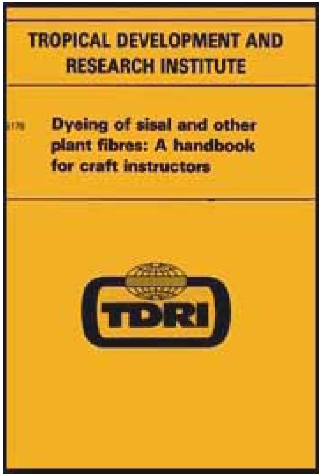

Dyeing of Sisal and other Plant Fibres: A Handbook for Craft Instructors (NRI)

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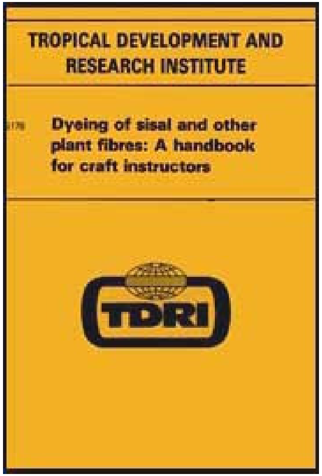
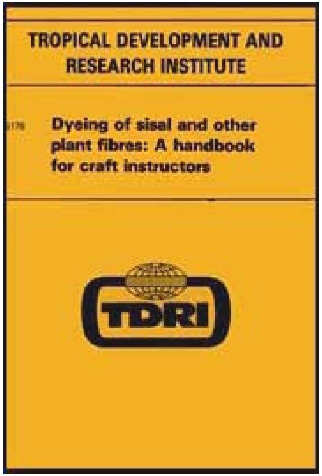


A. J. Canning and C. G. Jarman

November 1983
Tropical Development and Research Institute 127 Clerkenwell Road, London

Overseas Development Administration



Dyeing of Sisal and other Plant Fibres: A Handbook for Craft Instructors (NRI)

Appendices

1. Conversion tables

Specific gravity	Concentration (per cent*)
0.9992	0
1.0007	1
1.0022	2
1.0037	3
1.0052	4
1.0067	5
1.0083	6
1.0098	7
1.0113	8
1.0127	9
1.0142	10
1.0214	15
1.0284	20
1.0350	25
1.0412	30
1.0470	35
1.0523	40
1.0571	45
1.0615	50
1.0653	55
1.0685	60
1.0712	65
1.0733	70
1.0746	75
1.0748	80
1.0739	85
1.0713	90
1.0660	95
1.0553	100

Figure Table A - Acetic acid: relationship between specific gravity

and concentration at 15°C

Specific gravity	Concentration (per cent by weight*)	Concentration (per cent by volume†)
0.9983	0	0.00
1.0020	1	0.82
1.0041	2	1.64
1.0071	3	2.48
1.0094	4	3.30
1,0116	5	4.14
1.0142	6	4.98
1,0171	7	5.81
1,0197	8	6.68
1,0222	9	7.55
1,0247	10	8.40
1,0371	15	12.80
1,0489	20	17.17
1,0610	25	21.73
1.0730	30	26.37
1,0848	35	31.10
1.0864	40	35.90
1.1086	45	40.82
1.1208	50	45.88
1.1321	55	51.01
1.1425	60	56.13
1.1544	65	61.44
1.1656	70	66.80
1.1770	75	72.27
1,1881	80	77.67
1.1964	85	83.19
1.2045	90	88.74
1.2141	95	94.48
1.2213	100	100.00

Figure Table B - Formic acid: relationship between specific gravity and concentration 20°C

Density (° Bé)	Specific gravity	Density (° Tw)	Concentration (per cent sulp
0	1,0000	0.0	0.00
1	1,0089	1.4	1.02
2	1.0140	2.8	2.08
3	1.0211	4.2	3.13
4	1,0284	5.7	4.21
5	1,0357	7.1	5.28
6	1,0432	8.6	6.37
7	1.0507	10.1	7.45
8	1,0584	11.7	8.55
9	1,0662	13.2	9.66
10	1.0741	14.8	10.77
11	1.0821	16.4	11.89
12	1.0902	18.0	13.01
13	1.0985	19.7	14.13
14	1.1069	21.4	15.25
15	1.1154	23.1	16.38
16	1.1240	24.8	17.53
17	1.1328	26.6	18.71
18	1.1417	28.3	19.89
19	1.1508	30.2	21.07
20	1.1600	32.0	22.25
21	1.1694	33.9	23.43
22	1.1789	35.8	24.61
23	1.1885	37.7	25.81
24	1.1983	39.7	27.03
25	1.2083	41.7	28.28
26	1.2185	43.7	29.53
27	1.2288	45.8	30.79
28	1.2393	47.9	32.05
29	1.2500	50.0	33.33
30	1.2609	52.2	34.63
31	1.2719	54.4	35.93
32	1.2832	56.6	37.26
33	1.2946	58.9	38.58
34	1.3063	61.3	39.92
35	1.3182	63.6	41.27
36	1.3303	66.1	42.63
37	1.3426	68.5	43.99

38	1.3551	71.0	45.35
39	1.3679	73.6	46.72
40	1.3810	76.2	48.10
41	1.3942	78.8	49.47
42	1.4078	81.6	50.87
43	1.4216	84.3	52.26
44	1.4356	87.1	53.66
45	1.4500	90.0	55.07
46	1.4646	92.9	56.48
47	1.4796	95.9	57.90
48	1.4948	99.0	59.32
49	1.5104	102.1	60.75
50	1.5263	105.3	62.18
51	1.5426	108.5	63.66
52	1.5591	111.8	65.13
53	1.5761	115.2	66.63
54	1.5934	118.7	68.13
55	1.6111	122.2	69.65
56	1.6292	125.8	71.17
57	1.6477	129.5	72.75
58	1.6667	133.3	74.36
59	1.6860	137.2	75.99
60	1.7059	141.2	77.67
61	1.7262	145.2	79.43
62	1.7470	149.4	81.30
63	1.7683	153.7	83.34
64	1.7901	158.0	85.66
64¼	1.7957	159.1	86.33
64½	1.8012	160.2	87.04
64¾	1.8068	161.4	87.81
65	1.8125	162.5	88.65
65¼	1.8182	163.6	89.55
65½	1.8239	164.8	90.60
65¾	1.8297	165.9	91.80
66	1.8354	167.1	93.19

Figure Table C - Sulphuric acid: relationship between specific gravity, density and concentration

Liquor ratio	Volume of liquor (litres) for given weight of fibre (kilograms)				
	1 kg	2 kg	3 kg	4 kg	5kg
10:1	10	20	30	40	50
15:1	15	30	45	60	75
20:1	20	40	60	80	100
25:1	25	50	75	100	125
30:1	30	60	90	120	150
40:1	40	80	120	160	200
50:1	50	100	150	200	250

Figure Table D: Volume of liquor required with weights of fibre between 1 kilogram and 5 kilograms to obtain liquor ratios in the range of 10:1 to 50:1

Concentration (g/l)	Weight of additive (grams) for given volume of liquor (litres)				
	20 l	40 l	60 l	80 l	100 l
1	20	40	60	80	100
2	40	80	120	160	200
3	60	120	180	240	300
4	80	160	240	320	400
5	100	200	300	400	500
6	120	240	360	480	600
7	140	280	420	560	700
8	160	320	480	640	800
9	180	360	540	720	900
10	200	400	600	800	1,000
20	400	800	1,200	1,600	2,000
30	600	1,200	1,800	2,400	3,000
40	800	1,600	2,400	3,200	4,000
50	1,000	2,000	3,000	4,000	5,000

Figure Table E: Weight of additive required with volumes of liquor between 20 litres and 100 litres to obtain concentrations in the range of 1 - 50 9/1

Percentage on weight of fibre	Weight of additive (grams) for given weight of fibre (kilograms)				
	1 kg	2 kg	3 kg	4 kg	5 kg
0.1	1	2	3	4	5
0.2	2	4	6	8	10
0.3	3	6	9	12	15
0.4	4	8	12	16	20
0.5	5	10	15	20	25
0.6	6	12	18	24	30
0.7	7	14	21	28	35
0.8	8	16	24	32	40
0.9	9	18	27	36	45
1.0	10	20	30	40	50
2.0	20	40	60	80	100
3.0	30	60	90	120	150
4.0	40	80	120	160	200
5.0	50	100	150	200	250
6.0	60	120	180	240	300
7.0	70	140	210	280	350
8.0	80	160	240	320	400
9.0	90	180	270	360	450

Figure Table F: Weight of dyestuff or additive required with vveights of fibre between 1 kilogram and S kilograms to obtain percentages on weight of fibre in the range of 0.1 - 9.0 per cent

2. Near equivalents of withdrawn dyes

New dyestuffs are continually being introduced to the market whilst others are withdrawn. Consequently some of the materials described are no longer available. However, close equivalents of many withdrawn dyes are available from other manufacturers. These near

equivalent dyes have different trade names but share the same Colour Index Generic Name (e.g. Cl Reactive Yellow 22).

In this Appendix sources of dyes with the same Generic Name as the withdrawn dyes mentioned in the handbook are listed: full addresses for the manufacturers are given in Appendix 3.

It is emphasised that none of these near equivalents have been investigated by the Tropical Development and Research Institute and it is not certain that their properties and behaviour are identical to those dyes investigated.

Safety note: Two dyes in Table G are based on the chemical benzidine. This chemical is a suspected carcinogen and its use is now restricted. The actual dyestuffs, although allegedly safe, should be treated with care to ensure that they do not contaminate the person, the atmosphere, or the work area. If they are used, the working area should be washed down frequently and the dyers should wear protective clothing, inclusive of face masks, and wash themselves thoroughly after handling the dyes (see Safety precautions and first aid treatment).

Withdrawn dye and Colour Index Generic Name	Near equivalent and manufacturer*
Supranol Fast Scarlet GN CI Acid Red 85 (Benzidine dye – *see* Safety note)	Polan Scarlet 2G (POL) Midlon Red PG (Chem) Milling Fast Red G, Multicuer Red BG (Mult) Milling Brilliant Scarlet GN (FW) Vilmanol Fast Red G, Vilmanyl Red N-G (VIL)
Coomassie Violet R CI Acid Violet 17	Acid Brilliant Milling Violet 4BS (Amar) Acid Violet 5BNS (ATL) Merantine Violet S4B, S4R (LBH) Hispacid Brilliant Violet S4 BF (RBM)
Lissamine Turquoise AN CI Acid Blue 7	Patent Blue AS (Amar) Erio Glaucine X (CGY) Kayacyl Pure Blue FGA (KYK) Merantine Blue AF (LBH) Acid Turquoise Blue A (POL) Sandolan Turquoise E-AS (S)

Figure Table G

Coomassie Blue FF CI Acid Blue 15	Lurazol Brilliant Blue BA (BASF) Supranol Blue B (BAY) Erio Brilliant Blue R (CGY) Xylene Brilliant Blue BC, Xylene Milling Blue BC (S)
Lissamine Green G CI Acid Green 3	Atlacid Green L (ATL) Merantine Green G (LBH)

	Acid Green S (S)
Sevron Yellow 3RL CI Basic Yellow 15	Atacryl Yellow 3RLA (ATL) Altocryl Fast Yellow RN (CKC) Sumiacryl Yellow E-3RD (NSK)
Astrazon Orange 3RL CI Basic Orange 27	Astrazon Orange 3R (BAY)
Synacril Blue R CI Basic Blue 22	Astrazon Blue FGL, FGLN (BAY) Maxilon Blue BL, 2GB (CGY) Altocryl Fast Blue F2G, Intradene Fast Blue BL (CKC) Synacril Blue RN (ICI) Anilan Blue FGL (POL) Sandocryl Blue BFE (S) Yoracryl Blue G (YCL)
Durazol Yellow 6G CI Direct Yellow 46	Solius Yellow 6G (FDN)
Durazol Violet R CI Direct Violet 51	Atul Direct Brilliant Fast Helio B (AP) Atlantic Fast Violet FFB (ATL) Sirius Violet BB (BAY) Saturn Violet BB (Chem) Diphenyl Brilliant Violet B, Pergasol Violet RA (CGY) Solius Violet 2B (FDN) Sumilight Violet BB (NSK) Helion Violet 2B (POL) Hispaluz Violet FFB (RBM) Chloramine Brilliant Fast Violet 3B, Solar Violet 2B (S)
Chlorazol Blue G CI Direct Blue 10 (Benzidine dye: *see*	Direct Blue 10 (PyO) Hispamin Blue DG (RBM)

Safety note)	
Durazol Blue 4R CI Direct Blue 67	Atul Direct Supra Light Fast Blue 3R (AP) Direct Fast Blue 3RLL (CE) Solar Brilliant Blue A (S) Solophenyl Blue 3RL (CGY) Suprexcel Blue 4RL (LBH)

Figure Table G (continued 1)

Durazol Green 5G CI Direct Green 28	Atlantic Resin Fast Green 5GL (ATL) Saturn Green LG5, Rybantin Green 5GL (Chem) Intralite Fast Green 5GLL, Intramet Green 5GLL (CKC) Solius Light Green 3G, Tetramine Light Green 5GL (FDN) Suprexcel Green 5GL (LBH) Helion Green 5GL (POL)
Chlorazol Black BV CI Direct Black 19	Benzo Fast Black G (BAY) Direct Fast Black VG (CE) Direct Fast Black G (Chem) Diphenyl Black G, GN (CGY) Columbia Fast Black G, GB; Cutamin Black CG (FW) Kayarus Black G (KYK) Viscose Black NG (LBH) Viscose Black G (POL) Carta Black G, Solar Black G (S) Benzanil Black VN (YCL)
Dispersol Red C-B CI Disperse Red 91	Atlantic Polycron Pink REL (ATL) Palanil Brilliant Pink REL, P-REL (BASF) Chemilene Brilliant Pink REL (CE) Navinyl Brilliant Pink REL (IDI)
Procion Yellow MX-4G CI Reactive Yellow 22	Basilen Yellow M4 GD (BASF) Chemictive Brilliant Yellow M4G (CE) Mikacion Brilliant Yellow 4GS (KYK) Acticrom Brilliant Yellow F4G (Mult) Vilmafix Yellow 4G-A (VIL)

Figure Table G (continued 2)

Near equivalents of withdrawn dyes (available April 1982)

3. Addresses of dyestuff and chemical manufacturers or their agents

Manufacturers of dyestuffs and chemicals are too numerous to be listed here. However, an extensive list of dyestuff manufacturers can be found in Volume 5 of the Colour Index together with trade names of dyes listed by their Colour Index Generic Name (Colour Index Number). Dyestuff manufacturers frequently also offer a range of dyebath assistants and after-treating agents. There are also companies which specialise in making textile processing chemicals. Only companies able to supply those dyes (or their near equivalents) and proprietary chemicals mentioned in this handbook are given. Sources of common chemicals such as salt and soda are not included. Abbreviations used in the text for the names of manufacturers are given before the full name and address.

Mention of a particular company or product does not imply recommendation by the Tropical Development and Research Institute to the exclusion of others.

