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Investigation of Removal of Dyes from Waste Water by Polythene

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Abstract: *A new concept of using grafted polythene for decontamination of industrial waste water is proposed. Grafted polythene has a ion exchange capacity 3-3.5 meq./gm (Dry weight) and is capable of removing coloration through ion exchange process without applying any additional energy. The interesting feature of this study is that we use waste polythene to save environment and employing the same for removing coloration from industrial waste water that can be recycled for further industrial use. It was observed that grafted polythene sheet is capable to remove 66.32% Rhodamine, 91.92% Methylene blue, 55.20% Fluorescence and 88.16% Eosine, within 8 Hrs.*

Key words: *Gamma Radiation, radiation dose, free radicals, grafting, contamination*

I. Introduction:

The western Rajasthan is famous for dyeing and printing Industries of textile. These dyeing and printing industries consume large quantity of water for dyeing and printing of cotton cloths and in return produce highly colored polluted wastewater which is discharged into the rivers. The colored water spoils the agriculture land, soil, agriculture crops, vegetables and drinking water in the wells, ponds etc. which will be harmful to human health and animals.

Lots of studies have already been carried out for removal of coloration from waste water by various groups of authors. The use of Indian Rosewood (Garg et al, 2004),[1] rice husk activated carbons (Rahman, 2012),[5] fly ash (Mohan et al, 2002),[3] composite coagulant (Gao et al, 2007) [2] has been reported for removal of dyes from waters.

Recently, coconut coir pith (Shankar et. al, 2014) is effectively used for color removal wherein coconut coir pith is used as an adsorbent and the process requires control of various parameters adsorbent dosage, agitation speed and maintaining of pH making the whole process a bit tedious. [6]

In the present communication, we have used simply grafted polythene for color removal and just by dipping it into the dye contaminated solution for a given period of time it removes color from the waste water. There is no need of controlling various parameters as mentioned above and also no agitation is required. The quantitative percentage removal of dye is possible simply by recording optical density and dye loading capacity of the Polythene sheet employing UV-Vis spectroscopy.

II. Material and Methods:

The process of color removing from the industrial waste water was carried out in two stages (i) development of grafted polythene film (Teraesa & Douglas, 1985) [7] and (ii) application of developed grafted polythene film for removal of water soluble colored dyes and pigments from industrial wastewater.

In the process, polythene (PE) waste is used as base material for grafting of acrylate ion on the polythene surface with gamma nuclear radiation. It is necessary to optimize the methodology for radiation grafting of polythene sheet by determining the parameters like soaking time (Fig.1), concentration of inhibitor (Fig.2), concentration of monomer (Fig.3), dose rate (Fig.4), and total accumulated dose given to sample for grafting (Fig.5). The developed grafted polythene has a tendency to remove coloration through ion exchange process.

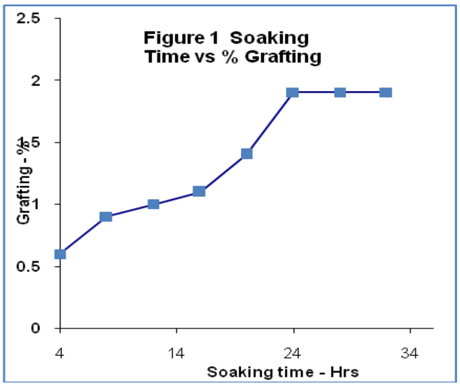


Figure 1 Soaking Time vs % Grafting
Grafting - %
Soaking time - Hrs
2.5
2
1.5
1
0.5
0
4
14
24
34

