removal)		1-ethyl-3-methylimidazolium-L(+)-lactate (EL) (% Removal)	
		Disperse Dye	Direct Dye	Disperse Dye	Direct Dye
1	1:10	50	100	90	90
2	1:05	50	80	61	60
3	1:02	75	50	24	60
4	1: 01	75	20	15	20

*IL- Ionic Liquid

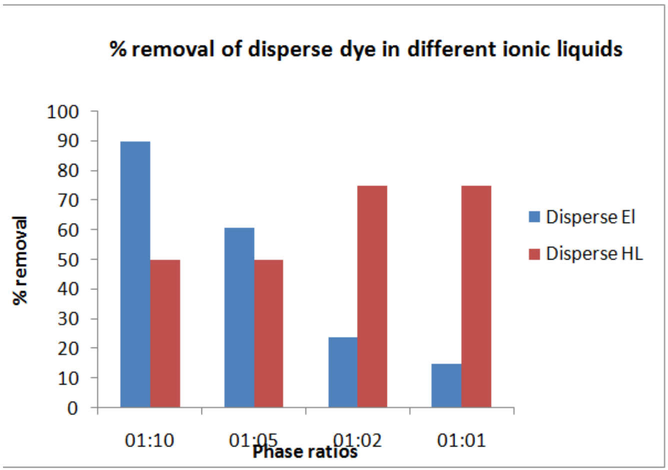


Fig.1. % Removal of Disperse dye in different ionic liquids

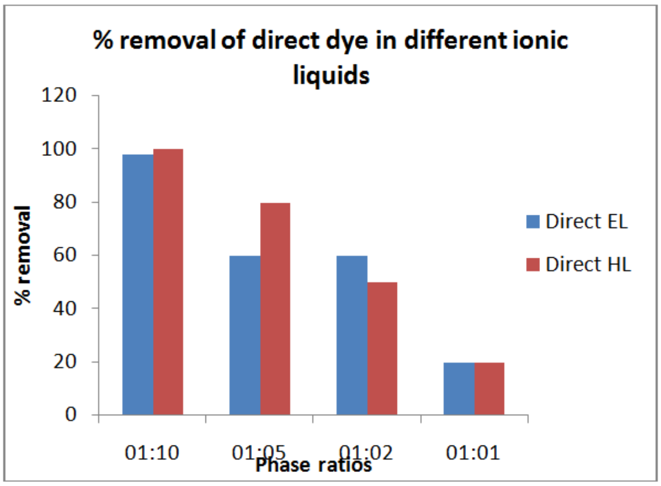


Fig.2. Effect of removal of direct dye with two different ionic liquids

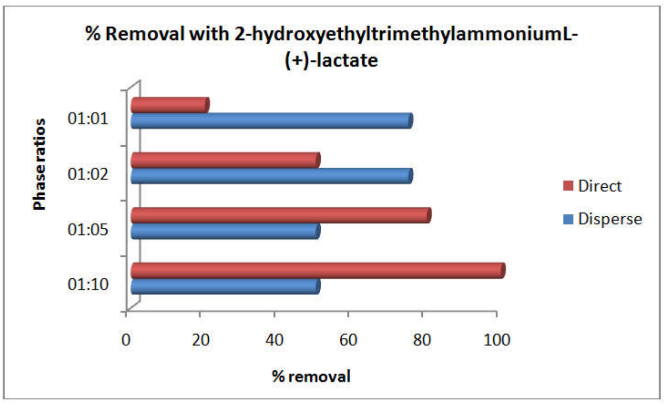


Fig.3. % removal of direct and disperse dye in 2-Hydroxyethyltrimethylammonium- L(+) Lactate

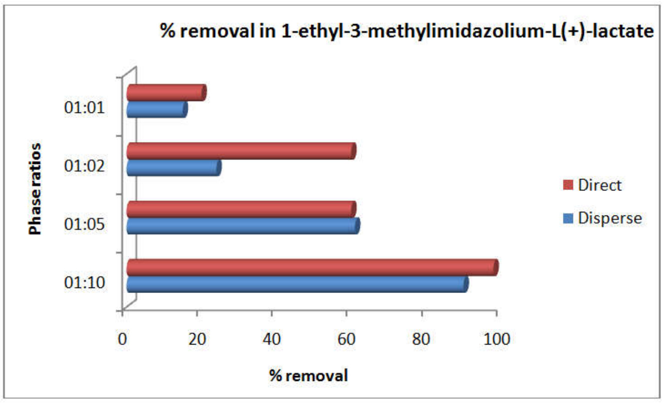


Fig.4. % removal of direct dye and disperse dye with 1-Ethyl-3-Methylimidazolium Lactate (+)