Dyestuff manufacturers or their agents

Amar	Amritlal Chemaux Ltd

	Rang Vdyan
	Sitladevi Temple Road
	Mahim
	Bombay 400 016
	INDIA
AP	
	Atul Products Ltd
	PO Atul
	Valsad 396 020
	Gujarat
	INDIA
ATL	Atlantic Chemical Export
	Corp.
	10 Kingsland Road
	Nutley
	NJ 07110
	USA
BASF	BASF AG

	Carl Boschstrasse 38
	D-6700 Ludwigshafen
	FEDERAL REPUBLIC OF GERMANY
BAY	Bayer AG
	D-5090 Leverkusen-Bayerwerk
	FEDERAL REPUBLIC OF GERMANY
CAS	Cassella AG
	Hanauer Landstrasse 526
	PO Box 6000
	Frankfurt/M 61
	FEDERAL REPUBLIC OF GERMANY
CE	Chemiequip Ltd
	501 Embassy Centre
	Nariman Point
	Bombay 400 021
	INDIA
CGY	Ciba-Geigy AG

	CH-4002 Basel
	SWITZERLAND
Chem	Chemapol AG
	Kodariska 46, C S 100 10
	Prague 10
	CZECHOSLOVAKIA
CKC	Crompton and Knowles
	Dyes and Chemicals
	International Division
	PO Box 33188
	Charlotte
	NC 28233
	USA
	Durham Chemicals
	Distributors Ltd
	55 - 57 Glengall Road
	London SE 15 6NO

	ENGLAND
Dylon	Dylon International Ltd
	Worsley Bridge Road
	Lower Sydenham
	London SE26 5HD
	ENGLAND
FDN	N.V. Frado
	Tilburg
	THE NETHERLANDS
FW	Chemie-Export-Import
	Storkowerstrasse 133
	DDR-1055 Berlin
	GERMAN DEMOCRATIC REPUBLIC
HOE	Hoechst AG
	ATA Geschaftsbereich
	D/Farben
	Postfach 80 03 20

	6230 Frankfurt/M 80
	FEDERAL REPUBLIC OF GERMANY
ICI	Imperial Chemical Industries
	plc PO Box 42
	Hexagon House
	Blackley Manchester M9 3DA
	ENGLAND
IDI	Indian Dyestuff Industries Ltd
	Mafatlal Centre Nariman
	Point Bombay 400 021
	INDIA
KYK	Nippon Kagaku Co. Ltd
	Tokyo
	JAPAN
LBH	Holliday Dyes and Chemicals
	Ltd
	PO Box B22

	Leeds Road
	Deighton
	Huddersfield HD2 1UH
	ENGLAND
Mult	Multichrom SAIC
	Almirante Brown 778
	Ramos Mejia-Pcia
	Buenos Aires
	ARGENTINA
NSK	Sumitomo Chemical Co. Ltd
	Osaka
	JAPAN
POL	CIECH
	Jasna 12
	Postfach 271
	PL-00-950 Warsaw
	POLAND

	PO LAND
PyO	Pigmentos y Oxidos SA
	Ave. Industrias Pte. 930
	Apartado Postal No. 844
	Monterrey
	N.L.
	MEXICO
RBM	S.A. Rovira, Bachs y Macia
	Avda. Jose Antonio 744
	Barcelona 13
	SPAIN
Roum	Chimimportexport BD
	Republicii 10
	Postfach 1-74
	R-70033 Bucharest
	ROUMANIA
Sandoz AG Lichstrasse 35	
	CH-4002 Basel

	CH-4002 Basel
	SWITZERLAND
VIL	Vilmax SA
	Parera 114
	Buenos Aires
	ARGENTINA
YCL	Yorkshire Chemicals plc
	Kirkstall Road
	Leeds LS3 ILL
	ENGLAND

CHEMICAL MANUFACTURERS OR THEIR AGENTS
Cargo Fleet Chemical Co. Ltd
Eaglescliffe Industrial Estate
Eaglescliffe
Stockton-on-Tees
Cleveland TS16 OPN
ENGLAND
(Agents for products of ICI Petrochemicals Division, e.g. Synperonic BD)

Durham Chemicals Distributors Ltd
55 - 57 Glengall Road
London SE 15 6NQ
ENGLAND

Rudolf and Co. KG
Spreestrasse 3 - 7
Postfach 749
D-8192 Geretaried 2
FEDERAL REPUBLIC OF GERMANY

Sandoz AG
Lichstrasse 35
CH-4002 Basel
SWITZERLAND

Textile Dyestuffs and Chemicals Ltd
Cliffe Road
Brighouse
West Yorkshire HD6 1HD
ENGLAND

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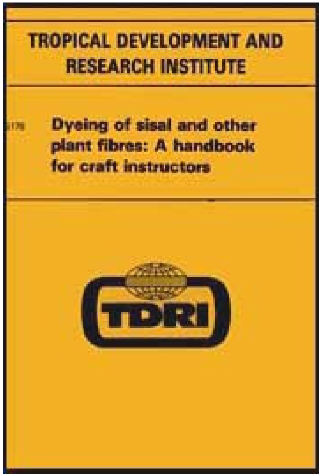

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NOTE

Mention of a particular company or product does not imply recommendation by the Tropical Development and Research Institute to the exclusion of others.

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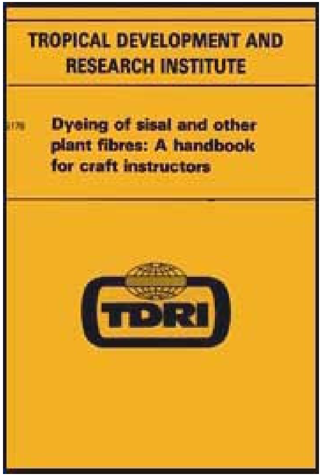

Dyeing of Sisal and other Plant Fibres: A Handbook for Craft Instructors (NRI)

Summaries

Summary

Dyeing of sisal and other plant fibres: A handbook for craft instructors

This report is intended primarily to help craft instructors in the tropics to obtain better quality dyeings on sisal and similar fibres.

General advice is given on the chemicals and equipment required. The basic principles of dyeing are described followed by some elementary economics and advice on using a dye recipe. A colour map is included. Methods of testing for light and water fastness are described.

Detailed instructions for using reactive, direct, acid, basic and disperse dyes are given together with some practical observations on selected dyes.

Rsum

Teinture des fibres de sisal et d'autres fibres vegetales: Manuel pour techniciens-instructeurs

L'objet de ce rapport est en premier lieu d'aider les techniciens-instructeurs dans les pays tropicaux a obtenir des teintures de meilleure qualit, des fibres de sisal et autres fibres de m,m, type.

Des recommandations gnrales vent donnes en ce qui concerne les

produits chimiques et l'quipement ncessaires. Les principes fondamentaux de la teinture vent dcrits, suivis de quelques notions lmentaires concernant l'conomie et de conseils pour l'utilisation d'une formule de colorant. Une carte de couleurs est incluse. Les mthodes de contrle de la stabilit a la lumire et a l'eau vent dcrites.

Des instructions dtailles pour l'utilisation de colorants ractifs, directs, acides, basiques et disperses vent compltes par quelques observations concernant des colorants choisis.

Resumen

El tenido de sisal y de otras fibras vegetales: Manual pare los instructores del oficio

Este informe tiene como fin principal ofrecer ayuda a instructores del oficio en los tropicos, de modo que puedan obtener tenidos de mejor calidad con sisal y otras fibras similares.

Se facilita asesoramiento general en torno a los productos qumicos y equipos requeridos. Se describen los principios bsicos del tenido, seguido de ciertos aspectos de tipo economico, as' como de

asesoramiento sobre como usar una receta de tenido.

Se incluye un mapa de colores y se describen mtodos para comprobar las resistencias a la luz y el agua.

Se incluyen instrucciones detalladas para el uso de tintes de tipo reactivo, directo, cido, bsico y disperso, junto con algunas observaciones practicas sobre los tintes selectos.

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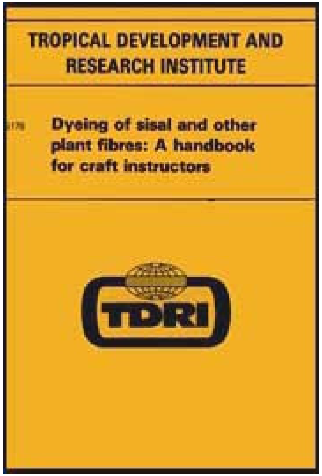

Glossary

Acid dye	an anionic dye (see Anionic dye) which forms ionic links with cationic substances in the fibre.
Affinity	within the context of this handbook affinity is an attraction between the dye and the substrate.
Anionic dye	a dye that gives negatively-charged coloured ions
Balance	sensitive scales used in laboratories for weighing materials accurately.
Basic dye	a cationic dye (see Cationic dye) which forms links with

Basic dye	a cationic dye (see Cationic dye) which forms links with anionic substances in the fibre.
Batchwise processing	a process in which the whole of the material passes through each treatment as a single unit (batch). It thus differs from continuous processing in which all the material passes successively through each treatment stage as for example when a roll of cloth passes through a bath from beginning to end.
Baum (° Be)	an arbitrary scale of specific gravities (see Specific gravity) devised by French chemist Antoine Baum.There are two scales having, at 60° F, the following relationships to specific gravity:
	(i) Materials more dense than water
	°B= (145 - 145)/Specific gravity
	(ii) Materials less dense than water
	°B = (1 40 - 1 30)/Specific gravity
	(Appendix 1, Table C uses the scale for materials more dense than water).
Blending	mixing two or more different dyes in order to match a

	particular hue (see Hue).
Cationic after-treating	a colourless basic dye which is applied to fibre dyed agent with direct or reactive dyes to make the dye more water fast by forming larger molecules which migrate out of the material less readily.
Cationic dye	a dye that gives positively-charged colouredions
Cellulosic	made of or containing cellulose - a chemical, based on the sugar glucose, found in all plants. Some fibres, e.g. cotton, consist almost entirely of cellulose; others, such as jute and sisal, consist of about 70 per cent cellulose.
Colour Index	an authoritative, descriptive catalogue of natural and synthetic colourants and intermediates in terms of generic name and constitution where disclosed.
Complex	a large molecule formed by an association between two or more smaller molecules. Complexes may be formed between dyes and metals (as in 1:2 metal complex dyes) or between cationic after-treating agents (see Cationic after-treating agent) and dyes containing anionic water solubilising groups (see Anionic dye).
Contrast	the degree of visible difference between two adjacent

	materials. For example black and white produce a high contrast whilst grey and white or grey and black produce a lower contrast.
Depth	the colour quality that is associated with the amount of dyestuff present. Increased dyestuff gives increased depth. In dyeing, depth is usually the amount of dyestuff used in the dyebath expressed as a percentage of the weight of air-dry fibre dyed (see also Standard depth).
Direct dye	an anionic dye having substantivity (see Substantivity) for cellulosic fibres
Disperse dye	a dye which will disperse but not dissolve in water and be adsorbed by certain synthetic fibres (e.g. polyester, acetate, nylon).
Dispersol dye	an Imperial Chemical Industries plc (ICI) brand of disperse dye.
Dylon Cold	reactive dyes packaged in sizes convenient for the home dyer marketed by Dylon International Ltd.
Dylon Multi-purpose	International Ltd, which will colour almost any textile material.a blend (see Blending) of dyes marketed by Dylon dye
Exhaust	-a batchwise dyeing process (see Batchwise processing) in

dyeing	which the dye is attracted to, and gradually adsorbed onto, the material from a large volume of liquor, until the dye in the liquor is exhausted. The dyebath is discarded on completion as opposed to the use of a standing bath (see Standing bath. See also Pad-batch dyeing).
Fastness	the ability of a colour to resist change when exposed to light or water, etc.
Generic Name	the ColourIndex classification of a colourant or intermediate according to application properties. Dyestuffs which share the same Colour Index Generic Name usually contain the same chemical as their major component.
Hue	the visual colour, e.g. red, blue, green, etc. (See also Shade).
Insoluble	chemicals which remain solid when stirred in a liquid (see Disperse dyes).
Ionic	chemicals which in solution yield anionic and cationic particles (ions) (see Anionic dye and Cationic dye).
Liquor	the liquid containing the dissolved chemicals used for processing textiles.
Liquor ratio	the ratio of the weight of liquor used in processing to the

	weight of air-dry material processed, e.g. Iiquor ratio 20:1 means, for example, 20 kg of liquor used on 1 kg air-dry material. Low liquor ratio is called a 'short' liquor; high liquor ratio is called a 'long' liquor.
Metal complex dye	a dye comprising simple dye molecules complexed with a metal to form larger, more water fast molecules -a 2:1 metal complex has two dye molecules associated with one metal atom.
Molecule	the smallest particle of a compound which can exist as that particular chemical substance. It is composed of atoms-the smallest particle of a chemical element that can exist as a discrete substance. Some molecules (e.g. sodium chloride! are made up of only two atoms (one of sodium and one of chlorine) whilst others (dye molecules for example) are composed of around 1 00 atoms.
Normal depth see	
Pad-batch dyeing	Standard depth. methods of dyeing in which the dye is first 'padded' on the material (see Padding) and the material is then left for a period of time to allow the dye to penetrate into and fix onto the fibres ('batching') (see Canning et al.

	(1977)).
Padding	distributing liquor throughout the material, often by dipping and then squeezing to remove the excess.
Procion MX dye	-a dyestuff made by Imperial Chemical Industries plc (ICI), which reacts chemically in the cold with cellulose. The reacted dye cannot be removed from the cellulose by ordinary physical means, e.g. washing .
Reactive dye	a dye which is designed to react chemically with the substrate (see Substrate).
Sequestering agent	a compound which prevents metallic ions from causing unwanted reactions by forming a complex with them.
Shade	term used in dyeing to describe the depth of colour, e.g. 'light', ‘dark','pale', 'deep', etc. (see also Depth and Standard depth).
Sisal	a coarse, hard, stiff sisalana .fibre obtained from the leaf of Agave
Sodium bicarbonate	a mild alkali used with TDRI's pad-batch dyeing method to fix the dye. This chemical is also commonly called bicarbonate of soda.
Sodium	a non-caustic alkali which is stronger than sodium

Sodium carbonate	a non-caustic alkali which is stronger than sodium bicarbonate. The anhydrous powder is known as soda ash and the hydrated crystals are 'washing soda'.
Space-dyeing	the production of multi-colour yarns by the application of various dyes at intervals along a yarn.
Specific gravity (Sp.gr.) -	the ratio of the weight of a substance to the weight of the same volume of water.
Standard depth	an arbitrarily chosen medium visual depth, judged to be equal for all hues, which enables dyeing, fastness or other properties to be compared on a uniform basis. Conventionally, standard, or normal, depth is symbolised '1/1 N'; lighter depths as, e.g. '1/3N'; and heavier depths as, e.g. '2/1 N'.
Substantivity	an attraction between a fibre and a dyestuff.
Substrate	the material to which dye is applied.
Synacril dye	an Imperial Chemical Industries plc (ICI) brand of basic dye.
Tinctorial yield	a measure of the strength of a dye. Some dyes (of high tinctorial yield) produce a deep shade with a small amount of dye, whilst others (of low tinctorial yield) give only a pastel

	shade with the same amount of dye.
Twaddell (°Tw)	a system used for reporting the densities of liquids which are heavier than water. The relationship with specific gravity (see Specific gravity) is: Specific gravity = ((°Tw X 5) + 1,000)/1,000
Vegetable dyes	colouring matters, usually of unknown character and composition, obtained from plants.

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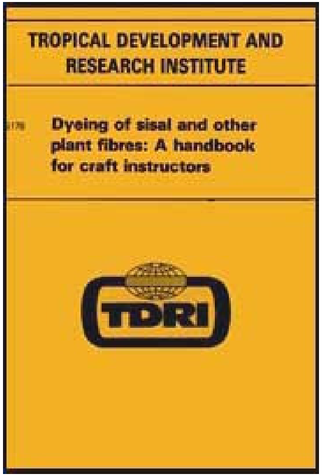

Dyeing of Sisal and other Plant Fibres: A Handbook for Craft Instructors (NRI)

Safety precautions and first aid treatment

Safety precautions

Chemicals (dyes, dyeing assistants, wetting and penetrating agents, after-treating agents, etc.) can cause severe burns and may irritate the eyes, respiratory system and skin. Some chemicals are poisonous when swallowed or absorbed through the skin or mouth.

Accidents can usually be prevented by maintaining a clean and tidy working area, wearing protective clothing (aprons or overalls, gloves, facemasks, goggles) and always taking safety precautions. Instructors should stress these points at every opportunity.

If chemicals must be used, the following precautions must be observed:

1. Avoid contact with the chemical. Always wear protective clothing.

2. Avoid breathing the dust or vapour. Always wear facemasks. Use narrow-mouthed beakers, jars or bottles whenever possible. Pour or spoon carefully.

3. Avoid using concentrated solutions whenever possible.

4. Avoid handling large containers of chemicals whenever possible. Transfer some of the chemical to a smaller container-accurate pouring or spooning is then much easier and safer.

5. Always wipe up spillages immediately and rinse the cloth thoroughly.

6. Always wash all utensils thoroughly after use.

7. Always wash hands thoroughly with soap and water after using any chemicals.

First aid treatment

Splashes of chemicals on the skin

1. Flood the splashed area with large quantities of running water

and continue for at least 10 minutes.

2. Remove all contaminated clothing, taking care not to cause further contamination.

3. If the situation warrants it, arrange for transport to hospital or refer for medical advice to the nearest doctor. Provide information to accompany the casualty on the chemical responsible and brief details of the first aid treatment given.

Splashes of chemicals in the eye

1. Flood the eye thoroughly with large quantities of gently running water either from a tap or from an eyewash bottle and continue for at least 10 minutes.

2. Ensure the water bathes the eyeball by gently prising open the eyelids and keeping them apart until the treatment is ended.

3. All eye injuries due to chemicals require medical advice. Arrange for transport to hospital. Provide information to accompany the casualty on the chemical responsible and brief details of the first aid treatment given.

Ingestion of poisonous chemicals

1. If the chemical has been confined to the mouth, give large quantities of water as a mouth wash. Ensure that the mouth wash is not swallowed.

2. If the chemical has been swallowed, give copious drinks of water or milk to dilute it in the stomach.

3. Do not induce vomiting.

4. Arrange for transport to hospital. Provide information to accompany the casualty on the chemical swallowed and brief details of the first aid treatment given and if possible an estimate of the quantity and concentration of the chemical consumed.

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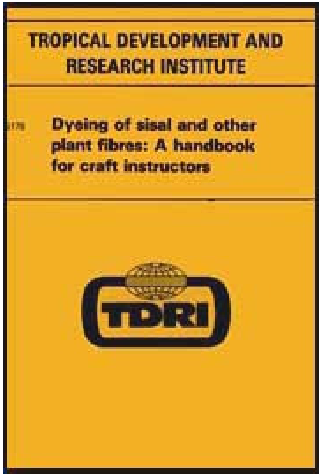
Dyeing of Sisal and other Plant Fibres: A Handbook for Craft Instructors (NRI)

(introduction...)



Introduction

Sisal can be dyed in a wide range of bright colours which are water and light fast. However, to obtain good quality colours, it is important to choose the correct dyes from the large range available and to use them properly. This handbook is based on research carried out at the Tropical Development and Research Institute (TDRI) (formed by the amalgamation of the Tropical Products Institute and the Centre for Overseas Pest Research) into the

improvement of the quality of colours used on craft goods made from sisal and other plant fibres. Although it is intended primarily for craft instructors in the tropics it should be useful to managers of craft co-operatives and to teachers in schools and colleges.

In Part 1 the raw materials are described, followed by general advice on the chemicals and equipment required and the buying of dyes. The basic principles of a good dyeing technique are then described, together with some elementary economics and an explanation of some terms used in a dyeing recipe. Finally, methods of testing for fastness are described.

