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Contents

Chapter No 1	7
1.1. Direct Dyes:	7
1.2. Properties of Direct Dyes:	7
1.3. Classification of Direct Dyes:	7
1.3.1. Class A: Self Leveling Direct Dyes:.....	8
1.3.2. Class B: Salt Controllable Direct Dyes:.....	8
1.3.3. Class C: Salt and Temperature Controllable Dyes:	8
1.4. Duller in color and poorly washing fastness.....	9
1.5. Inexpensive	10
1.6. Single dye bath.....	10
1.7. Protein fibers	10
1.8. Light fastness	10
1.9. How direct dyes bond to the fiber.....	11
1.10. Solving the wash fastness problem for direct dye.....	11
1.11. Safety Issues with Direct Dye	12
Chapter No 2.....	13
2.1. Abstract.....	13

2.2. Silica sol and its working method.....	14
2.3. Rate of Response.....	14
Chapter No. 3.....	16
3.1. Objectives	16
3.2. The purpose of choosing direct dyes is	17
3.3. Plan of Action	18
3.4. Problem Statement	20
Chapter No 4.....	25
4.1. Introduction	25
4.2. Bleaching.....	25
Calculations:	26
4.3. Dyeing.....	26
4.3.1 Dyeing (A);.....	27
4.3.2. Dyeing (B);.....	27
Calculations:	28
4.3.3. Dyeing (C);.....	29
Calculations:	29
4.3.4. Dyeing (D);.....	30
Calculations:	31
4.4. Fixation.....	32

Chapter No 5	33
5.1. Introduction.....	33
5.2. Crocking.....	33
5.2.1 Dry crocking	34
Principles.....	34
5.2.2. Wet crocking.....	34
5.2.3. Test summery	35
5.3. Light fastness	36
Operates used.....	36
Principle	37
5.3.1 Test summary	37
5.4. Washing fastness.....	40
Apparatus used.....	40
5.4.1. Test summary	40
5.5. Wet fastness	41
Apparatus	41
5.5.1 Test summary	41
Chapter No 6.....	42
6.1. Laundering/Washing fastness test.....	42
6.1.1 Graphical representation of data.....	43

6.2.	Wet fastness test.....	49
6.3.	Crocking test	54
6.5.	Light Fastness test.....	56
6.6.	Conclusion	57

Chapter No 1

About Direct Dyes

1.1. Direct Dyes:

Direct dyes are also called substantive dyes because of their excellent substantivity for cellulosic textile materials like cotton and viscose rayon. This class of dyes derives its name from its property of having direct affinity for cellulosic fibres, when applied from an aqueous solution.^[1]

1.2. Properties of Direct Dyes:

Chemically, direct dyes are sodium salts of aromatic sulphonic acids and most of them contain an azo group as the main chromophore. They are in general duller than the fibre reactive dyes, and exhibit poor wash fastness. Goods dyed with direct dyes unless; given a proper after treatment tend to bleed with every wash. The direct dyes in many cases exhibit a better light fastness as compared to the reactive dyes.^[1]

1.3. Classification of Direct Dyes:

The direct dye in the colour index system refers to various planar, highly conjugated molecular structures containing one or more sulfonate groups which render solubility to the dye molecule. Their planar structure and length enable them to lie along side cellulose fibres and maximize the Van-der-waals, dipole and hydrogen bonds. As in other classes of dyes, the direct dyes can also be classified in many ways like the chemical nature of the chromophore, or by their dyeing

characteristics and performance properties, but in general the most popular way of classification by the dyes is by means of their dyeing characteristics.

The classification of direct dyes by SDC is based essentially on the compatibility of different groups of direct dyes with one another under certain conditions of batch dyeing. There are three groups: A, B, and C.

1.3.1. Class A: Self Leveling Direct Dyes:

1.3.2. Class B: Salt Controllable Direct Dyes:

1.3.3. Class C: Salt and Temperature Controllable Dyes. ^[3]

1.3.1. Class A: Self Leveling Direct Dyes:

These dyes have good leveling characteristics and are capable of dyeing uniformly even when the electrolyte is added at the beginning of the dyeing operation. Dyes in this group have good leveling properties and are capable of dyeing uniformly even when the electrolyte is added at the beginning of the dyeing operation. ^[3]

1.3.2. Class B: Salt Controllable Direct Dyes:

These dyes have poor leveling or migration properties. They can be controlled by addition of electrolyte, usually after the dye bath has reached the dyeing temperature. They require relatively large amount of salt to exhaust well. ^[3]

1.3.3. Class C: Salt and Temperature Controllable Dyes:

These dyes show relatively poor leveling or migration and their substantivity increases very rapidly with increasing temperature. Controlling rate of rise of the dye bath temperature, as well as controlling the salt addition, controls their rate of dyeing.