Thus the results observed are almost comparable. At lower ratios the removal is 15% in case of disperse dye and 20% in case of direct dye while at higher ratios 1:10 the removal is 90% in case of both disperse dye and direct dye, Figure1and Figure 2 present these results. Figure 3 and Figure 4 show the % removal of dye with two ionic liquids and dyes.

In 2-Hydroxyethyltrimethylammonium- L(+) Lactate, the removal of direct dye is better at higher ratios of ionic liquid and is better for disperse dye at lower ratios. However in case 1-ethyl-3-methylimidazolium-Lactate-L(+), overall better results have been observed with direct dye. Thus it can be concluded that the asymmetric cationic moiety of the ionic liquid has affected % removal along with type of dye being extracted.

Conclusion

Type of ionic liquid and quantity of ionic liquid affect the % dye removal. Cations in the ionic liquids have effect on the % removal of dye.

Acknowledgement

Our thanks are due to University of Delhi for the financial aid and the Principal, Dyal Singh College for providing infrastructure and continuous support for working on the project.

REFERENCES

Ahmad, A.L., S.W. Puasa, M.M.D. Zulkali, 2006. Micellar-enhanced ultrafiltration for removal of reactive dyes from an aqueous solution, Desalination 191, 153–161.

Ali, M., Sarkar, A., Pandey, M.D. and Pandey, S. 2006. “Efficient precipitation of dyes from dilute aqueous solutions of ionic liquids”. *Analytical Sciences*, 22, 1051-1053.

Arvanitoyannis, I., I. Eleftheriadis, E. Tsatsaroni, 1989. Influence of pH on adsorption of dye-containing effluents with different bentonites, Chemosphere, 18; 1707–1711.

Bali, U. 2004. Application of Box–Wilson experimental design method for the photodegradation of textile dyestuff with UV/H2O2 process, Dyes Pigm. 60;187–195.

Bes-Pia’ A., J.A. Mendoza-Roca, M.I. Alcaina-Miranda, A.Iborra-Clar, M.I. Iborra-Clar, 2003. Combination of physico-chemical treatment and nanofiltration to reuse wastewater of a printing, dyeing and finishing textile industry, Desalination 157; 3–80.

Chen, X. F. Li, C. Asumana, G. Yu, 2013. Extraction of soluble dyes from aqueous solutions with quaternary ammonium-based ionic liquids, *Sep. Purif. Technol*., 106 105–109.

Fan, J., Fan, Y., Zhang, S. and Wang, J. 2011. "Extraction of azo dyes from aqueous solutions with room temperature ionic liquids". *Separation Science and Technology,* 46, 1172-1177.

Gharehbaghi, M. and F. Shemirani, 2012. A novel method for dye removal: ionic iquid based despersive liquid–liquid extraction (IL-DLLE), CLEAN - Soil, Air, Water. 40, 290–297.

Kannan, N. and M.M. Sundaram, 2001. Kinetics and mechanism of removal of methylene blue by adsorption on various carbons, Dyes Pigm., 51; 25–40.

Khataee, A.R., G. Dehghan, A. Ebadi, M. Zarei, M.Pourhassan, 2010. Biological treatment of a dye solution by Macroalgae Chara sp.: effect of operational parameters, intermediates identification and artificial neural Network modeling, *Biores. Technol*., 101; 2252–2258.

Kurbus, T., Y.M. Slokar, A. Majcen, D.B. Vonˇcina, 2003. The use of experimental design for the evaluation the influence of variables on the H2O2/UV treatment of model textile wastewater, *Dyes Pigm*., 58; 171–178.

Li, C., and Xin, B. 2008. "Extraction and mechanisms of acid dyes into a room temperature ionic liquid". *2nd International Conference on Bioinformatics & Biomedical Engineering*, 3519-3522.