Part 2 deals in greater depth with the classes of dye which have been found to be suitable for use on sisal, namely the reactive, direct, ionic (acid and basic) and disperse dyes. (A supplement to this handbook (Canning and Jarman, 1983) presents tabulated information on the fastness properties of a large number of dyes applied to sisal or abaca. These tables should assist the dyer to choose the most suitable dye for a particular application).

Although it deals with the dyeing of wool, the craft instructor will find much useful practical advice on craft dyeing in Weaving Guide

Lesotho Project Primer, No. 2 (White, 1981).

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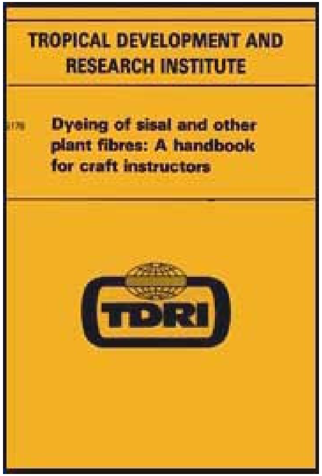


Dyeing of Sisal and other Plant Fibres: A Handbook for Craft Instructors (NRI)

Part 1: Basic information and essential requirements

Materials and equipment

Fibres

Sisal is obtained from the thick leaves of a tropical plant known to the botanist as Agave sisalana (Lock, 1969). It is grown mainly in East Africa and Brazil, most of it on large plantations (see Plate 1) using power driven machines for its extraction, although good quality fibre is extracted by smallholders using simple tools (details can be obtained from TDRI). Henequen is obtained from the leaves of the plant Agave fourcroydes which is grown in Mexico (see Plate 2). It is extracted in a similar way to sisal. Fique and cabuya (Furcraea spp.) from Colombia, and Mauritius fibre (Furcraea gigantea var. willemettiana) are all extracted from leaves (Kirby, 1963).

Abaca is extracted from the leaf-sheath of the plant Musa textilis which is grown mainly in the Philippines, but also in Ecuador (Kirby, 1963). The closely-related banana plant also yields a useful fibre (Jarman et al., 1977).

Fibres extracted from plant stems by resting, such as jute

(Corchorus capsularis and C. olitorius) from Bangladesh and India (Dempsey, 1975), and kenaf (Hibiscus cannabinus) from Thailand, can also be dyed using the methods described in this handbook.

Coir (Jarman and Jayasundera, 1975) or coconut fibre (from India and Sri Lanka) is extracted from the husks of the coconut palm Cocos nucifera. The natural brown colour of unbleached coir limits the range of possible hues and the fibre is less readily penetrated by dyes than is sisal. Not all the dyes mentioned in this handbook will therefore be suitable for coin

Selection of fibre

The first step towards good quality colour is to choose suitable material for dyeing. Some strands of sisal are pale cream whilst others are light brown. Different hues (see Glossary) will be produced even though the same recipe is used to dye them. If a uniform colour is required the fibre must therefore be all the same colour. It is important also to choose light-coloured fibre if bright colours are required.

Fibres of different fineness and also fibres from plants grown in

different localities will dye differently. Batches from different sources should therefore either be dyed separately or mixed thoroughly before dyeing.

Variation in the chemical composition of fibres can also affect the fastness properties: 'woody' or lignified fibres, such as sisal, jute, and coir, give colours that are less light fast than those on pure cellulosic fibres such as cotton and flax.

Dyeing loose fibre, yarn and cloth

Sisal is best dyed in the form of loose fibre. In yarn or woven structures the sisal is tightly packed and the liquor therefore cannot circulate freely round each fibre strand and the colour will not be evenly distributed throughout the material. Dyed yarns often contain a core of undyed fibres which become exposed during wear, producing a faded appearance. However, this problem does not arise if the sisal is dyed before it is spun. Pad-batch dyeing (see Glossary) gives much better penetration of the dye.

The dyeing of the fibre before spinning has the added advantage that fibres of different colours can be blended (see Glossary) to produce

interesting colour effects in the finished yarn. Blended fibres will give a yarn of mixed hues whilst blends of white and coloured fibres will appear of overall lighter colour. Light colours produced in this way will be more light fast than when the dye is in a pale shade in all the fibres.

It is possible to dye fibre in the form of woven cloth or matting but the need to obtain good penetration is just as important as in the case of yarn.

Dyestuffs

Only modern synthetic dyestuffs are dealt with in this handbook. They are readily available in most parts of the world and are easy to use. Natural dyes are of variable composition and hence difficult to match, and their use requires considerable skill (Crouch, 1981).

Different fibres present different dyeing problems, and today dye manufacturers offer dyestuffs designed for particular types of fibres. Although each individual dyestuff can only be used successfully on certain fibres, many dyes are similar and have been grouped into a number of classes according to use. The Colour Index (Society of

Dyers and Colourists/American Association of Textile Chemists and Colorists, 1982) gives the classification of dyes; it also lists similar dyestuffs which are available from different manufacturers.

Unfortunately, there are no dyestuffs specially developed for sisal but, since it has similarities to other textile fibres, a number of dyestuffs which may be used to colour sisal can be selected from the wide range of dyes intended, for example, for cotton, wool and polyester. For craft work, however, only the following groups of dyes are recommended:

(i) Reactive
(ii) Direct
(iii) Acid (Anionic)
(iv) Basic (Cationic)
(v) Disperse

Reactive dyes (see Glossary) are generally the most useful group for the craft worker. They can be obtained in small packs and are widely available (see Plate 3). They are also easy to use and give good quality, durable colours. Furthermore, unlike other groups of dyes, they can be used with the mad-batch' (see Glossary) method of

dyeing which gives good penetration of the dye into the interior of spun yarns and can also be used for dyeing ropes.

Some colours produced from selected direct and acid dyes (see Glossary) have better light fastness than those produced from reactive dyes. However, many acid and direct dyes have poor-to-moderate water fastness on sisal. For most craft goods (except for floor and wall coverings) high light fastness is rarely needed.

Basic and disperse dyes (see Glossary) generally produce colours of poor light or water fastness, or both, on sisal but they are generally useful when a high degree of durability is not needed (such as for beach hats, which are soon discarded). However, a few of the dyes give colours of good quality.

Identifying dyes

Dyes are often bought from local stores or in bazaars-the craft worker will therefore not always find it easy to identify the group to which a dyestuff belongs. However, for workers who must use such sources the following information should prove useful:

Reactive dyes are easily recognised from the instructions provided.

In these it will be stated that the dye is suitable for cotton and linen, and is used in cold water. Soda, or a proprietary brand of fixing agent, will also be used in the process. It may also be stated that the dye is suitable for wool but different instructions are given for dyeing this fibre. 'Dylon Cold' dyes are reactive dyes; but care should be taken that these dyes are not confused with Dylon's similarly-packed 'Multi-purpose' dyes.

Direct dyes are also fairly easy to recognise. The instructions will state that the dyes are suitable for cotton and, possibly, wool. They will instruct the user to apply the dye from hot water to which salt only is added. Some direct dyes sold in the domestic market are also claimed to be suitable for leaf and best fibres.

Acid and basic dyes are difficult to distinguish as both may be used on wool. However, since they are both applied from hot water to which a little acid has been added, correct identification is not of great practical importance. Most dyes that are sold in bazaars, etc. for straw dyeing are basic dyes; dyes recommended for wool alone are probably acid dyes.

It is unlikely that disperse dyes will be found on the domestic

market, except in mixtures. Individual craft workers therefore need not consider this type of dye, although it might be used at craft centres.

Multi-purpose dyes are mixtures of dyes designed to colour almost any textile fibre. They can be used on sisal but the shades produced will probably be of poorer water fastness than on other textile fibres. Workers who use these dyes should follow the manufacturer's instructions but should extend the boiling period. The dyes are easily recognised from the instructions since the manufacturers will claim that the dyes are suitable not only for natural fibres such as cotton, linen and wool, but also for synthetic fibres such as acetate, nylon and polyester.

Blending dyes

The craft dyer is often asked to match a particular colour. However, even with a large number of dyes to hand, it is usually not possible to obtain a match with a single dye. Therefore, it is necessary to mix together or blend dyes to obtain a matching shade.

In theory, by blending together in different proportions two or three

dyes giving bright hues of yellow, magenta (a bluish red) and cyan (a greenish blue), it is possible to obtain almost any colour. However, suitable dyes with these bright colours are rarely available and are usually expensive, but the practical dyer should be able to produce an adequate shade range from cheaper alternatives.

By making use of the colour map inside the back cover of this handbook the dyer will obtain some idea of the hues which can be obtained by blending together whichever dyes are to hand. The bright colours are located at the edge of the map, and shades typically produced in practical dyeing are enclosed by the lines joining the points marked 'yellow', 'red' end 'blue'. It will be seen from the edge of the map that gradually increasing the proportion of one of these colours relative to another gives a progressive change in hue.

Adding the third colour in increasing proportions gives a progressive dulling, shown by crossing the map from the edge to the grey centre, and produces first either olive greens, navy blues, maroons or browns and (depending on the depth of shade) finally greys and blacks.

The map also gives some idea of the shades which can be obtained by blending dyes which are not yellow, red or blue. With two dyes, a line drawn between their two colours passes approximately through the possible range of hues; with three dyes, lines joining the three colours approximately enclose the possible range of hues.

Dyes from different sources may vary in strength-sometimes even those of the same Colour Index Generic Name (Colour Index Number) from the same manufacturer-therefore the amount of dye needed when matching a hue may vary. When using the same dyestuffs all the time, it is possible to estimate almost exactly the required quantities at the first attempt. However, even slight variations in the dyeing technique will affect the amount of dye taken up and it will therefore usually be necessary to make final adjustments to the blend to produce a colour that is of the desired hue. Table 1 gives examples of the hues obtained on sisal using three ICI 'Procion MX'dyes: Procion Yellow MX-8G, Procion Red MX-5B and Procion Blue MX-3G.

Procion Yellow MX-8G parts by weight	Procion Red MX-5B parts by weight	Procion Blue MX-3G parts by weight	Hue obtained

100	–	–	Greenish yellow
99	1	–	Yellow (pale shades) Golden yellow (deep shades)
95	5	–	Yellowish orange to reddish orange
80	20		
70	30	–	Scarlets
50	50	–	
40	60	–	Reds (slightly blue in pale shades at 20/80)
20	80	–	
10	90	–	Reds
–	100	–	
–	90	10	
–	80	20	Rubines (plums)
–	50	50	
–	40	60	Purples (violets)
–	20	80	
–	10	90	Reddish blues (violet in pale shades at 10/90
–	5	95	
–	2	98	Blues
–	–	100	
5	–	95	Greenish blue
20	–	80	Bottle green
30	–	70	Deep greens

40	–	60	Deep greens
50	–	50	Leaf greens
70	–	30	
80	–	20	Lime greens
90	–	10	
95	–	5	Greenish yellow
96	2	2	Golden yellow
88	6	6	Golden brown
80	10	10	Orange brown
70	15	15	Brown
60	20	20	Reddish brown
40	30	30	Maroon
20	40	40	Bordeaux
26	16	58	Dark brown
20	12	68	Reddish grey
20	10	70	Greenish grey
21	6	73	Dark olive
12	6	82	Bluish grey

Table 1 - Main hues obtained using mixtures of three ICI 'Procion MX' dyes

Dyes selected for blending must: (i) be compatible with each other, and with the material to be dyed; and (ii) produce colours that are of similar fastness. (Basic dyes are not compatible with direct, reactive or acid dyes since they will react in the dyebath to form a complex).

One cannot be certain that a mixture of dye powders, however thoroughly they are mixed, will remain uniformly distributed in the container. It is better, therefore, either to weigh out the dyes and mix them just before use, or to dissolve them separately and mix the solutions before use.

Chemicals

Certain chemicals are needed in the dyebath either to help the fibre adsorb the dye or to help the dyer produce level colours (colours that are evenly distributed over the fibre surface). Alternative chemicals to those recommended by the dyestuff manufacturer can often be used. The following chemicals are commonly used in dyeing.

Dyeing assistants

Salt

Salt is used with reactive and direct dyes to help the fibre adsorb the dyestuff. Common salt (e.g. that used in cooking), sodium chloride, is normally used nowadays as it is usually cheaper and more readily available than the alternative, Glauber's salt (sodium sulphate). With most dyes either can be used but sometimes a dye manufacturer will indicate the preferred chemical.

Glauber's salt can be obtained in two forms crystalline and calcined. The crystalline form, although dry to the touch, contains water of crystallisation in a quantity approximately equal to the weight of actual sodium sulphate, so that if only crystals are available the quantity used must be twice the required amount of the calcined salt.

The quantity of salt used in the dyebath is usually similar for both the common salt and the calcined Glauber's salt; an equal weight of calcined Glauber's salt may therefore be used as a substitute for the common salt. However, some differences in shade may result from using different types of salt.

Safety note: Glauber's salt although not poisonous should not be taken by mouth.

Soda ash

Soda ash (commercial anhydrous sodium carbonate) is used with reactive and direct dyes. Washing soda crystals can be used as an alternative but, as in the case of Glauber's salt crystals, allowance must be made for the water of crystallisation they contain. Approximately 3 times (2.7 exactly) the weight given for soda ash is needed if washing soda crystals are used. For example, 37.8 9 (14 X 2.7 9) of washing soda must be used to substitute for 14 9 of soda ash to give the correct concentration of sodium carbonate in the dye liquor. As washing soda gradually loses its water of crystallisation it cannot be used to give exact weights of sodium carbonate and it is always preferable to use soda ash-especially when matching shades.

Sodium bicarbonate

Sodium bicarbonate, sometimes called bicarbonate of soda or sodium hydrogen carbonate, is a weak alkali used in pad-batch dyeing (see Glossary) with reactive dyes.

Acids

Acid dyes (including 1: 2 metal complex, see Glossary) and basic dyes are best applied from an acid solution. For dyeing sisal it is recommended that only acetic and formic acids are used. These relatively weak acids are not likely to damage the fibre, but if neither can be obtained dilute sulphuric acid can be used instead. This is a strong acid which is dangerous to handle even when in a dilute solution and, if used to excess, will damage the fibre. The craft worker should never handle concentrated sulphuric acid or attempt to dilute it. Only dilute solutions should be used and these can be obtained from the chemical supplier.

Some ordinary acid dyes will dye deep shades from a dyebath containing acetic acid or vinegar, thus avoiding the need for replacing formic acid with a stronger acid such as sulphuric acid. Acetic acid is also used in the copper after-treatment of selected direct dyes.

Acids are sold commercially at various concentrations and, in order to ensure that the correct amount is used, dyeing instructions give the quantity of the particular acid to be used at a specified

concentration. However, the initial concentration of the acid used is not important so long as the final quantity in the dyebath is that required. For instance, it makes no difference whether 60 9 of 30% acid or 30 9 of 60% acid is used.

Acetic acid

Safety note: Acetic acid causes burns. Avoid breathing the vapour and contact with the eyes and skin (see Safety precautions and first aid treatment).

Traditionally, the concentration of acetic acid quoted in dyeing instructions is 30% by weight. Nowadays, however, other concentrations, e.g. 60% or glacial (100%) acetic acid are sometimes quoted. Equivalent quantities are calculated as simple proportions. As acetic acid is sometimes labelled with its specific gravity only, a conversion table is given in Appendix 1, Table A.

Glacial acetic acid can sometimes be obtained from suppliers of photographic chemicals. However, since it is an unpleasant chemical, craft workers should dilute this acid in a measured proportion before use.

Glass, china or enamelled vessels should be used when diluting the acid since the concentrated acid softens or dissolves some plastic materials. The concentrated acid should be used in containers with narrow openings and, when open, should be held well away from the face to avoid breathing the acrid fumes. Since many dyeing instructions specify weights of 30% acid, and since it is easier to measure solutions by volume than by weight, it is suggested that, for convenience, a solution containing 30 grams/litre (9/l) of the 100% acid is prepared; 10 ml of this solution can then be used in place of each gram of 3096 acetic acid in the instructions*. This solution can be prepared safely as follows:

1. If the concentrated acid is supplied in a large bottle carefully pour acid from it into a small bottle using a funnel.

2. Measure 970 ml of water into a measuring cylinder and pour into a one litre bottle. Then pour 30 ml of acid from the small bottle into the cylinder and pour into the litre bottle. Mix thoroughly and label.

Vinegar is a very impure form of acetic acid containing about 5 per cent by weight of acetic acid, but it can be used (6 ml for every 1 g of 30% strength acid needed) if the pure acid cannot be obtained.

Formic acid

Safety note: Formic acid causes burns and is irritating to the skin, eyes and respiratory system. Avoid breathing the vapour and avoid contact with the skin and eyes (see Safety precautions and first aid treatment).

Traditionally, the concentration of formic acid quoted in dyeing instructions is 85%: 100 9 of 85% formic acid contains 85 9 of formic acid.

Quantities of other concentrations are calculated by simple proportion. In Appendix 1, Table B specific gravities and percentage concentration by volume of formic acid are converted to percentage concentration by weight.

Formic acid should be obtainable from suppliers of pharmaceuticals, or industrial or laboratory chemicals. Laboratory grades are of about 98% strength but for practical purposes these may be regarded as 100% formic acid.

Concentrated formic acid is an unpleasant chemical to handle. It should therefore be diluted to a solution containing 85 g/l, 10 ml of

which will replace each gram of 85% formic acid required.