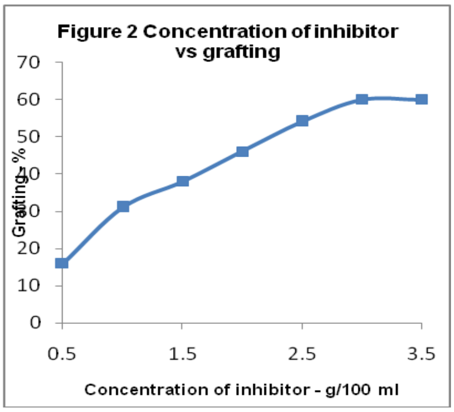


Figure 2 Concentration of inhibitor vs grafting
Grafting - %
Concentration of inhibitor - g/100 ml
70
60
50
40
30
20
10
0
0.5
1.5
2.5
3.5

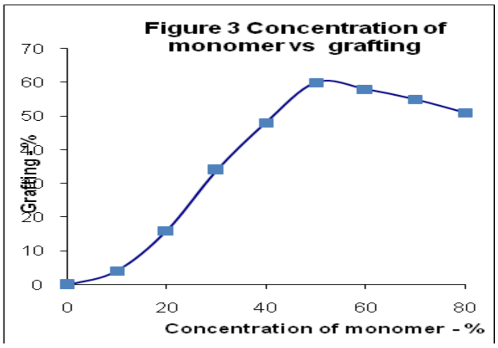


Figure 3 Concentration of monomer vs grafting
Grafting - %
Concentration of monomer - %
70
60
50
40
30
20
10
0
0
20
40
60
80

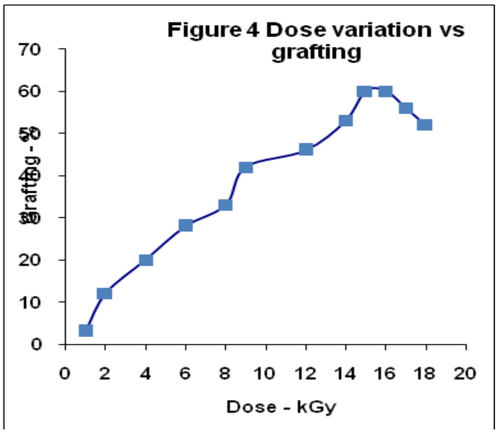


Figure 4 Dose variation vs grafting
Grafting - %
Dose - kGy
70
60
50
40
30
20
10
0
0
2
4
6
8
10
12
14
16
18
20

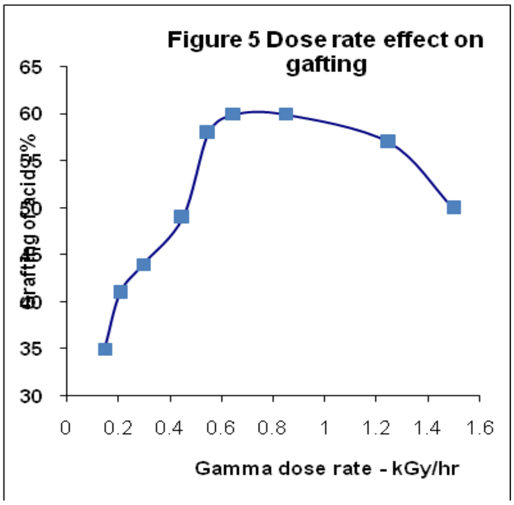
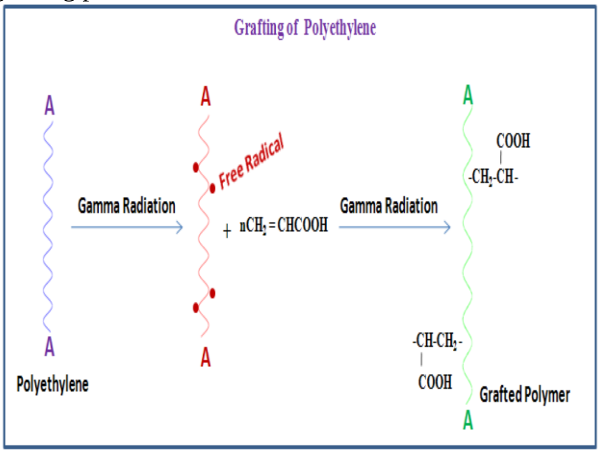


Figure 5 Dose rate effect on gafting

2.1 Mechanism of reaction:

During exposure to gamma radiation, ionizing radiation forms the active sites in the monomer as well as at the polythene sheet (backbone), resulting into the formation of polymer chains with subsequent attachment of the carboxylic group at the active site by free radical mechanism as shown in Fig.6.