Direct dyes are a class of hot water dyes for use on cellulose fibers, such as cotton. It is one of the two types of dyes that are mixed in 'all purpose dyes'. (The other type in the mixture is an acid dye, which will not stay in any cellulose fiber for long.) Try to find them pure, without the useless (for cotton) and money-wasting acid dyes mixed into the 'all-purpose' dyes.

In most cases, better results will be obtained, often with versatile and easier-to-use cool water methods, if you use fiber reactive dye instead of direct dye. However, there are some cases in which direct dye is preferred. ^[3]

1.4. Duller in color and poorly washing fastness

The colors of most direct dyes tend to be duller than those provided by fiber reactive dyes, especially after fading in the laundry. The wash fastness of direct dyes is poor: expect anything dyed with them to 'bleed' forever. They lack the permanence of the cold water fiber reactive dyes which most hand-dyers prefer for use on cellulose fibers. As a result, clothing dyed with direct dyes should be laundered in cool water only, with closely similar colors. The wash fastness problem can be reduced by following dyeing with the use of a cationic after-treatment such as Retayne. ^[1]

1.5. Inexpensive

The main reason why direct dyes are used is because of cost. Although the widely available all-purpose dyes which contain a mixture of direct and acid dyes are very expensive, per pound of fabric to be dyed, direct dyes sold alone and purchased in bulk are among the cheapest of all dyes. ^[1]

1.6. Single dye bath

Direct dyes are applied in hot water, typically between 175°F and 200°F. They can be applied in the same boiling-water dye bath with acid dyes (whether for same-color effects, as in all-purpose dyes, or contrasting effects, as in the case of AlterEgo brand dyes). ^[1]

1.7. Protein fibers

Direct Dyes are used on cellulose fibers such as cotton, rayon, and linen, but they will also color silk and wool unless dyeing is accompanied by a chemical 'reserving agent', which unfortunately is unavailable to home dyers. ^[1]

1.8. Light fastness

Direct dyes are not generally more lightfast than fiber reactive dyes; many direct dyes are less resistant to light than similarly-hued fiber reactive dyes, and both tend to be less lightfast than vat dyes. There are just a few cases in which a particular direct dye may be more lightfast than similar shades of fiber reactive dyes. For example, Color Index Direct Orange 39 and Direct Blue 86 are quite reasonably lightfast, with a rating of 6 (on a scale of 1 to 8). While some fiber

reactive oranges are as lightfast, not all are; the popular Color Index Reactive Orange 4 rates only 4 on that scale, while the Turquoise Reactive Blue 140 rates 5-6 on that scale.

Unfortunately, the cationic dye fixatives, such as Retayne, that are required to render the wash fastness of direct dyes acceptable also reduce light fastness somewhat. ^[1]

1.9. How direct dyes bond to the fiber

Direct dyes are only loosely associated with the fiber molecule through the property called substantivity, which is the tendency of the dye to associate with the dye without strong bonds. This substantivity is increased by increasing the size of the dye molecule, so direct dyes tend to be large. Small dye molecules tend to be bright, while large dye molecules tend to be duller (as there are more parts that can absorb additional wavelengths of light), so direct dyes are generally much less bright in color than fiber reactive dyes. Substantivity is said to result from a combination of the relatively weak Van der Waals forces and some hydrogen bonding. ^[2]

1.10. Solving the wash fastness problem for direct dye

All direct dyes perform rather poorly with respect to washfastness. Without an appropriate after-treatment, direct dyes bleed a little with every washing, losing their brightness and endangering other clothes washed in the same load. However, there are special after-treatments which may be used to solve this problem. (Vinegar is not among them! In spite of claims you may see to the contrary, you cannot use vinegar to set any dye on cotton or other cellulose materials.) A cationic dye fixative, such as Retayne, which essentially "glues" the dye into the fiber, works very well to make fabric dyed with direct dyes washable without occult of the dye. ProChem and Dharma Trading Company both carry Retayne; if you're lucky, perhaps your local quilter's supply shop

will, too. Aljo and Dharma have their own brand names of similar products, as well. See Sources for Dyeing Supplies for contact information, to mail-order these products. ^[2]

1.11. Safety Issues with Direct Dye

Most direct dyes are safe to use. As with all dyes, it is very important not to breathe the dye powder (or indeed any powdered substance), and direct exposure of the dyebath to the skin should be avoided by the use of gloves.