Sulphuric acid

Safety note: Sulphuric acid in concentrated form reacts violently with water and should never be used by the craft worker. The concentrated acid burns the eyes and skin severely. Even in diluted form it irritates the eyes and may cause burns; it will irritate the skin and may give rise to dermatitis (see Safety precautions and first aid treatment).

The use of sulphuric acid with sisal is not recommended as it will almost certainly have a tendering (weakening) effect on the fibre. Moreover, it is an extremely corrosive liquid and must be handled very carefully. If craft workers have to use this acid it should be used only in diluted form. Sulphuric acid would normally be used only as an alternative to formic acid, which is stronger than acetic acid, but it could be used carefully as a substitute for the weaker acetic acid if vinegar is not available.

It is suggested that a solution containing 100 9/l is obtained of which 10 ml can be used to replace each gram of 85% formic acid

specified in the instructions.

As with formic and acetic acids, sulphuric acid is sold in a range of concentrations. These concentrations are measured in different ways, e.g. degrees Baum, (°Be), degrees Twaddell (°Tw), or as specific gravity (Sp.gr.). In Appendix 1, Table C the percentage concentration of sulphuric acid solutions measured in these units is given.

Although in wool dyeing equal amounts of either 85% formic acid or 98% sulphuric acid are used, it is recommended that workers who must use sulphuric acid should experiment a little. It is suggested that only a small amount of acid is added at the commencement of dyeing (e.g. about 0.5 9/100 9 of fibre) with further small additions throughout the dyeing. Alternatively, after the small addition at the commencement of dyeing, the remaining quantity could be added in the final stages of dyeing (e.g. 10 - 15 minutes before removing the fibre from the liquor) or a reduced amount added-probably without adverse effect on the depth of colour produced. Either method could help to preserve the strength of the fibre.

The dyed fibre should be rinsed well and, if possible, steeped in a

solution of sodium acetate (4 g/l) before drying in order to remove traces of sulphuric acid from the fibre. This is because sulphuric acid, unlike acetic and formic acids, is not volatile and will become concentrated within the fibre on drying, causing damage to the fibre substance. Sodium acetate may be obtainable from some chemists. If not it will be necessary to contact one of the suppliers of chemicals listed in Appendix 3.

Wetting and penetrating agents

Wetting and penetrating agents are chemicals which, when added to the dyebath, help the water to wet and penetrate the fibre. Most wetting and penetrating agents decrease the size of dye particles in solution. These smaller particles diffuse more rapidly into the fibre and deposit more evenly over the fibre surface. However, because the dye is more soluble, the dye liquor retains more dye and less exhausts (see Glossary) onto the fibre. Nevertheless the improvement in the quality of colours usually justifies the small loss of dyestuff.

A few words of caution are needed on the use of wetting and penetrating agents. There are a large number of these sold under

different names by dyestuff manufacturers and the results obtained are not always the same. As in the case of dyes, the agents can be anionic (acidic), cationic (basic), or non-ionic, and the ionic nature of an auxiliary can influence the behaviour of the dye. Anionic wetting agents could, for example, compete with acid dyes for a site on the fibre. This would slow down the rate at which the dye deposits on the fibre and this, although helping the dyer to produce a level colour, would cause the transfer of dye to the fibre to be incomplete at the end of dyeing. Similarly, if an anionic agent is used with a basic (cationic) dye the agent would have a direct affinity for the dye. This could cause the dye to remain in the dye liquor or, if the choice of dye and agent is totally unsuitable, cause an insoluble complex (see Glossary) of the dye and agent to precipitate in the dyebath. It is recommended, therefore, that craft workers use the non-ionic wetting and penetrating agents, such as Synperonic BD, with which the authors have experienced no difficulties using any of the dyes mentioned in this handbook.

Craft workers who are unable to obtain special dyeing auxiliaries should experiment with household detergents (e.g. washing-up liquid). Since these products are mainly anionic they should be used with caution with acid or basic dyes. Soap should not be used, as

this would produce scum with hard water.

After-treating agents

Three types of after-treatment are described:

(i) copper after-treatment of selected direct dyes:
(ii) cationic after-treatment of direct and reactive dyes;
(iii) back-tanning of basic dyes.

These treatments are similar in that the dye reacts with the chemical used to form a complex which, being in the form of larger particles than the untreated dye, is more difficult to remove from the fibre, thus improving the water fastness of the colour.

Copper after-treatment

Copper sulphate is an effective after-treatment for improving both the light and water fastness of some, but not all, direct dyes. It is normally supplied as blue crystals which contain water of crystallisation. Instructions for dyeing usually quote the weight of this crystalline copper sulphate needed. There is, however, a white anhydrous form of copper sulphate and if only this can be obtained,

the weight required would be 0.64 times the weight specified for crystals. For example, only 3.2 g (5 X 0.64) of anhydrous copper sulphate is needed to replace 5 9 of the crystals. Copper sulphate can be obtained from some pharmacies, as it is sometimes used as a fungicide.

Safety note: Copper sulphate is poisonous. Avoid contact with the skin and eyes (see Safety precautions and first aid treatment).

As an alternative to copper sulphate, some dyestuff manufacturers* offer special copper-containing agents for after-treating suitable direct dyes and will supply instructions for their use. Some examples of these are:

Coprantex B (COY)
Resofix CV (S)

Copper after-treatments often change the hue of the dye considerably. Trials should therefore be carried out to determine whether the final colour will be acceptable.

Cationic after-treatment

The cationic agents used for after-treating direct dyes are examples of auxiliaries that form a complex with acid dyes (see section on wetting and penetrating agents). As the direct dyes are also acid dyes, in the chemical sense, these auxiliaries also form a complex with the direct dyes. Examples of cationic after-treating agents are:

Levogen WW (BAY)
Matexil FC-PN (ICI)

Although the cationic agents form a complex with acid dyes they are normally only used with direct dyes. As the acid dye particles are much smaller than the direct dye particles, the improvement in water fastness of acid dyes is rarely significant, and the resultant changes in hue and loss of light fastness are usually unacceptable. The agents find some use with reactive dyes and the use of selected agents is a promising alternative to hot water washing to make reactive colours fast. As cationic after treatments cause changes in hue and loss of light fastness, only shades which bleed to an unacceptable degree are treated.

Back-tanning

Basic dyes form a relatively insoluble salt with tannic acid. This salt forms a complex with a salt of antimony making it even more insoluble. Thus, the water fastness of basic dyes can be improved by treatment with tannic acid, followed by addition of an antimony salt (usually tartar emetic, the common name for potassium antimony tartrate). This treatment, known as back-tanning, was formerly used with basic dyes on cotton, which has no direct affinity for these dyes.

For sisal, the treatment is only worthwhile with basic colours which have fairly good light fastness, because in general there is little point in improving the water fastness of a dyed fibre which has poor light fastness.

Tannic acid occurs naturally in many plants (especially tree barks) and many craft workers may have a local supply. Tartar emetic (Potassium antimony tartrate) can probably be obtained from pharmacies.

Safety note: Antimony compounds such as tartar emetic are poisonous, some also irritate the skin, eyes and respiratory system. Tartar emetic must therefore be handled with care (see Safety

precautions and first aid treatment).

Buying dyestuffs and chemicals

Bulk buying

Most large dyestuff manufacturers normally sell dye in minimum packs of 25 kg of a single colour. However, they usually have agencies which will generally supply packs of a size more suited to the small craft dyer. Whilst there is a considerable saving in cost when purchasing dyes in large quantities, only large craft organisations will find it worthwhile.

Buying in small quantities

The UK firm of Durham Chemicals Distributors Ltd (see Appendix 3 for address) will supply, on a cash with order basis, their own dyestuffs and auxiliary chemicals, and a very large selection of those from ICI and BASF, in quantities as small as 1 kg or even 100 9 with some products (e.g. Procion dyes). They will also supply 1 lb packs but these are not standard and would therefore prove more costly.

Dylon dyes are sold in small packs, and should be available to most

craft workers from their local store or market. Packs are of three sizes ranging from about 6 9 to 500 9. Dylon International Ltd (see Appendix 3 for address) will no doubt advise on sources of supply in case of difficulty.

Dyes packaged for home dyeing can usually be obtained from local stores or bazaars. Hints on identifying these are given on p.16.

Craft workers will probably have to obtain disperse dyes directly from the dyestuff manufacturers or their agents.

Equipment

Dye vat

A metal dye vat should be used if it is to be heated directly over a flame. However, when heating is by steam, or with an electric immersion heater, the vessels can be made from a wide variety of materials such as wood, concrete (acid resistant), glazed pottery, or high-melting-point plastics. However, with absorbent materials such as untreated wood, use of a vessel must be confined to a specific dye.

Many dyestuffs are spoilt by the presence of iron or copper. Also, the acids and alkalis used in dyeing attack many metals. Therefore, rusty or bare metal containers must not be used. However, with stainless steel, or enamelled iron or enamelled copper containers there is little risk of contamination. Vessels used for washing fibre can be made of metal, such as zinc (galvanised steel), but not metals which rust.

Where there is a number of dyers all dyeing small quantities of fibre it could save time and money if they formed a dyeing co-operative to purchase a large communal dye vat and to buy dyes and chemicals in bulk.

Other equipment

Scales and measures will be needed if the dyer has to control accurately the hue and depth of colour obtained. Accurate measures make possible the matching of shades on separate batches of fibre- an essential requirement for some customers.

Two or three graduated vessels will be required for accurate measuring of large and small volumes; also a large-capacity scale

for weighing the material to be dyed to an accuracy of 1 9, and a low-capacity scale (e.g. a simple chemical laboratory type balance accurate to 0.1 9) for weighing the dyestuffs and other chemicals.

Measuring water into the dye vat in large-scale operations is tedious when using graduated vessels, and the use of a dipstick will save time. A dipstick can be made by cutting a notch in a straight pole to mark the depth of water in the dye vat at, say, 5-litre intervals the first time the dye vat is filled. A separate dipstick will be needed for each dye vat of different shape or size.

In addition to the equipment mentioned so far, a stout rod for stirring, a robust thermometer, and lines on which to dry the fibre are useful. For large-scale operations, some form of hoist for lifting wet fibre from the dyebath would be very useful (see Plate 4).

Technique

Basic principles

The main purpose of dyeing is to make the finished goods more attractive. However, uneven dyeing and the presence of loose dye will detract from the appearance. Moreover, the customer will not be

pleased if a shower of rain causes the colour to run, spoiling the design and possibly his clothing. Also the goods must be competitive with similar products, and if dyeing adds considerably to the cost of the article or the colours are not sufficiently durable, the prospective purchasers may well turn to alternative products. Cost and durability are both affected by dyeing technique.

It is not possible to describe one ideal dyeing technique, since the choice depends on the customer's requirements and the circumstances of the individual dyer. However, there are certain basic rules that must be followed, and all techniques involve a compromise between quality and economics. The essential steps are given below and form the basis of the dyeing instructions:

1. Select material of uniform colour for dyeing.

2. Choose the colour and decide what fastness properties are required for the end product; then select the cheapest dyestuffs which give these. (For example, it is not necessary to use dyes of high light fastness for party hats that will be used only once-though such an article needs to be moderately water fast to prevent a shower of rain from staining other articles).

3. Choose a dyeing method suitable for use with the chosen dyes. Three methods are mentioned in this handbook:

(i) Exhaust dyeing in which a batch of fibre is dyed from a liquor that is used only once and then discarded. This technique enables dyers to produce matching colours on different batches of fibre with relative ease (provided that the composition of the dye liquor and the dyeing conditions are carefully controlled) but obviously leads to the wastage of chemicals that are not consumed in the dyebath. However, provided that dyes which exhaust well are used, the loss of dyestuff is negligible and other chemicals used in the dyebath are relatively cheap.

(ii) Standing bath dyeing is basically similar to exhaust dyeing. However, after the first dyeing the dyebath is replenished with dyestuff and chemicals and a further dyeing is carried out. This replenishment may be repeated several times. Experience is required to calculate the exact amount of dyestuff and chemicals needed for replenishment.

(iii) Pad-batch dyeing is a recently-developed method based on the use of reactive dyes (see p. 43 and Glossary). It is often (as

described by Canning et al., 1977) carried out in the cold and uses low liquor to fibre ratios (1: 1 compared with 20: 1 for exhaust dyeing).

When using either the exhaust or standing bath method:

4. Select dyestuffs that exhaust well onto the material. (If the dyes do not have a strong affinity for the material a large proportion will be lost with discarded dye liquor. Such dyes are best applied by the standing bath technique since this is less wasteful).

5. Make sure that the correct auxiliary chemicals are used in the dyebath.

6. Make certain that all the dye is dissolved before placing any fibre in the dyebath. In order to avoid lumps, first mix acid, direct, reactive and basic dyes to a smooth paste using 2 ml of water or acetic acid solution, as appropriate, for each gram of dye; then add more water to disperse the dye before adding it to the dyebath. With disperse dyes the powders are first sprinkled into water using about 15 ml of water for each gram of dye (the dye will not disperse properly if too much or too little water is used). Lumps of dye in the

dyebath will give rise to uneven colours and impaired fastness properties. They should be broken up whilst pasting, and filtering (e.g. through a muslin cloth) should be used only as a last resort.

7. Never place the fibre in a dyebath which is above 50°C. Increase the temperature slowly. Placing the fibre in a hot bath will cause the dyestuffs to be taken up rapidly and the levelling of colour will be difficult to control.

8. Make sure that the dye liquor covers the goods. Thorough and efficient stirring must be used to give good circulation, especially in the warming-up period and the early stages of boiling during which most of the dye exhausts. Inadequate circulation of liquor will result in unevenly coloured fibre. The agitation of the fibre produced by boiling cannot be relied on to distribute the dye evenly.

9. Dyeing must be continued for an hour or more even though the fibre may appear adequately coloured after only a short period of dyeing. The colour built up initially lies at the surface of the fibre and will rub off easily.

10. After removing the fibre from the dyebath it must be rinsed

(preferably in running water) to remove adhering dye liquor, otherwise the fibre will become coated with loose dye on drying.

Costs of dyeing

The craft dyer should keep an account of all the various costs involved in dyeing, including his own time and the cost of heating the dyebath. Considering the following questions may help the dyer to find ways to reduce costs:

1. Can the cost of dyestuff be lowered? There is often a cheaper alternative dye. However, sometimes it is advantageous to buy a more expensive dye. The strengths (or tinctorial yields) of dyestuffs differ and it may cost less to use a smaller amount of a stronger dye to produce the same colour.

2. Is too much dye being used? There should only be sufficient dye in the bath to produce the required depth of colour. Too much dye will produce too deep a shade or tempt the dyer to remove the fibre too soon-leading to poor penetration of dye. In either case dye will be wasted.

3. Can less acid be used? Acid is used with both acid and basic dyes.

Some acid dyes need less acid to fix them than others and less acid is needed with pale shades than with deep. With basic dyes the acid slows down the adsorption of dye and thus aids levelling. In this case more acid is needed when dyeing pale shades since with these it is less easy to control dye adsorption.

4. Can less salt (or other dyeing assistants) be used? Salt in the dyebath increases the proportion of direct or reactive dye that adsorbs onto the fibre. By using extra salt the dyer can reduce the quantity of dye in the bath. The dyer will need to calculate at what point the cost of salt (or soda or other dyeing assistants) becomes greater than the cost of dyestuff saved

5. Can less fuel be used? Fuel is usually expensive and sometimes hard to find. It may be possible to reduce heating time by increasing the amount of dyeing assistants. It may not be necessary to boil for so long-especially if good penetration is not essential. Insulation of the dyebath will help to reduce fuel consumption.

6. Can less time be used? Not all processes require the craft dyers undivided attention (e.g. the batching operation of pad-batch dyeing); however, most do and the dyer should keep a record of all

the time spent exclusively on each separate dyeing. Before extending the time of dyeing to increase the adsorption of dye the dyer should calculate whether it would be cheaper to, for example, add more salt instead.

7. Can less wetting agent be used? Wetting agents assist the production of uniform colours. However, they reduce dyebath exhaustion and thus increase wastage of dye. The minimum amount should therefore be used.

8. Can less water be used? By reducing the quantity of water the dyer can save on dyestuff and assistants since the exhaustion will be increased. Less fuel will be needed to heat a smaller quantity of water. However, the amount of water should not be reduced so much that circulation of liquor is restricted.

Making matching shades

Dyers are often asked to reproduce fashionable colours by blending dyes (see p. 17) or to produce several batches of fibre in identical shades. This latter aspect is important, since marketing organisations need to illustrate goods in catalogues and must be

able to supply identical goods on repeat orders.

When producing a new colour for the first time, the experienced dyer starts with a few 'trial and error' test dyeings. These trial dyeings are usually made on a few grams of material. The small quantities of dyestuffs and chemicals required can be measured on an accurate balance but, as an alternative, solutions can be carefully diluted. For example, a dyer who has only kitchen equipment can dissolve one teaspoonful of chemical in four cupfuls of water and, by taking only one cupful of this solution, can scale down the size of operation four times. The small-scale dyer will find this method of working advantageous-especially when working with blends where, for example, 10 teaspoonfuls of dye solution 'A' mixed with 3 teaspoonfuls of dye solution 'B' give exactly the right colour on 250 9 of fibre. Dyers could not measure such small quantities accurately using teaspoons of dye powder. (Unfortunately, this method would be wasteful with reactive dyes as solutions of these become useless if kept for more than a few hours). After the right conditions have been found, the operation can then be scaled up. All that is needed to do this is to increase proportionately the quantities of each ingredient [including the fibre and water) to obtain the required amount of dyed fibre.

