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Vat Dyeing Using Hydroxyacetone as a Reducing Agent

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Abstract

For dying the cotton with vat dyes, first it is required to reduce the dye using reducing agents. The reduction potential of reducing agent has to be matched with the dye for proper dying. Otherwise the problem of over reduction and under reduction may arise and leads to the change in shade. In conventional vat dyeing process, the vat dye is dissolved using sodium hydrosulphite (hydrose), which is a powerful reducing agent followed by solubilising with sodium hydroxide. This process creates very high pollution problem. In this study, an attempt has been made to see the effect of hydroyaceton and its combination with hydrose as reducing agent. Different reducing agents with different reduction potential at different concentration have been used for dying the cotton fabric with vat dye. And the comparisons of different reducing agents and their blend have been observed in terms of dye pick up and fastness property.

Keywords—Vat dyes, reducing agent, hydroxyaceton, hydrose.

I. Introduction

Vat dye is the most popular among dye classes used for coloration of cotton, particularly, when high fastness standards are required to light, washing and chlorine bleaching[1].Vat dyes are practically insoluble in water, but can be converted into water soluble form called leuco dye by reduction with a strong reducing agent like hydrose and solubilising agent sodium hydroxide. The reduced dyestuff penetrates into the fiber and it is reoxidised on the fiber back to the insoluble form, which remains fixed in the fabric[2, 3]. The use of sodium hydrosulphite is being criticized for the formation of non-environment friendly decomposition products such as sulphite, sulphate, thiosulphate and toxic sulphur[4]. Therefore many attempts are being made to create alternate for the sodium hydrosulphite that cause less pollution.

The most commonly employed reducing agent in vat dyeing is sodium hydrosulphite (Na2S2O4), commonly known as hydrose. This compound is not stable in strong alkaline conditions in the absence of air. Alkaline solution of hydrose has a certain degree of reduction potential and thus, can reduce all commercial vat dyes to their water soluble forms, economically and quickly, without any chance of over reduction. To ensure complete conversion sodium hydroxide is dded prior to hydrose addition. After several decades of research and development there is still no commercial reducing technology, including electrochemical processes available today that can replace sodium hydrosulphite in all areas of vat dye application. Unfortunately, it is impossible to use catalytic hydrogenation technique directly in the dye house due to high explosion and fire risk 11.

The various alternative reducing agents for vat dying have been tried, the zinc and ferrous sulphate as a reducing agent studied by P. Santhi [5].

In this paper hydroxyaceton has been considered for its various advantages[6]. Hydroxyaceton is an organic and sulphur free molecule with mild reducing agent. From safety point of view it is not self incinerating, low risk and cost of insurance also it can be store next to other chemicals. Mainly it is environmental friendly, as it is biodegradable organic substance in waste water. Application in open and closed dying machines as it shows no oxidation with oxygen from air.

II. Methods

First, confirm that you have the correct template for your paper size. This template has been tailored for output on the A4 paper size The grey cotton fabric was initially pretreated by standard scouring treatment using sodioum hydroxide and by bleaching treatment using hydrogen peroxide as per the standard method.

Conventional dyeing was carried out on cotton fabric using hydros as a reducing agent . Similarly, the dyeing was also carried out using hydroxyacetone and its combination with hydros, and its combination with other reducing agent as alternate reducing agents.

The dyeing reciepe includes vat dye 2.0% owm,turkey red oil 2.0%owm,NaOH 2.0% owm, MLR 1:30, temperature 60◦C treatment time 45 min and reducing agents (separately) hydroxyacetone (5%,10%,15% owm) ,ferrous sulphate (5%,10%,15% owm), hydrose (5%,10%,15% owm) ,hydroxyacetone+hydrose (2.5%+2.5%,5%+5%,7.5%+7.5% owm) hydroxyacetone+ferrous sulphate (2.5%+2.5%,5%+5%,7.5%+7.5% owm)

The dye take up % at required frequency is determined by using spectrophotometer. Initially the concentration of various dye liquors with specific reducing agent is determined before and after dyeing and from this pick up % is calculated.

The dyed cotton samples are taken and stitched with bleached cotton fabric and washed in the laundro meter after that fastness rating is given by using grey scales.

III. Results And Discussions

Before The vat dying is carried out using different reducing agents, and dye pick up percentage and washing fastness have been compared as shown in table 1.

table 1: Vat dying using different reducing agent at different concentration

Reducing agent	Concentration % of reducing agent (owm)	Dye concentration (%)		Dye pick up (%)	washing Fastness
		Before	After		
Hydroxyaceton	5	2.25	1.86	0.39	5
	10	2.8	2.38	0.42	5
	15	3.01	2.53	0.48	5
Sodium hydro sulfite (hydrose)	5	2.94	2.32	0.62	4
	10	2.98	2.26	0.72	4
	15	2.99	2.3	0.69	4
Ferrous sulphate	5	2.25	2.01	0.24	4
	10	2.35	1.98	0.37	4
	15	2.41	2.01	0.40	4
Sodium hydro sulfite + Hydrooxyacetone	5	2.79	2.25	0.54	5
	10	2.89	2.39	0.56	5
	15	2.97	2.35	0.62	5
Ferrous sulphate +Hydrooxyacetone	5	2.1	2.06	0.04	5
	10	2.17	2.13	0.06	5
	15	2.27	2.25	0.02	5

For the same concentration of reducing agent and for the same vat dye, hydros is giving more dye pickup than hydroxyaceton and after that their combinations. Ferrous sulphate is giving very less dye pick up even if it is mix with hydos, furthermore the combination of ferrous sulphate and hyroxyaceton is giving almost no pick up.

The hydros is having reduction potential around -970 mV which is more than that of hydroxyaceton -811 mV in alkali solution, therefore hydos is giving more reducing the dye and hence more pick up. The vat dyes are having reduction potential in the range ca. -650 mV to ca. -980 mV, so for some vat dyes it may give over reduction. But if the combination of hydos and hydoxyaceton is used it may reduce the reduction potential of hydros to some extent and can give the better result.

For the dyes having less reduction potential, the hydroxyaceton alone can easily be used for the better yield. On other hand the reducing agent Ferrous sulphate is not suitable either alone or in combination with hydros and hydroxyaceton.

If the concentration of particular reducing agent is changed then there is a little change in the dye pick up. Hydoxyaceton is showing good washing fastness than hydros, it may be due to maching of reduction potential of hyroxyaceton with the vat due. For hydros comparitivly poor washing fastness may be due to overreduction of dye.

IV. Conclusion

For environment friendly approach of vat dye selection of reducing agent play an important role. Out of different available reducing agent hydroxyaceton can be the choice for this, but for the dyes having low reduction potential. Also for other dyes for getting good dyeing it may be used in combination of hydros.

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The template will number citations consecutively within brackets [1].

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