Figure 6 Mechanism of reaction:
Showing radiation induced grafting processes



2.2 Characterization of Grafted Polythene

The formation of grafted polythene sheet was verified by evaluating % increase in weight of polythene and taking the difference in between the weight of grafted and non grafted film as reported for developing ion exchange powder from polythene waste (N. K. Soni, 2008) [4] and shown in Fig.7.

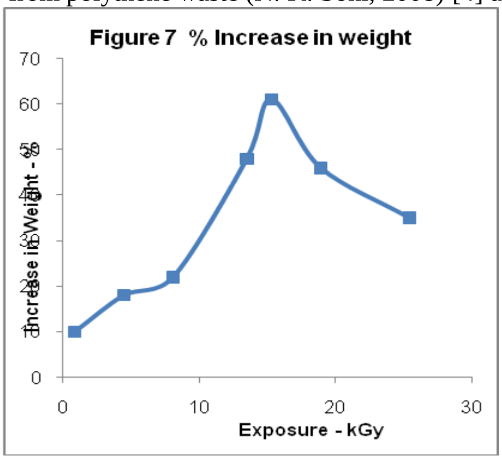
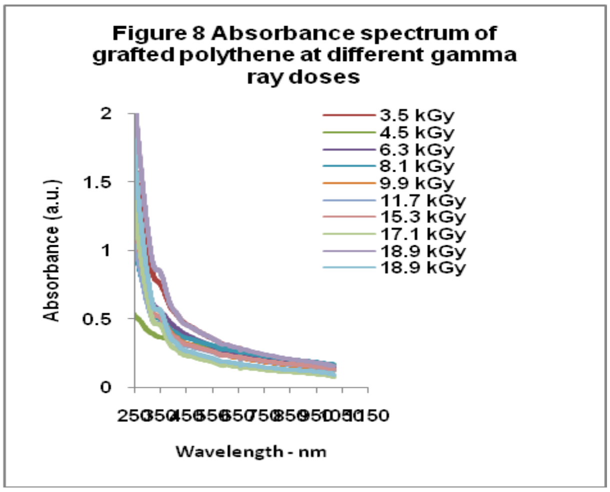
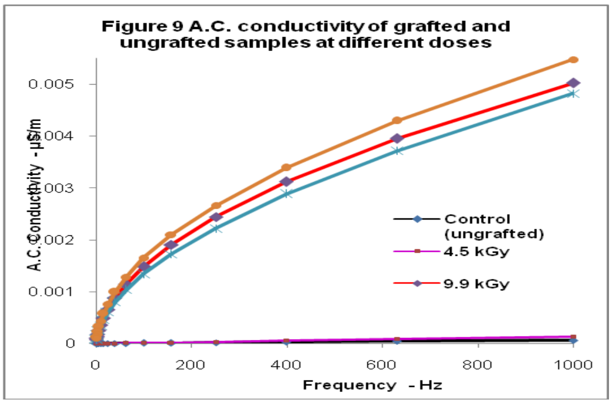


Figure 7 % Increase in weight

Absorbance of the polythene increases with exposure to radiation doses i.e. from 3.5 kGy to 18.9 kGy. Increase in absorbance of polythene indicates more grafting of acrylate ions on polythene as shown in Fig. 8.



To determine the ion exchange capacity of the radiation grafted polythene film, it was placed into the known concentration of alkaline solution for a period of 8 hrs. Then by conducting acid–base titration calculated the ion exchange capacity of the polythene. Further, a.c. conductivity was measured by placing the grafted film in between two electrodes and recording the impedance characteristics as reflected in Fig.9.