By using identical dyebath conditions for each batch of fibre, matching shades can be produced. An experienced dyer always measures the ingredients used in the dyebath and keeps a record of the entire dyeing process. By consulting this record (or 'recipe'}it is possible to reproduce the same colour on a subsequent occasion. However, to obtain identical shades, it may sometimes be necessary to make small adjustments to the dyebath at the conclusion of dyeing.

When dyeing matching shades the quantity of water in the dyebath must be kept constant. Throughout the course of dyeing, water will be lost through evaporation. This water must be replaced, or the concentration of dyestuff will increase and cause increased adsorption of dye. Conversely the addition of too much water when topping up the dyebath will cause a decrease in the quantity of dye adsorbed by the fibre. The water level can be checked with the aid of a 'dipstick' (see p. 25).

In the next section commercial dyeing practices which enable the dyer to reproduce colours accurately are described.

The dyeing recipe

Commercial dyers usually work from a general recipe in which the quantities of ingredients relate to a unit weight of fibre. When using such a recipe only a few simple calculations are needed for dyeing a batch of fibre of any given size. Also, dyestuff manufacturers find the general recipe a convenient method of providing instructions.

The general recipe does not give detailed information on the application of the dyes. However, the quantities of ingredients used are readily derived from information expressed in the following terms 'Liquor ratio', 'percentage' end 'Concentration'. These terms are widely used and, in dyeing, relate the quantity of ingredient to the air-dry weight of the fibre to be dyed.

Liquor ratio (LR)

The liquor ratio (LR) refers to the quantity of water required in the dyebath. The ratio is the weight of liquor required for each unit weight of air-dried fibre to be dyed. For example, a liquor ratio of 20:1 indicates that the weight of liquor required is twenty times the weight of air-dried fibre to be dyed.

It is usual to convert the weight of liquor to a volume, which is more

easily measured. In dyeing, the density of the liquor is taken to be equal to that of water (i.e. 1 kg of liquor equals 1 litre). Therefore, with a liquor ratio of 20:1, 20 litres of water will be used for each kilogram of fibre.

Percentage shade

The depth, or intensity, of colour is usually controlled by varying the quantity of dye in the dyebath. In practice, the quantity of dye is expressed as a percentage of the weight of the air-dried fibre to be dyed. Consequently there are a number of terms in common use such as 'per cent shade', 'at .... per cent', 'per cent depth', etc. Whatever term is used in the dyeing recipe, the actual quantity of dye to use in the dyebath is calculated as in the following example in which the weight of dye needed to dye a 0.5 per cent shade on 5 kg of fibre is calculated:

Weight of dye needed	= (Weight of fibre X percentage shade)/100
	= (5,00O g X 0.5)/100
	= 25 g

Actual weights needed in the dyebath of other ingredients given as percentages on the weight of fibre are calculated similarly. However, it is important to make sure that 'percentage on the weight of fibre' is not confused with the 'percentage strength of a chemical solution' used (e.g. acetic acid (30%), acetic acid (60%), formic acid (85%)).

Depth of colour

The term 'percentage shade' is not a direct measure of the depth of colour of the dye. Visual depth of colour depends on the concentration of dye at the surface of the fibre and this will vary at a given percentage depth with differences in dyeing technique (e.g. time of dyeing, liquor ratio, concentration of salt or acid). Different dyestuffs of the same colour, and also the same dyestuffs from different manufacturers, give different visual depths of colour when used at the same percentage shade. Although manufacturers endeavour to maintain consistency, recipes should be checked, and adjusted if necessary, each time a new batch of dye is used.

Concentration

Quantities of ingredients are sometimes given as a concentration

(e.g. grams/litre, g/l). If, for example, the dyeing recipe specifies salt at a rate of 10 grams/litre (9/l) one must use 10 grams of salt for each litre of dye liquor needed. In order to determine how much ingredient is needed in the bath the actual volume of liquor needed must first be calculated using the liquor ratio (LR) given in the recipe and the weight of the fibre to be dyed. A typical calculation of the quantities of ingredients needed is given in the following example

3 kg of fibre is to be dyed at a liquor ratio of 20:1. The recipe specifies 5 g/l of salt in the dye liquor

(i) The quantity of water needed is

Water at LR of 20:1 = 20 X weight (kilograms) of fibre = 20 X 3 kg = 60 litres

(ii) The quantity of salt needed is:

Salt at 5g/l = 5 9 X volume (litres) of liquor = 5g X 60 = 300 g.

Concentrations of chemicals used in the dyebath are now commonly expressed as parts/1,000 (parts by weight of dye liquor). However,

the more traditional units of 9/l and Ib/100 gallons are equivalent since 1 litre of water weighs 1,000 g and 100 gallons of water weigh 1,000 lb.

Completion of the recipe

The same dyeing time, dyeing temperature and sequence of operations are used irrespective of the size of the batch of fibre.

Fastness testing

Introduction

Many chemicals and environmental factors can cause colours to change their depth of shade and also, occasionally, their hue. Some changes are caused by the physical removal of dye and, whilst the visual colour may not be affected, this removed dye may stain adjacent materials.

Colour fastness is not solely a property of the dye. Fastness properties are also affected by the material on which the dyestuff is used. Sisal, for example, unlike cotton, contains substances which contribute to the action of light in fading the dyes and most dyes

are, therefore, less light fast on sisal than they are on cotton. The substances in sisal usually turn brown, causing the colour of the dyed material to change. Colour fastness of a dye is also dependent on depth of shade. Deep shades resist light better than pale shades of the same dye, but dye is more readily lost by physical means from deep shades, leading to reduced water fastness and greater risk of staining onto other materials.

When evaluating dyes it is important that the depth of colour can be described accurately to allow fair comparisons between dyes. This is usually done with the aid of pattern cards which illustrate and describe hues in terms of internationally agreed standard depths of colour. Such pattern cards conform to ISO Recommendations R105 and include British Standard BS1006: Section A01: 1978, Standard depth: matt. Only colours of equal visual depth can be usefully compared.

When choosing dyes, the dyer must consider colour fastness from two aspects: firstly, the changes of colour that could occur during subsequent processing of the dyed material; and secondly, changes that could occur during use of the finished article.

After-treatment of some dyes (e.g. directs) to improve their water fastness, or subsequent application of lacquers to the finished goods, may cause change of colour. The change, of course, is important if the dyer is aiming to produce a specific colour on the finished goods and the dyer must then know what changes will take place so that compensation can be made for them. For craft workers who make hats, fastness to dry heat is of importance: hats are often formed on hot moulds, or by ironing, and these processes could cause loss of dye.

Colour fastness in use is far more important. Many dyed goods are necessarily exposed to adverse treatment during use, for example, by cleaning. With hats and bags, a shower of rain could cause colours to run and stain the user's clothing. Table mats could become wet from spillage and stain the table cloth. Therefore, it is the dyer's responsibility to ensure that the fastness properties of the colours produced are suited to the goods for which the material is to be used.

All colours fade in use, but provided that this is consistent with age it does not worry the user seriously. However, if each colour changes to a different extent, or changes in the hue occur, the art

design may be spoilt and this the user will find unacceptable. Therefore, colours of similar fastness must be used on individual articles and blends must be prepared from dyes with similar fastness properties.

Fastness requirements of sisal goods can be expected to be less stringent than those for cotton and woollen goods. It is very unlikely, for example, that sisal will be washed with hot water and detergents, except when it is used in matting, or that it will be dry-cleaned or bleached, so fastness to these treatments need not be considered. However, fastness to light and cold water (e.g. rain) is of great importance - especially for more expensive durable goods.

Since fastness properties are important, craft workers should test the quality of new dyes before they are used for durable goods. Test methods are described in this section. However, provided that dyeing conditions are not altered it is unnecessary to test subsequent dyeings with the same dye.

There are a number of recognised tests for colour fastness, the results of which can be expressed in numerical terms. For workers who are interested in this subject, a complete set of colour fastness

tests (BS 1006: 1978 Methods of test for colour fastness of textiles and leather), based on the recommendations made by the International Organization for Standardization, is available. As it is unlikely that craft workers will have the equipment or expertise to follow these special tests, some alternatives are given here. The basis of these alternative tests is the comparison of performance given by the new dye with that given by one that has proved satisfactory in service.

Water fastness

Tests for water fastness are designed to determine whether water will cause fading, running of colour with spoilage of design, and staining of other goods. To obtain this information the craft worker must carry out two separate tests, each one run concurrently with a similar test conducted on dyed sisal (or other material) that has satisfactory water fastness.

Loss of colour and staining onto undyed sisal (see Figure 1)

The test is done as follows:

1. Take a small portion of sisal (about 10 cm long) dyed with the

new dye, and plait it with an equal weight of undyed sisal. Secure the plait at each end, for example, with rubber bands.

2. Immerse the plait in thirty times its own weight of cold, preferably distilled, water for 4 hours (1g water = 1 ml).

3. Remove the plait from the water, separate the dyed and undyed fibre and leave to dry

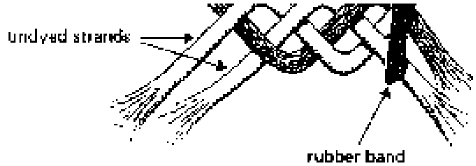
4. Compare the tested dyed sisal with the untested dyed sisal to assess the degree of change in or loss of shade (if any).

5. Compare the undyed sisal used in the test with some undyed sisal that was not tested, to assess the degree of staining.

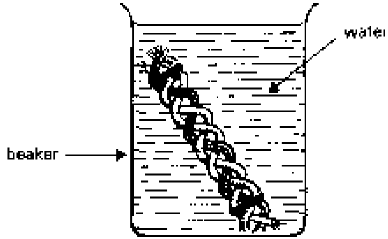
Repeat steps 1 - 5 with dyed sisal {or any other material) that is known to have satisfactory water fastness. If the degree of change in shade and staining for the sisal dyed with the new dye is the same or even less than that of the satisfactory dyed sisal or other material then it is safe to use fibre dyed with the new dye.

1. Plait the dyed strand with the undyed strands and secure the ends of the plait

with rubber bands.



2. Immerse the plait in a beaker of cold water.



3. Separate the strands and leave to dry. Examine carefully for loss of colour and staining onto the undyed strands.

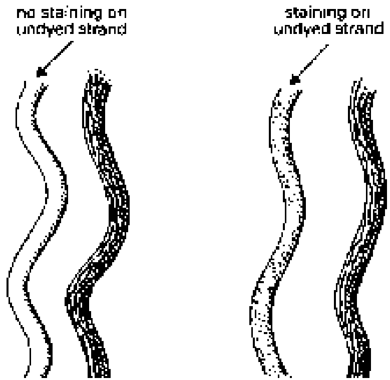


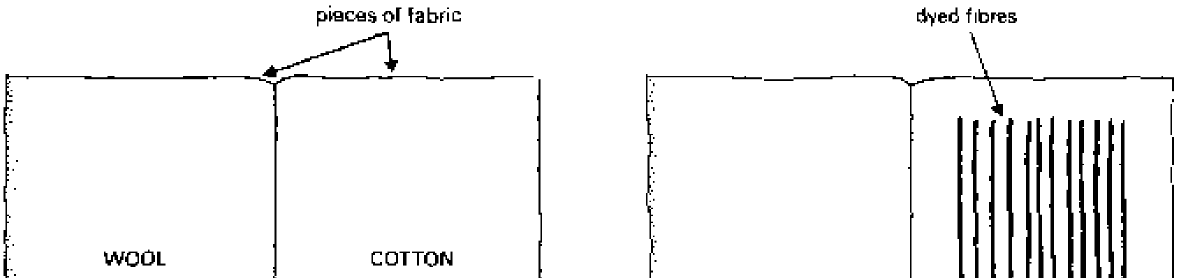
Figure 1: Water fastness testing: loss of colour and staining onto undyed sisal

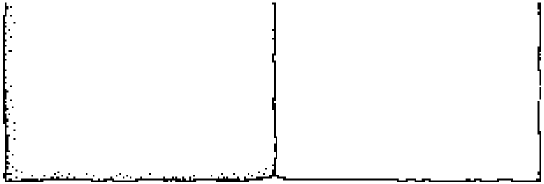
Loss of colour and staining onto wool and cotton (see Figure 2)

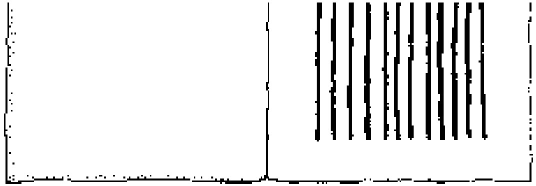
The test is done as follows:

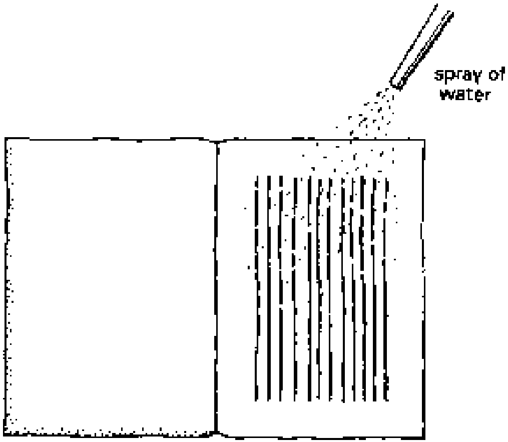
1. Take two pieces of cloth of approximately equal size (a 5 cm or 2 in. square is suggested), one of which is undyed wool, and the other is undyed cotton, and stitch the cloths together along one edge.

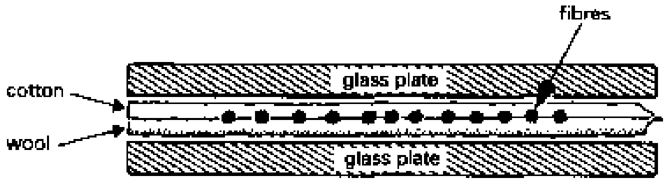
2. Take a portion of sisal dyed with the new dye weighing about half of the combined weight of the cloths and spread this evenly between the two cloths.



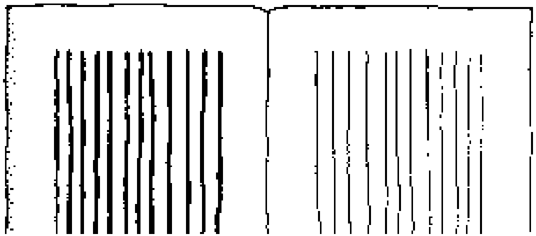





spray of
water


fibres
glass plate
cotton
wool
glass plate


water
dish



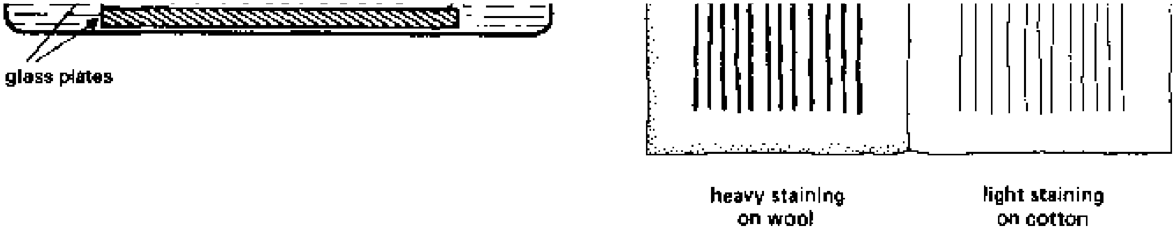


Figure 2: Water fastness testing: loss of colour and staining onto wool and cotton

3. Wet the test specimen with cold, preferably distilled, water.

4. Place the wet test specimens between two glass plates weighing approximately 50 9 each and of a size similar to that of the cloths (a 58 mm square of 6 mm thick glass plate weights approximately 50 9).

5. Place the 'sandwich' in a dish and cover with cold, preferably distilled, water.

6. Press the top plate evenly and lightly to remove bubbles of air from between the plates, and then allow to stand for 15 minutes.

7. Without disturbing the plates, pour off the water from the dish (a

film of water should remain within the plates).

8. Leave for a further 4 hours, then separate the sisal from the cloths and allow to dry.

Repeat steps 1 - 8 with dyed sisal (or any other material) that is known to have satisfactory water fastness.

9. Place the dyed sisal from the test alongside a portion of the dyed sisal of similar size that has not been tested, and compare the contrast (see Glossary) with that shown by similar portions from the test on the satisfactory dyed sisal. If the colour under test shows equal or less contrast than the proven colour, the fastness with respect to loss of colour is equal to or better than the proven colour.

10. Similarly, place the cloths from the test alongside similar-sized portions of the same materials that have not been used in the tests and compare the contrasts shown with those shown between similarly arranged cloths from a test on the proven colour. Equal or less contrast demonstrates equal or better fastness with respect to staining.

Wool and cotton have been chosen because these two materials are

commonly used in clothing. However, if it is known that the fibre will be in contact with other materials, such as nylon or polyester, then a similar test using cloths made of these materials should be carried out.
If in either of the water fastness tests the fibre dyed with the new dye produces a worse staining or has a greater loss of or change in shade than the satisfactory dyed sisal (or other material), then an alternative dye should be tested.

Light fastness

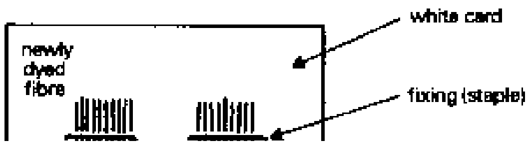
It is important that, having spent much time and trouble on an article, the dyes do not fade quickly.