Li, Y.F., W.T. Chen, K. Qi, 2001. Experimental study on treatment of reactive gaudy red X-3B dye wastewater by immobilized Fe3+– TiO2 photocatalytic oxidation, *Adv. Mater. Res. J*., 332–334; 1594–1599.

Martı'nez-Huitle, C.A. and E. Brillas, 2009. Decontamination of wastewaters containing synthetic organic dyes by electrochemical methods: a general review, *Appl. Catal. B.Environ*., 87, 05–145.

Mezohegyi, G., F.P. van der Zee, J. Font, A. Fortuny, A.Fabregat, 2012. Towards advanced aqueous dye removal processes: a short review on the versatile role of activated carbon, *J. Environ. Manage*., 102, 148–164.

Muthuraman, K. Palanivelu, 2005. Selective extraction and separation of textile anionic dyes from aqueoussolution by tetra butyl ammonium bromide, Dyes Pigm. 64; 251–257.

Nagel-Hassemer, M.E., L.A. Coral, F.R. Lapolli, M.T.S.P.Amorim, 2012. Avaliac¸a˜o do Efeito do pH na Descolorac¸a˜o e Degradac¸a˜o do Corante CI Reactive Blue 182 Catalisada por UV/H2O2, Quim. Nova 35, 900–904.

Namasivayam, C. and D. Kavitha, 2002. Removal of Congo Red from water by adsorption onto activated carbon prepared from coir pith, an agricultural solid waste, Dyes Pigm. 54, 47–58.

Neamtu, M., A. Yediler, I. Siminiceanu, M. Macoveanu, A. Kellrup, 2004. Decolorization of disperse red 354 azo dye in water by several oxidation processes – A comparative study, Dyes Pigm.60, 61–68.

Oller, I., S. Malato, J.A. Sa' nchez-Pe' rez, 2011. Combination of advanced oxidation processes and biological treatments for wastewater decontamination—A review, *Sci. Total Environ*., 409;4141–4166.

Pang, Y.L. and Abdullah, A.Z. 2013. "Current status of textile industry wastewater management and research progress in Malaysia: A review". Clean Soil, Air, Water, 00 (0), 1-14.

Patel, T.M., T. Roy, A. Mishra, K. Nath, 2012. Reclamation of dye wastewater using a flat sheet nanofiltration membrane: study of permeate flux and quality, *J. Sci. Ind. Res*., 71; 437–442.

Pei, Y.C., Wang, J.J., Xuan, X.P., Fan, J., and Fan, M. 2007. "Factors affecting ionic liquids based removal of anionic dyes from water". *Environmental Science & Technology,* 41 (14), 5090-5095.

Purkait, M.K., S.D. Gupta, S. De, J.K. Basu, 2003. Nanofiltration of textile plant effluent for color removal and reduction in COD, *Sep. Purif. Technol*., 31;141–151.

Siboni, M.S., M. Samarghandi, J.K. Yang, S.M. Lee, 2011. Photocatalytic removal of reactive black-5 dye from aqueous solution by UV irradiation in aqueous TiO_2: equilibrium and kinetics study, *J. Adv. Oxid. Technol*., 14 302–307.

Taziki, M., F. Shemirani, B. Majidi, 2012. Robust ionic liquid against high concentration of salt for preconcentration and determination of rhodamine B, *Sep. Purif. Technol*., 97; 216–220.

Vijayaraghavan, R., Vedaraman, N., Surianarayanan, M., and MacFarlane, D.R. 2006. "Extraction and recovery of azo dyes in an ionic liquid". *Talanta*, 69, 1059-1062.

Visser, A.E., Swatloski, R.P., and Rogers, R.D. 2000. "pH-Dependent partitioning in room temperature ionic liquids". *Green Chemistry*, 1-4.

Wang, Z., Xue, M., Huang, K., and Liu, Z. 2011. "Textile dyeing wastewater treatment". Advances in Treating Textile Effluent. Professor R. Hauser, Ed. InTech, http://www.intechopen.com, 91-116.

Zhang, J., K.-H. Lee, L. Cui, T.-S. Jeong, 2009. Degradation of methylene blue in aqueous solution by ozone-based processes, *J.Ind. Eng. Chem*., 15, 185–189.

Zhong, P.S., N. Widjojo, T.-S. Chung, M. Weber, C. Maletzko, 2012. Removal of textile dyes from wastewater, *J. Membr. Sci*., 52; 417–418.

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