For determining its potential in color removal, known weight of grafted polythene 0.650 gm put into 1000ml of 0.1 molar solution of different dyes i.e. Methylene blue, eosin, Rhodamine and Fluoresine, respectively for 8Hrs. Absorbance of the dye loaded grafted polythene was recorded using SPECORD Photodiode array spectrophotometer and compared with bare grafted polythene. During the process of dye removal, measurement of the absorbance of the grafted polythene was carried out at different intervals of time i.e. 1Hr., 2Hr, 3Hr., 4Hr, 5Hr. and 7Hr., respectively for each of four dyes as shown in figures from Fig.10 to Fig. 13. As the dye gets adsorbed on grafted polythene, the absorbance varies with time and simultaneously water becomes colorless. Results reveals about 91.92% of Methylene blue, 88.16% of eosin, 66.32% of Rhodamine and 55.20% of Fluoresine get removed from wastewater as shown in Table-1. The removal of dyes from waste water depends upon various factors like electro negativity, size of the dye and its solubility in water etc.

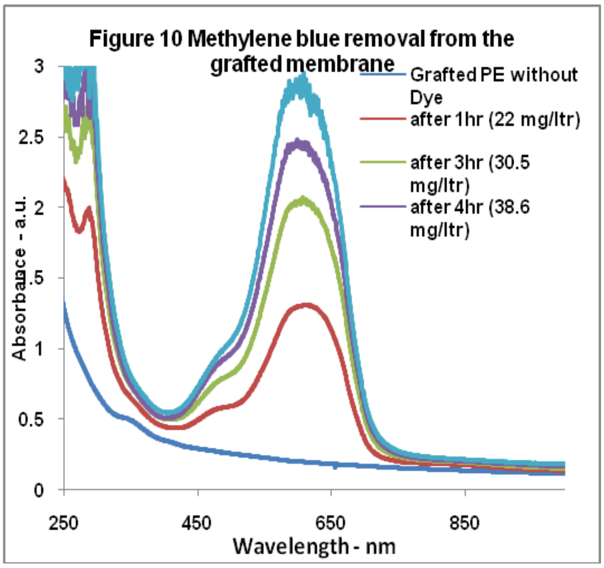


Figure 10 Methylene blue removal from the grafted membrane

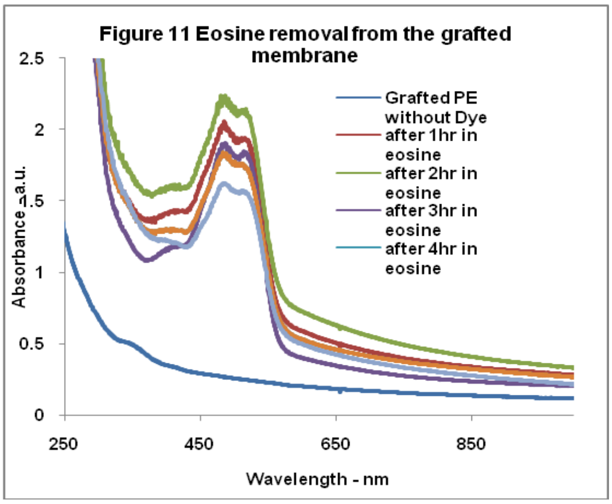


Figure 11 Eosine removal from the grafted membrane

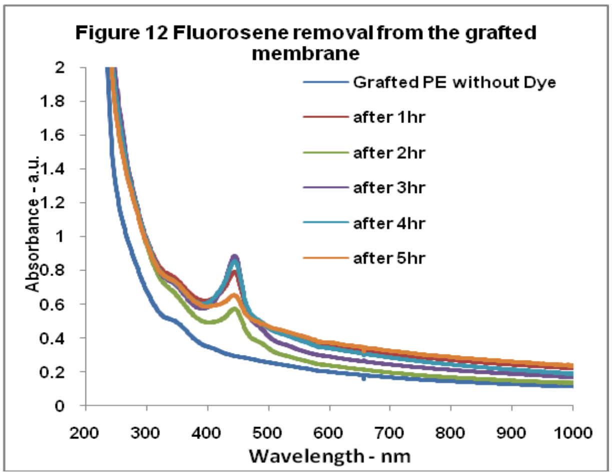


Figure 12 Fluorosene removal from the grafted membrane

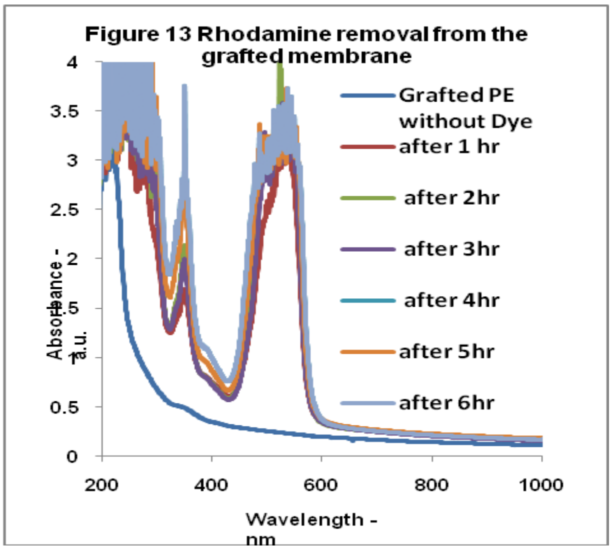


Table – 1 Evaluation of grafted polythene sheet

S. No.	Dye	Initial concentration (g/ltr.)	% Removal		
			After 3 Hrs.	After 5 Hrs.	After 7 Hrs.
1.	Rhodamine	0.7	37.17	55.34	66.32
2.	Methylene Blue	0.9	41.34	72.19	91.92
3.	Fluorosine	0.26	28.27	41.62	55.20
4.	Eosin	0.26	39.33	70.61	88.16

III. Result & Discussion:

During development of grafted polythene it was observed that for homo polymerization in the reaction, concentration of inhibitor, concentration of monomer, radiation dose and dose rate given to the polythene, have to be checked properly. It is also observed that during experiment weight of the polythene sheet increases from 10-60 % with increase in dimension from 104mm to 153mm. The a.c. conductivity determined for the control sample at 1 kHz frequency was found 6.54 x 10^{-5} µS/m and it increases up to maximum value of 547 x 10^{-5}µS/m for the sample grafted at 15.3 kGy gamma dose.