There are a number of standard tests for light fastness which are used by manufacturers and test houses. Basically these involve comparing the fastness of the test material with that of materials dyed in order of increasing fastness. Materials which are to be used for window curtains have to be of the highest light fastness (8 on the International Organization for Standardization (ISO) scale) whilst for cheap 'throw away' goods such as party hats, light fastness is unimportant. These international standards require

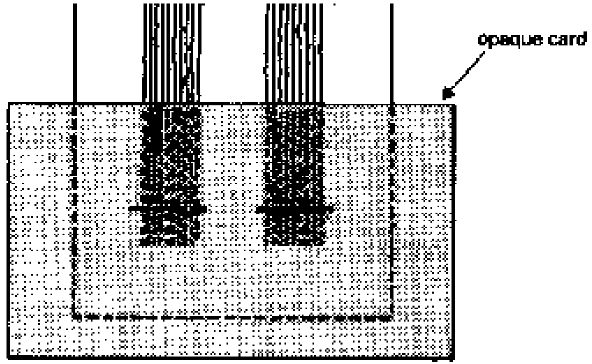
special equipment which the craft worker may find difficult to obtain. Fortunately adequate results can be obtained with quite simple equipment (see Figure 3).

A satisfactory test may be carried out by taking a bundle of dyed fibre (about 4 cm long) and mounting it on a card next to a similar-sized bundle of coloured fibres which are known to have satisfactory light fastness. About a quarter of each fibre is covered with an opaque card or aluminium foil and the whole assembly placed under glass in a position facing the mid-day sun. The glass should be at least 5 cm away from the fibre and should allow free circulation of air over the fibres. The specimens are examined daily for fading (shown by a sharp contrast (see Glossary) between the covered and exposed portions) and the performance of the new colour is compared with that of the proven colour. During the test a further cover may be placed over some of the exposed portion, so that the performance over the short term can be compared with that over the long term.

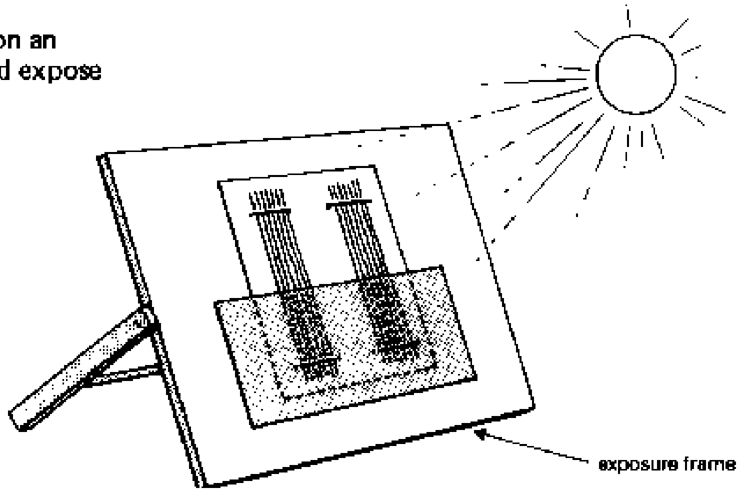
1. Mount a bundle of newly dyed fibre on a card next to a bundle of satisfactory dyed fibres. Partially cover the fibres with an opaque



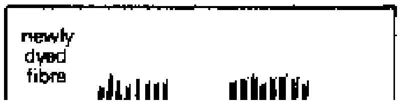
the fibres with an opaque card or foil.



2. Place the samples on an exposure frame and expose to sunlight.



3. Remove the opaque card and examine the fibre for signs of fading. (The



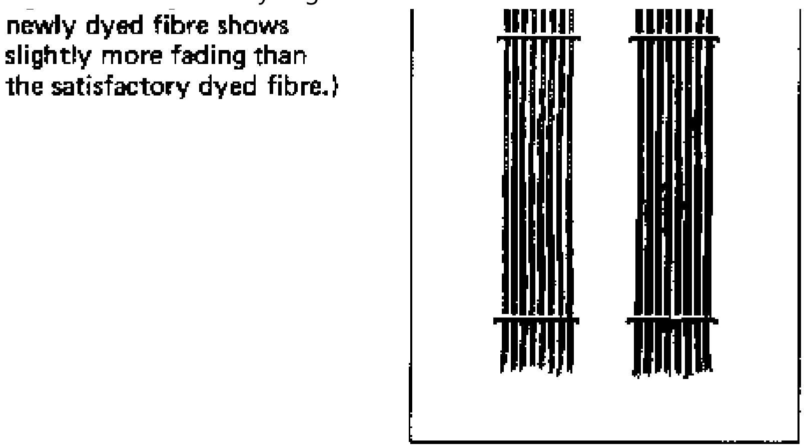


Figure 3: Light fastness testing

The colour used for comparison purposes can be on any fibre, it need not be on sisal. As with the water fastness tests, the dyer can judge from the results whether the new dye is likely to have an acceptable light fastness on sisal.

Light fastness varies with the quality of light. Therefore, in different locations or with different light sources, different light fastness ratings could arise.

Fastness to processing

As mentioned previously, lacquering, hot pressing, and after-treatment of dyes could cause colour changes. If it is important for craft workers to know of these changes it is suggested that a small portion of the dyed fibre be subjected to the processing involved, and compared with the original dyed fibre. Any serious change of colour will then be apparent.

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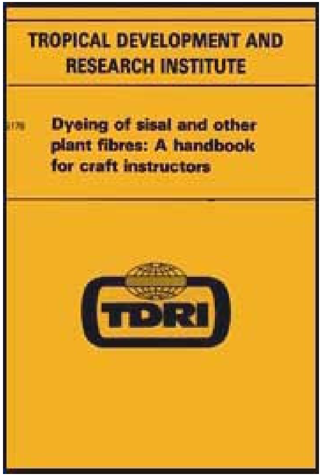


Dyeing of Sisal and other Plant Fibres: A Handbook for Craft Instructors (NRI)

Part 2: Use of Different classes of dyes

Reactive dyes

Introduction

The direct, acid, basic and disperse dyes are attached to the fibre by purely physical bonds. The reactive dyes were developed in order to give better fastness properties by chemically fixing the dye to the fibre. They are often derived by linking simple acid dyes to a chemical which combines with the cellulose in the fibre. Reactive dyes of special interest to the craft worker are those that can be applied in the cold using simple equipment (one method has been described fully by Canning et al., 1 977).

Manufacturers' trade names

Reactive dyes are of several types, ranging from those that can be applied in the cold, such as the 'Procion MX' range from Imperial Chemical Industries plc (ICI), to those that are usually applied at

higher temperatures, such as the 'Procion H' range. Only the 'Procion MX' and 'Dylon Cold' dyes have been investigated at TDRI.

Some other ranges which contain similar dyes are*:

'Acticrom F' (Mult)	'Mikacion M' (KYK)
'Amaryl' (Amar)	Ostazin' (Chem)
'Basilen M' (BASF)	'Vilmafix A' (VIL)
'Chemictive' (CE)	'Xiron' (FW)
'Helaktyn F' (POL)	

Dyes in some ranges are slightly less reactive than the 'Procion MX' dyes but could probably be applied to sisal by methods similar to that described in this section; some examples are*:

'Cibacron' (CGY)
'Drimarene K' (S)
'Levafix E' and 'EA' (BAY)
'Temazol' (HOE)

Choice of dyes

Tests carried out at TDRI (Canning and Jarman, 1974; Edwards and Canning, 1981) for light fastness, water fastness and penetration have shown that of the twenty-five 'Procion MX' dyes available in April 1982, the following nine are the best choices for dyeing sisal and similar fibres:

Procion Yellow MX-8G (Cl Reactive Yellow 86) Procion Yellow MX-4R (Cl Reactive Orange 14)

Procion Orange MX-G	(Cl Reactive Orange 1)
Procion Red MX-G	(Cl Reactive Red 5)
Procion Red MX-5B	(Cl Reactive Red 2)
Procion Red MX-8B	(Cl Reactive Red 11)
Procion Rubine MX-B	(Cl Reactive Red 6)
Procion Blue MX-3G	(Cl Reactive Blue 1)
Procion Brown MX-3RD	(not listed in the Colour Index)

A further dye found satisfactory, Procion Yellow MX-4G, has been withdrawn. Equivalents (Cl Reactive Yellow 22) are available from other manufacturers (i.e. BASF, CE, KYK, Mult and VIL, see

Appendices 2 and 3).

The following dyes penetrate less well into the fibre but can be used when durability is not of prime importance:

Procion Yellow MX-3R	(Cl Reactive Orange 86)
Procion Yellow MX-GR	(Cl Reactive Yellow 7)
Procion Orange MX-2R	(Cl Reactive Orange 4)
Procion Scarlet MX-G	(Cl Reactive Red 8)
Procion Scarlet MX-3G	(not listed in the Colour Index)
Procion Blue MX-R	(Cl Reactive Blue 4)
Procion Blue MX-2G	(Cl Reactive Blue 109)
Procion Blue MX-4GD	(Cl Reactive Blue 168)
Procion Blue MX-7RX	(Cl Reactive Blue 161)
Procion Navy MX-4RD	(not listed in the Colour Index)

From the nine 'Procion MX' dyes recommended for sisal-like fibres a wide range of shades can be obtained which should meet the needs of any craft worker. In fact over one hundred shades including yellows, oranges, reds, violets, blues, greens, browns and a black

have been produced at TDRI using only three of these dyes- Procion Yellow MX-8G, Procion Red MX-5B and Procion Blue MX-3G (see Table 1).

With 'Dylon Cold' dyes, shades A.10 Primrose, A.16 Camellia, and A.28 Riviera Blue are satisfactory for mixing to produce a wide range of shades. Of the remaining 'Dylon Cold' dyes, most will produce satisfactory colours but the following do not penetrate into the fibre and should be avoided:

Dylon Cold A.13 French navy
Dylon Cold A.15 Tartan green
Dylon Cold A.17 Cafe au fait
Dylon Cold A.50 Charcoal

Application of dyes

The use of dyes which are chemically reactive toward fibres is a new concept in dyeing. However, when exhaust dyeing using dyes such as ICI 'Procion MX' or Dylon 'Cold', the method of application differs from traditional methods only in that dyeing takes place in the cold.

In exhaust dyeing (see Glossary) the fibre is immersed in a dye

solution to which salt is added. When the dye has been adsorbed by the fibre, alkali (usually soda ash) is added to the dyebath and the fibre is left in this solution for a further period of time. The alkali causes most of the adsorbed dye to react with the fibre and fix in such a way that it is impossible to remove the colour with water, giving extremely high water fastness. However, the loose dye must be either removed by hot water washing, or fixed to the fibre by after-treatment. If this is not done, the water fastness will be poor. For some end-uses a combination of washing and after-treatment may be required.

The amounts of salt and soda to be used in exhaust dyeing vary with the depth of shade. Those generally recommended by ICI for cotton dyeing with 'Procion MX' dyes are given in Table 2.

Amount of dye in dyebath (percentage on weight of fibre)	Salt needed in dyebath at all liquor ratios (g/l)	Soda ash added to dye liquor at given liquor ratio (LR) during dyeing (g/l)		
		LR 15:1	LR 20:1	LR 30:1
Up to 0.5	25	5	3	2
0.51–2.0	35	5	4	2
2.01–4.0	45	10	8	4
Above 4.0	55	15	10	5

Source: Imperial Chemical Industries plc (undated)

Table 2: Recommended concentrations of common salt and soda ash to be used with ICI 'Procion MX' dyes

Although these quantities will produce satisfactory results with sisal, experienced dyers may vary the composition of the dyebath since salt and soda requirements are also influenced by:

(i) the relative costs of the salt, soda and dyestuff; and

(ii) the exhaustion characteristics of the dye.

By varying the dyebath composition, it is possible to determine the optimum conditions for producing specific colours at the lowest cost .

Penetration of dye into the fibre is improved considerably by the use of a warm process and this is recommended for articles such as carpets, which will be subjected to abrasive wear. However, temperatures above 50°C should not be used since too much of the dye will lose its reactivity through reaction with water.

An alternative method of applying these dyes, pad-batch dyeing, has been described by Canning et al. (1977) and will be mentioned only briefly. However, workers who use this method will find the information given in this handbook on after-treatments and blending useful. In the pad-batch method the fibre is first wetted with a concentrated alkaline dye solution ('padding') and then left in a wet state for a period of time ('batching') to allow the dye to penetrate and fix to the fibre strands. The method makes very effective use of the dye although, as with exhaust dyeing, washing is needed to remove unfixed dye.

The exhaust method is easier to control, therefore it should be used when producing matched shades. However, the pad-batch method (although it can be a little messy) will usually be less costly and less time consuming. Since it allows dyes to penetrate uniformly into the structure of yarns and fabric, the pad-batch method is ideally suited

to the dyeing of these materials.

Most craft workers will not be familiar with reactive dyes. However, provided that the following points are borne in mind, they should experience little difficulty.

1. The reactive dyes react not only with fibres, but also with water and body tissues. Therefore the dyes need careful handling. Avoid breathing dye powder by wearing a mask, wear gloves when handling and quickly wash off any dye which gets on the skin (see Safety precautions and first aid treatment).

2. The reactivity, which is essential for the production of water fast shades, is destroyed when moisture is present. The loss of reactivity is considerably more rapid when the dye is also warm or alkaline (after adding soda). Make sure therefore that:

(i) Dye powders are stored in airtight containers in a cool place.

(ii) Dye solutions are kept cool-especially if alkali (soda) has been added.

(iii) Dye solutions are used immediately after being prepared-they

must not be stored for later use.

3. Despite taking all precautions, some deterioration will occur and not all of the dye will fix to the fibre. Unless the deteriorated dye is removed by hot water washing or fixed to the fibre by after-treatment, the potentially excellent water fastness properties of these colours will not be achieved. The choice of method must be made before dyeing is started and the following points should be taken into consideration:

(i) Use of hot water washing to remove loose dye: Hot washing has the advantage that any potential health hazard from loose dye is avoided without the use of additional chemicals which could themselves be potentially harmful. Fibre finished in this way is more likely to find acceptance for articles such as children's toys. However, with some dyes-especially reds and in deep colours-several hot washes may be needed to remove all the loose dye.

(ii) Use of cationic after-treatment to chemically fix the loose dye: Some commercial after-treating agents are very effective in fixing loose dye and it has been found possible to eliminate the hot wash normally needed to obtain good colour fastness. By using these

treatments, dye could be saved since the colours obtained will be deeper than those obtained after washing the fibre. Although these treatments are widely used, workers should check with their marketing organisation that the dyed fibre will be suitable for its intended end-use.

Recipe for producing an Emerald Green Shade on 2.5 Kg of Sisal

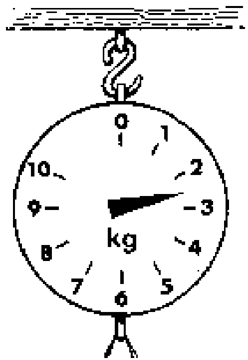
This recipe is based on the use of the exhaust dyeing method- reactive dyes cannot be applied by the standing bath method .

Materials and equipment required

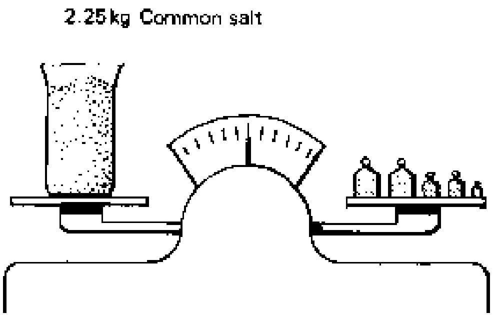
Sisal		2.5 kg
Procion Yellow MX-8G	37.5 g	(1.5 per cent on fibre)
Procion Blue MX-3G	37.5 g	(1.5 per cent on fibre)
Common salt (sodium chloride)	2.25 kg	(45 g/l)
Soda ash	400 g	(8 9/l)
Spring balance		
Laboratory balance		

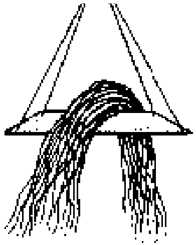
Beakers (or similar containers)	4	
Buckets		
Dye vat		(minimum capacity 60 litres)
Measuring cylinder or dipstick		
Stirring rods		1 small for bucket; 1 long for dye vat
Water		50 litres (Liquor ratio 20:1)
Drying lines		

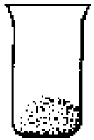
1. Weigh out 2.5 kg of sisal.