A careful adult who understands safety precautions can probably use these dyes safely, but they should never be given to children to use, since children are less likely to follow all safety rules.

[1]

Chapter No 2

Silica Sol

IUPAC: Dioxosilane

CAS: silica sol

FORMULA: O_2Si

ACTIVITY: insecticides (desiccant insecticides; inorganic insecticides)

NOTES: There is no ISO common name for this substance; the name “silica sol” has been used in the literature but has no official status. This substance is also known as amorphous silica sol, amorphous silicon dioxide and silica aerosol.

STRUCTURE: $O=Si=O$

2.1. Abstract

It is important to understand how silica sols vary in performance in order to select the most cost-effective sol for a particular application. M_H , the hysteresis corrected buffering capacity of silica sol, is the critical variable for assessing silica sol efficiency. Calculating the correct quantity of silica sol allows for the cost-efficient selection of an appropriate amount of buffering material. If certain variables in the calculation are unknown, such as leakage rate or external RH conditions, general recommendations based on average display conditions have been provided, both for

temporary exhibitions and for permanent displays. Finally, simple procedures for the use and maintenance of silica sol have been described. Passive humidity control within an exhibit case, when applied correctly, is a very simple and cost-efficient method of protecting museum collections from humidity induced damage.^[4]

2.2. Silica sol and its working method

In order to understand how silica sol functions, it is critical to understand the concept of Equilibrium Moisture Content (EMC). Many materials contain moisture. The quantity of moisture in hygroscopic materials depends on the temperature and RH of the surrounding air. If the temperature or RH changes, the moisture content within the object will change so that it will come into equilibrium with the new condition of the surrounding air.

Moisture content is the weight of water in an object expressed as a percentage of its dry weight. The EMC is the moisture content of an object in equilibrium with a specified RH. For example, if a piece of paper weighing 100 grams at 0% RH increases to 105 grams at 50% RH, it now has 5 grams of moisture compared to its dry weight, resulting in a 5% EMC at 50% RH:

$$(105 \text{ g at 50\% RH} - 100 \text{ g at 0\% RH})/100 \text{ g (dry weight)} = 0.05 = 5\% \text{ EMC}^{[5]}$$

2.3. Rate of Response

There is no significant difference between the rate of response of different types of silica sols during adsorption or desorption (Figs. 4, 5). The location and distribution of the silica sol are the critical factors that determine rate of response. In a space where there is no air movement, it takes approximately one day for a single layer of silica sol to fully adjust to a new RH level

within a moderate range (10-20% change in RH). If silica sol is placed in a tray approximately 2.5 cm (1 inch) deep with sol, it will take much longer for the full amount of sol to equilibrate to a 10-20% RH change (approximately one month). Therefore, it is important to maximize the surface area of the sol relative to its total volume.

It is important to allow for a maximum zone of air exchange between the silica sol and the space that it is supposed to condition. If the silica sol is located in a space below the visible portion of the case, the air exchange is limited to a small slot or set of holes. Therefore, the silica sol may not effectively offset changes in RH within the display area, either from a rapid changes in temperature, or from a rapid rate of leakage. A future publication will discuss the question of air exchange and silica sol location. ^[4]

Chapter No. 3

Research Methodology

[Note: this project is influenced by the Research work of B. Mahltig . T. Textor “Combination of Silica sol and Dyes on Textiles”. Their project results in tremendous success. I used silica sol for direct dyes.]

3.1. Objectives

I propose to study the fastness properties of a fabric when dyes are applied to it with a combination of silica sol. This combination is applied using four different methods. Following goals are achieved:

1. To study the process and results of all these three methods. (These methods are studied differently to know if silica sol coating should be applied before dyeing or after dyeing. Result from both the methods are compared.)
2. To investigate the result by performing leaching and bleaching test.
3. To study the relevance to industry.

The methods by which fastness can be increased of a fabric are either complex or expensive. Many of them are not. But application of silica sol is cheap, simple to carried out and the results are desirable. This method meets all the criteria which are sufficient to satisfy one’s customer. ^[3]