Ion-exchange capacity of the grafted polythene increases from 0.4 - 3.5 meq/gm with radiation dose ranging from 1KGy to 15 KGy and accordingly removal of contaminant up to 92% takes place.

Additionally, Optical density of the grafted sheet increases from 0.5 to 3.5 due to adsorption dyes and pigments from waste water. In case of Methylene blue dye removal, grafted polythene was kept in the Methylene blue solution and it was observed that during process of adsorption optical density (OD) of Methylene blue increases from 1.2 to 3.0.

Grafting polythene using gamma radiation technique is easier and cost effective for getting homogenous grafting on the polythene with minimum requirement of chemical. Secondly, exhausted grafted polythene after removal of color dyes may be reuse simply by regenerating the same with 10% of acidic solution. Process for removal of dye from waste effluent is very simple and maintenance of other parameters like Ph, addition of coagulant and electric consumption is not required.

IV. Conclusion:

In the present study a novel concept of using radiation grafted polythene as an ion exchange membrane for dye removal from industrial waste is applied. The process has been evolved for development of grafted polythene with gamma radiation, and further their characterization in terms of ion exchange capacity. The developed grafted polythene sheet showed an ion exchange capacity up to 3.5 meq./g and it was noticed that 92% of dyes gets removed from wastewater within 7 Hrs. without applying additional energy. Grafted polythene sheet thus found to be more effective for removal of dyes & pigments form industrial waste effluents. This approach has therefore significant role in keeping the environment from white pollution.

Acknowledgement:

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