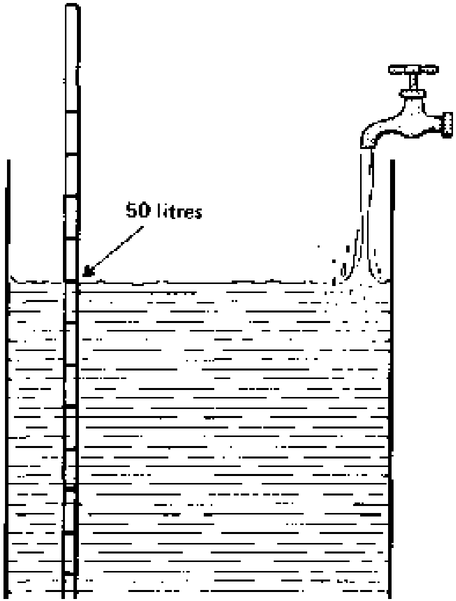
2. Weigh out in beakers and place to one side the following:



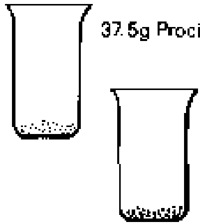




3. Pour 50 litres of water into the dyebath. A dipstick (*see* p.25) is useful for measuring the water.

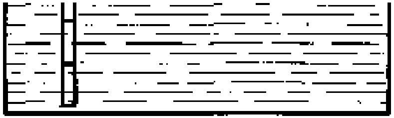


4. When dyeing is about to start, weigh into beakers:



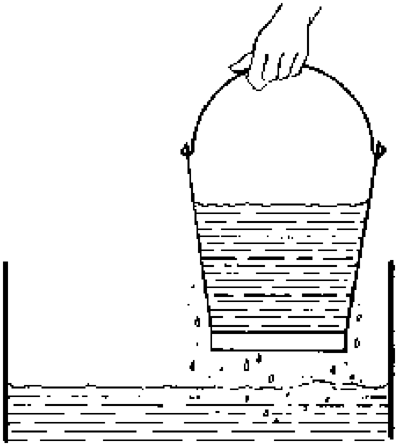
Do not open either tin until immediately before the contents are needed, and close the tins immediately after the correct amount of dye has been removed. This will prevent the dye in the tin from losing its reactivity.

Take care not to breathe dust from the dye.



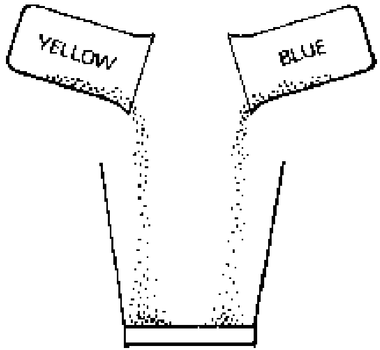
Preparing for dyeing

5. Take about three-quarters of a bucket of water from the 50 litres in the dyebath. Save this water for later use.

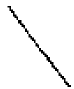


7. Using a little of the water taken from the dyebath at step 5, rinse the beakers which contained dye. Do not throw away the rinsings since they contain

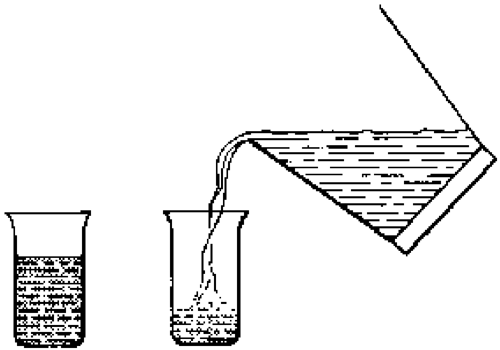
6. Empty the weighed dye powders into a clean dry bucket (be careful not to breathe the dust).



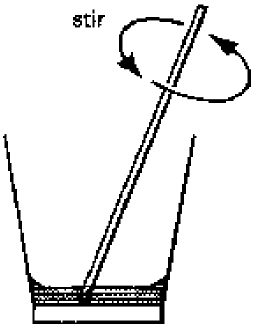
8. Add a little of the water taken from the dyebath at step 5 to the dye powder (about 2 ml for each gram of dye).

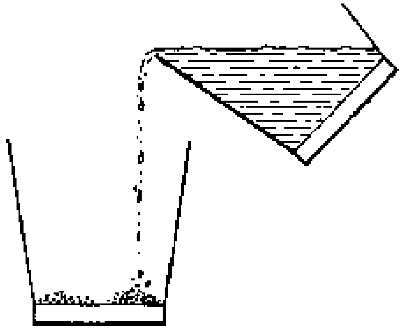


some of the weighed dye.

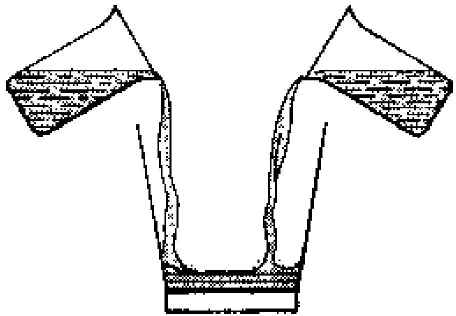


9. Mix the dye powder to a smooth paste with the water (there should be no lumps).



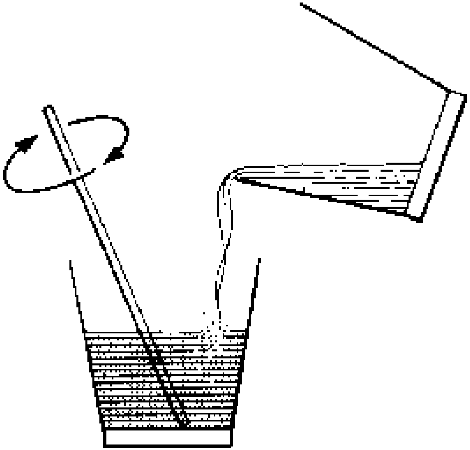


10. Pour the rinsing water from the dye beakers into the dye paste. Repeat rinsing of the beakers with water taken from the dye-bath at step 5 until they are clean.

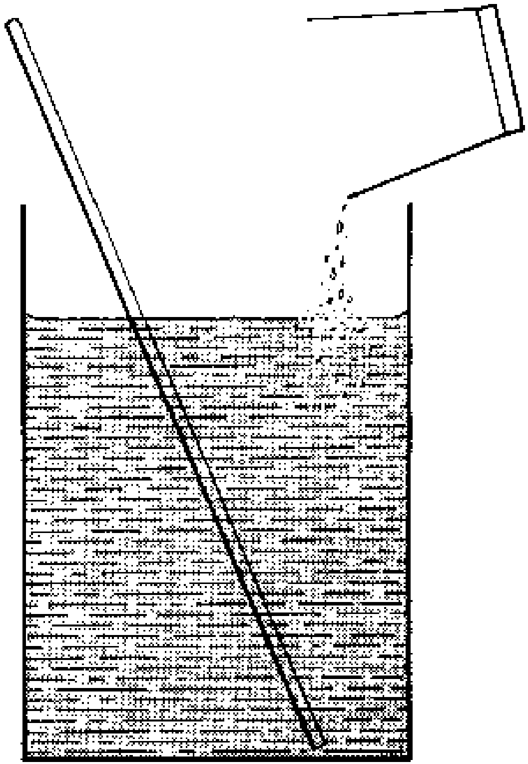


Preparing for dyeing (continued)

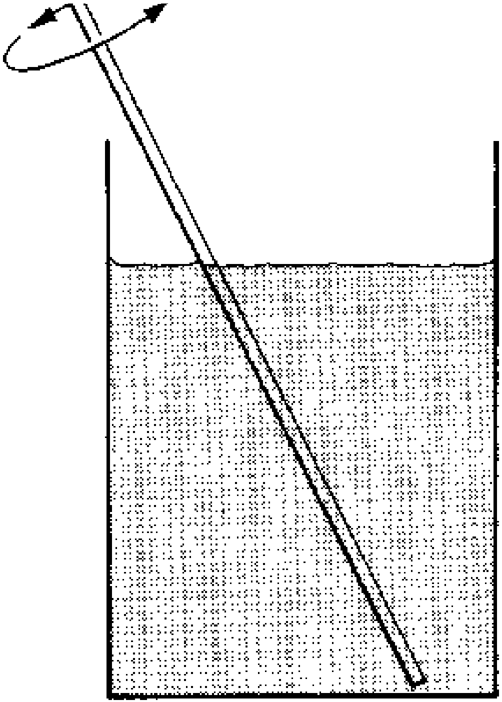
11. Add water taken from the dye-bath at step 5 to the pasted dye (use about half a bucket but save some for rinsing). Stir until all the dye powder is dispersed into the water.



12. Pour the dye dispersion into the dyebath. Then rinse the bucket into the dyebath using the remainder of the water taken from the dyebath at step 5.



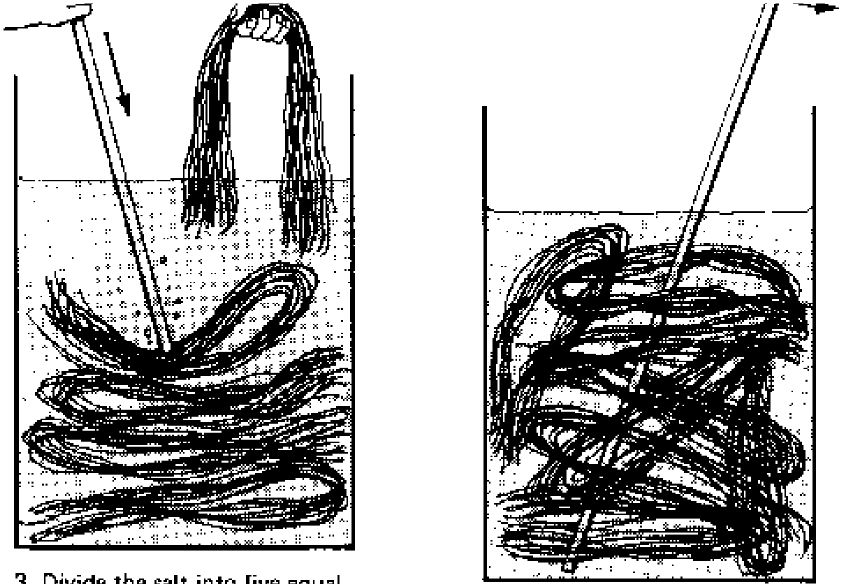
13. Stir the dyebath until all the dye has dissolved.



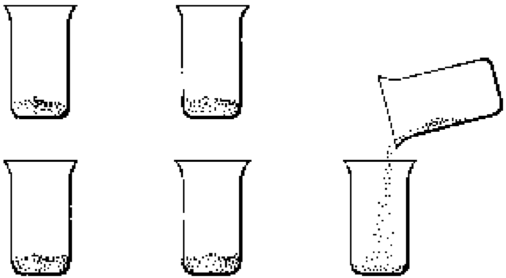
Preparing for dyeing (continued)

1. Put the sisal in the dyebath and press it below the surface of the dye liquor.

2. Stir well for 10 minutes. Make certain that the sisal remains submerged.
Do not heat the dyebath.

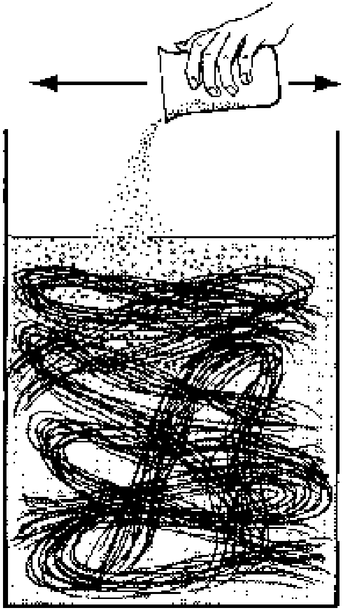


3. Divide the salt into five equal portions.

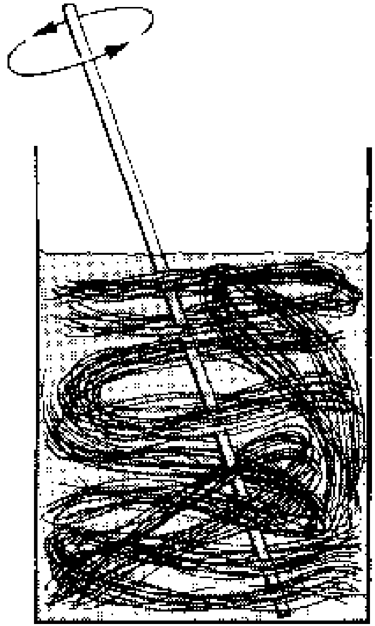


Dyeing

4. Take one of the five portions of salt and sprinkle it all round the dye liquor. It must not be allowed to settle onto only one part of the fibre.



5. Stir well for 10 minutes.



6. Add a further portion of salt as in step 4.

7. Stir for 10 minutes.

8. Sprinkle another portion of salt into the dye liquor.

9. Stir for 10 minutes.

10. Add the fourth portion of salt by sprinkling.

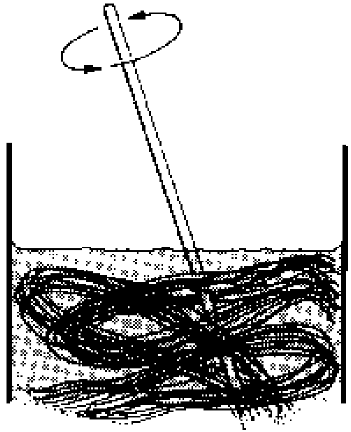
11. Stir for 10 minutes.

12. Sprinkle the final portion of salt into the dye liquor.

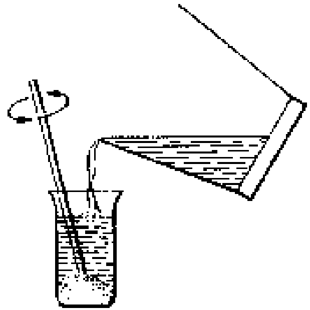
13. Stir for 10 minutes.

Dyeing (continued)

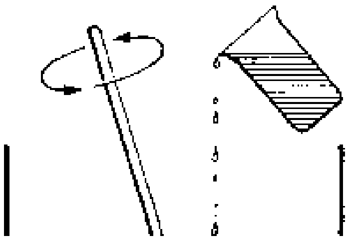
14. Continue dyeing for a further 2 hours. Stir the bath often at first, then at 10-minute intervals.



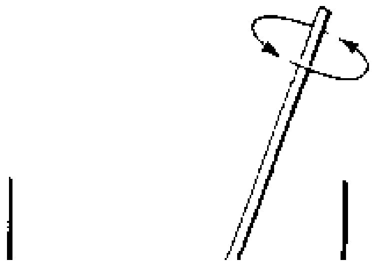
15. Dissolve the soda ash in a little water.



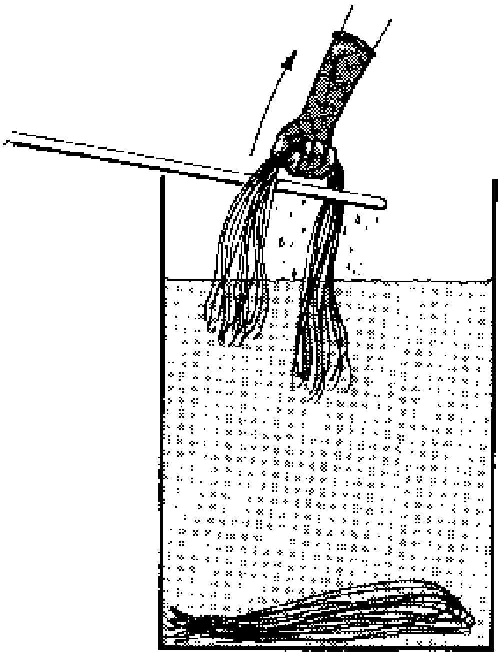
16. Slowly add the soda ash solution to the dye liquor whilst stirring the dyebath.



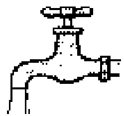
17. Stir the dyebath continuously at first, then at frequent intervals, for a further 1 hour.



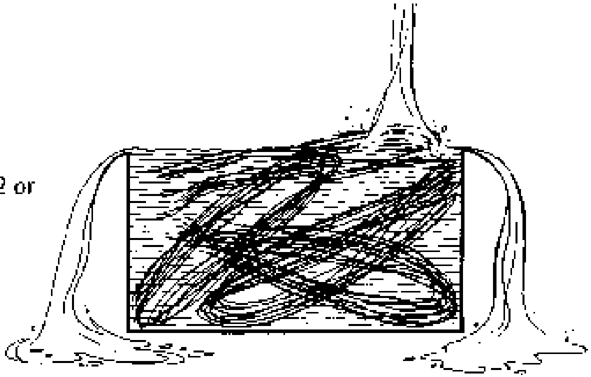
Dyeing (continued)



19. Rinse the fibre in cold running water until the rinsing water is free from colour.



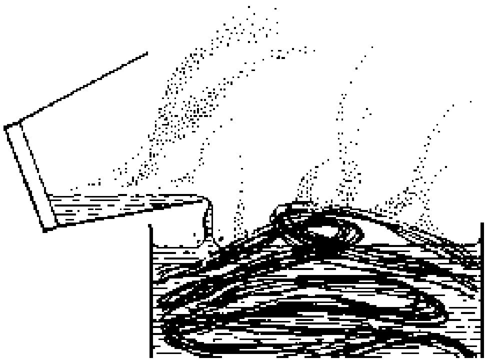
20. Remove the unfixed dye by washing as described on p.52 or fix it using an after-treating agent as described on p.53.

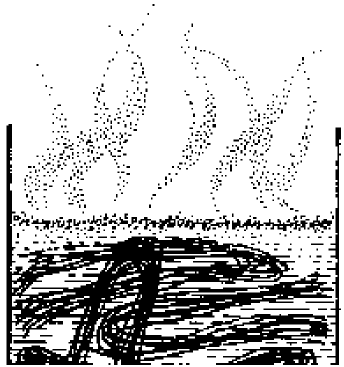


Dyeing (continued)

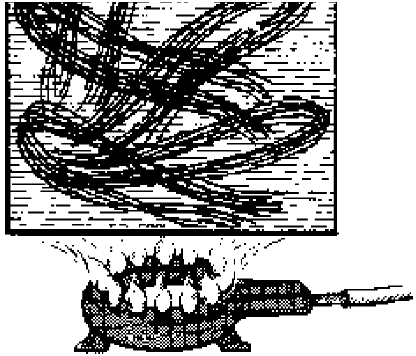
1. Rinse the dyed, cold-rinsed, wet fibre in very hot water – this removes some unfixed dye.

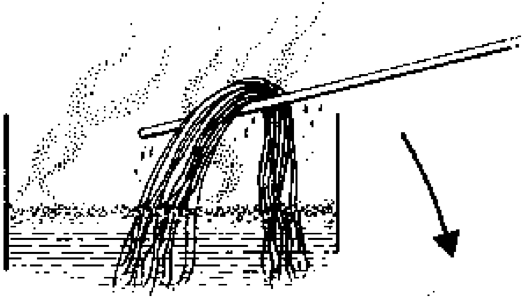
2. Place the hot-rinsed fibre in clean boiling water to which 5 g of soap or detergent has been added for each litre.



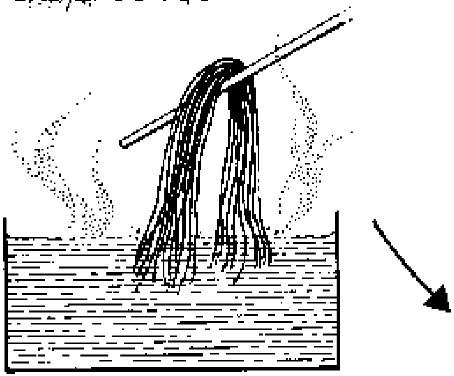


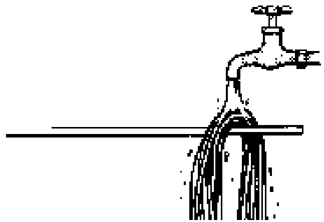
3. Remove the fibre from the boiling water then immediately rinse it in clean hot water — some loose dye will go back into the fibre if it cools.





Boil the liquor for 10—15 minutes with the sisal immersed. (It may be necessary to repeat the boil (*see* p.44).





4. Then, without delay, rinse the fibre thoroughly in clean cold water.

Removal of unfixed dye by washing

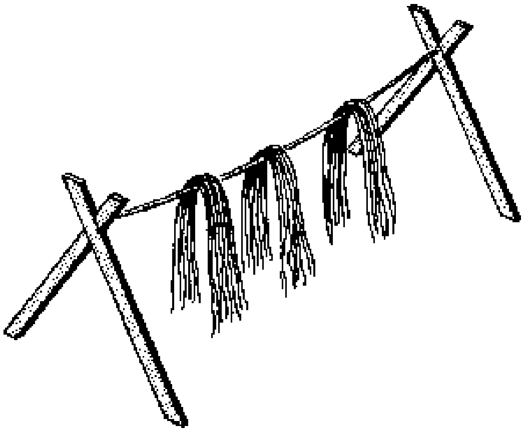


Figure Removal of unfixed dye by washing (continued)

After-treatment

Safety note: After-treating agents are acidic and in concentrated form can be corrosive causing skin burns. The concentrates should

therefore be handled with care. Users should wear protective clothing and have ready access to a copious supply of water. Once diluted, the agents are less dangerous but similar precautions should be taken (see Safety precautions and first aid treatment).

Introduction

Unfixed dye is usually removed from the fibre by boiling in detergent and washing in hot and cold water as described in the recipe. However, since this treatment requires a metal (preferably stainless steel) vessel and a source of heat it can be expensive for the craft worker. However, a new method has been developed at TDRI which is both simpler and cheaper. The unfixed dye is treated with a cationic agent which forms an ionic bond with the water solubilising group on the dye molecule. The larger molecule which is formed becomes trapped in the internal structure of the fibre making the dye more water fast. After-treatment causes some loss of light fastness and some change in colour. The agents mentioned here do not produce marked changes in colour.

Fixing Agent IS (Textile Dyestuffs and Chemicals Ltd) can be used to give a low cost treatment with no appreciable loss of light fastness.

Alternative agents* are:

Hydrocol KNC (Rudolf and Co. KG)
Sandofix WE-56 (S)
Fixitol P (Durham Chemicals Distributors Ltd)
Matexil FC-PN (ICI)

Of these, the Hydrocol and Fixitol cause the least loss of light fastness but the effectiveness of Fixitol tends to vary with different dyes. Both Matexil and Sandofix cause appreciable loss of light fastness of some shades.

The amount of an agent required depends on the amount of loose dye in the fibres- deeper colours need larger amounts of agent than pale shades, and pad-batch dyed fibre will need more agent than exhaust dyed fibre. Also, fibre that has been hot washed will need less agent than unwashed fibre. Craft workers will need to experiment to find the optimum level of treatment for their fibre. The following methods for use with Fixing Agent IS will provide a basis for experiments.

There are two alternative methods for applying the agents-an

exhaust method, and a pad-batch method. The pad-batch method gives better results but the fibre must first be dried.

In the following methods it is assumed that the fibre has been dyed by the pad-batch method using 20 9 of dyestuff in each litre of dye liquor (2 per cent on weight of fibre) then washed by rinsing in cold water only. The method is also based on the use of Fixing Agent IS in dry powder form.

The manufacturers of Fixing Agent IS recommend that the agent be used at 50 - 60°C in soft water slightly acidified with acetic acid. However, satisfactory results have been obtained at TDRI using the agent in the cold without acid. It is recommended though that alkaline waters, such as those softened with soda, are rendered just acidic with acetic acid before use. Anionic substances must be avoided so fibre must be rinsed free from wetting agents such as soaps or washing-up liquid.

Pad-batch method

1. Take 1 litre of water for each kilogram of fibre of the same colour to be treated. Pour this into a bucket or other suitable vessel.

2. Read section on Safety and first aid treatment. Weigh out an amount of Fixing Agent IS powder equivalent to 45 9 for each litre of water taken (in experiments at TDRI the amount of Fixing Agent IS was halved and the water fastnesses of the resultant colours were still of a high order).

3. Mix the after-treating agent to a smooth paste with a little water from the bucket.

4. Rinse the pasted powder into the bucket of water and stir well until all the powder has dissolved.

5. Divide the dyed, rinsed and dried fibre into small bundles.

6. Take one bundle of the fibre and dip it briefly into the after-treatment liquor (about 5 seconds, but no longer). Knead and swill the fibre round whilst it is immersed to ensure that every strand is wetted.

7. Immediately squeeze the excess liquor on the fibre back into the bucket. The fibre should take up its own weight of liquor but not be so wet that it drips. Each litre of liquor will treat 1 kg of fibre.

8. Place the wet fibre into a plastic bag to prevent it from drying.

9. Repeat steps 6, 7 and 8 using the same plastic bag. Surplus liquor can be saved for later use but do not use it for a new colour unless it is clean.

10. When all the fibre of one colour has been wetted with after-treatment liquor, close the bag and leave it overnight in order that the after-treating agent can penetrate into the fibre to fix loose dye.

11. Remove the fibre from the bag and rinse surplus after-treating agent and any loose colour from the surface of the fibre with cold clean water.

12. Hang the fibre in a shady place to dry.

Exhaust method

Note: This method may be used on either wet or dry fibre. However, since better results are obtained when using wet fibre, it is best used directly after the first rinse following the dyeing stage.

1. Take 5 litres of water for each kilogram (dry weight) of fibre to be

treated. Pour this into the bucket or other suitable vessel (with dry fibre use 6 litres for each kilogram of fibre). The fibre must be all of the same colour.

2. Read section on Safety precautions and first aid treatment. Weigh out an amount of Fixing Agent IS powder equivalent to 45 9 for each kilogram of fibre to be treated (4.5 per cent on weight of fibre).

3. Mix the after-treating agent to a smooth paste with a little of the water from the bucket.

4. Rinse the pasted powder into the bucket of water and stir well until the powder has dissolved.

5. Place the dyed and rinsed fibre into the liquor ensuring the whole amount is immersed rapidly.

6. Stir well for at least 5 minutes-repeated dipping of the fibre, ensuring it is immersed each time, gives effective stirring.

7. Leave the fibre in the liquor for a further 5 hours stirring frequently within the first hour then at intervals of about 30 minutes.

8. Remove the fibre and rinse it in clean water to remove any loose dye and aftertreating agent.

9. Hang the fibre in the shade to dry.

10. Discard the liquor where it will not contaminate food or water.

Storage

The agents are reported to remain stable for 6 - 12 months when stored in cool places (20 - 30°C). However, the agents mentioned in this handbook remained effective after being kept in the laboratory at TDRI for 2 years but this is no guarantee that they will remain effective for so long in the tropics.

Direct dyes

Introduction

The direct dyes were introduced primarily for use on cotton. Unlike the reactive dyes (see pp. 41 - 55) they do not react chemically with fibres but are retained by physical forces. Dyes of this type are said to be 'substantive', but are sometimes referred to es 'cotton' dyes.

Manufacturers' trade names

Most dyestuff manufacturers offer one or more ranges of direct dyes for cotton, for example:

'Airedale' end 'Benzanil' (YCL)
'Chloramine'(S)
'Chlorazol' end 'Durazol' (ICI)
'Benzo', 'Sirius' end 'Sirius Supra' (BAY)

Instructions given in this section for using direct dyes may be used with all direct dyes regardless of the source. Some manufacturers, however, offer dyes intended for application by special techniques. Bayer's range of 'Benzo Cuprol' dyes, for example, are applied initially in the same way as other direct dyes but develop their characteristically high light and water fastness properties and their final colour only when the dyed shades have been after-treated with copper sulphate . If dyes of this type are used, the manufacturers' special instructions must be followed carefully.

Class of dye	Migration of dye (ease of levelling)	Control of levelling	Shade correction
A	Good	No special precautions necessary	Prolonged boiling in dyebath
B	Moderate	Salt omitted from dyebath initially, added at intervals whilst liquor is brought to boil	Not possible
C	Poor	Salt omitted from dyebath initially, added at intervals to boiling dyebath with frequent stirring. Heating from 50°C controlled carefully	Not possible

Figure Table 3 - Method of application for direct dyes of different classes to produce level colours

Classification of direct dyes

Some of the direct dyes (Class A) will produce level colours using the normal method of application, others (Class B) will give level colours with controlled addition of salt, whilst the rest (Class C)

require very careful heating and application of salt to produce level colours. Unfortunately, dye manufacturers usually do not indicate the class of a particular dyestuff. The instructions given on pp. 58 - 60 are therefore suitable for a Class C dye but dyers will discover by trial and error to which class a dye may belong. They can then use Table 3 as a guide to the appropriate method of application.

Choice of dyes

With the large number of direct dyes that are available it is not possible to list all those suitable for the craft dyeing of sisal. However, most ranges of direct dyestuffs include dyes that will either penetrate fairly deeply into sisal fibres, or that can be used to produce light or water fast colours.

A number of ICI direct dyes have been examined at TDRI and it was found that generally the Class A dyes penetrated most deeply into sisal. Unfortunately, this group of dyes generally produces colours with lower water fastness than other types of direct dyes and the colours produced will usually need after-treatment with a cationic after-treating agent. Some examples of Class A direct dyes with fairly good light-fastness properties are:

Durazol Yellow F	(Cl Direct Yellow 50)
Durazol Red 2B	(Cl Direct Red 81)
Durazol Violet R	(Cl Direct Violet 51)
Durazol Blue 4R	(Cl Direct Blue 67)

Chlorazol Blue G (Cl Direct Blue 10)-classification unknown-and the Class C Durazol Yellow 6G also penetrate deeply into the fibre and, together with the above dyes, should be used for mats, etc. where good wear properties are needed.

If the goods are intended for outdoor use the colours should not run in the rain nor mark off onto other fabrics when wet. Most dyes when used in pastel shades will meet these requirements but for deeper shades, dyes must be either carefully selected, or after-treated with a cationic fixing agent. The following list includes the more water fast of the dyes investigated and a guide to the need for the use of after treatments is given in Table 4

Durazol Yellow 6G	(Cl Direct Yellow 46)
Chlorazol Scarlet 4B	(Cl Direct Red 23)

Durazol Orange 2G	(CI Direct Orange 34)
Durazol Green 5G	(CI Direct Green 28)
Chlorazol Black BV	(CI Direct Black 19)
Chlorazol Black GF	(CI Direct Black 22)

These dyes generally penetrate less deeply into the fibre but nevertheless are probably suitable for most purposes. However, although more water fast than the Class A dyes, deep colours will need after-treating. When considering after-treatments it must be remembered that the resultant shade may be different in hue and of lower light fastness than the untreated colour. It is also important to remember that reducing the depth of colour to improve water fastness will also reduce light fastness.

Since only a few of the large number of the direct dyes available have been evaluated, manufacturers may be able to recommend other dyes that penetrate well into the fibre and that have good light and water fastness on sisal. Also, when good light and water fastness is essential, it is worth considering using dyes of the 'Benzo Cuprol'

type offered by Bayer. Some dyes of this type are included in ICl's 'Durazol' and 'Chlorazol' ranges of direct dyes of which Durazol Green 5G, Durazol Blue 4R, Durazol Violet R and Chlorazol Blue G were examples.

For craft workers who are unable to keep a large selection of dyes, Durazol Yellow 6G, Durazol Red 2B and Chlorazol Blue G should produce a wide range of hues when blended. Of the direct dyes which have been examined at TDRI, they are probably the most suitable dyes for this purpose although the colours are not ideal.

Application of dyes

Sisal fibre is best dyed using a liquor to fibre ratio of 20:1. The fibre is placed in the dye liquor at about 50°C and the dyebath is then slowly heated, with stirring, to deposit the colour evenly on the fibre. Finally the fibre is left in the boiling liquor for 60 - 90 minutes to complete the adsorption of the dye and allow it to penetrate into the fibre.

Use of chemical dyeing assistants

Salt (either common salt or Glauber's salt) is used to increase the affinity (see Glossary) between the dye and the fibre. The amount required varies between 2 g/l and 20 g/l depending on the depth of colour. With deep shades the use of extra salt will ensure that as much as possible of the expensive dye exhausts onto the fibre. However, a point is reached where the cost of the salt exceeds the value of the dye saved and dyers will need to experiment to find the optimum quantity of salt.

Soda ash, or sodium carbonate is added to the dye liquor at a rate of 2 per cent on weight of fibre to prevent the dye behaving as an acid dye and thereby building up colour unevenly through residual acidity in the fibre.

A wetting and penetrating agent is added to the dyebath at a rate of about 1 g/l to improve the solubility of the dye and to speed the entry of water into the fibre.

Water

It is better to use soft or rain water in the dyebath since some direct dyes react with the calcium and magnesium in hard water to form a

scum on the fibre. The addition of soda has a similar effect. The use of a sequestering agent (see Glossary) is therefore recommended if soft water is not available.

Recipe for producing a Grey Shade on 3.5 Kg of Sisal

This recipe uses an exhaust method . Very experienced dyers may be able to reduce chemical costs by using an alternative technique known as the standing bath.

Materials and equipment required		
Sisal		3.5 kg
Durazol Green 5G	35 g	(1 per cent on fibre)
Durazol Red 2B	7 g	(0.2 per cent on fibre}
Common salt (sodium chloride)	350 9	(5 9/l)
Soda ash	70 9	(2 per cent on fibre)
Synperonic BD	70g	(1 g/l)
Spring balance		
Laboratory balance		

Beakers (or similar containers)	5	
Buckets		2
Dye vat		(minimum capacity about 80 litres)
Stirring rods	1 short for use in buckets; 1 long for use in dye vat	
Water		70 litres
Drying lines		(Liquor ratio 20:1)
Fuel		
Burner		

Preparing for dyeing	
1. Weigh out 3.5 kg of sisal.	
2. Weigh out in beakers and place to one side the following:	
35 g	Durazol Green 5G
7 g	Durazol Red 2B
70 g	Soda ash
350 g	Common salt

70 g	Synperonic BD

3. Pour 20 litres of water (about one-third of the total needed) into the dyebath and start heating it to save time later. A dipstick is useful for measuring the water.

4. Take about three-quarters of a bucket of water from the dyebath (be careful not to scald yourself since the water may be hot).

5. Empty the weighed dye powders into a clean dry bucket (taking care not to breathe the dust).

6. Using a little of the water taken from the dyebath at step 4 rinse the beakers which contained dye. Do not throw away the rinsings since they contain some of the weighed dye.

7. Add about 80 ml of water taken from the dyebath at step 4 to the dye powder.

8. Mix the dye powder to a smooth paste with the water (there should be no lumps).

9. Pour the rinsing water from the emptied dye beakers into the dye paste. Continue rinsing the beakers with water taken from the dyebath at step 4 until they are clean.

10. Add water taken from the dyebath at step 4 to the pasted dye (use about half a bucket but save some for rinsing). Stir until all the dye powder is dispersed into the water.

11. Pour the dye dispersion into the dyebath. Then rinse the bucket into the dyebath using water taken from the dyebath at step 4.

12. Rinse the Synperonic BD into the dyebath using the remainder of the water taken at step 4.

13. Stir the dyebath well then bring it to the boil with occasional stirring. Boil it for a few minutes to dissolve the dye.

14. Bring the dyebath to its full volume (70 litres) by adding 50 litres of cold water. Stir well.

The bath will now be at about 50°C-the maximum temperature at which dyeing should be started.

Dyeing

1. Put the sisal in the dyebath and press it below the surface of the dye liquor.

2. Slowly heat the dyebath, with stirring, taking about 30 minutes to reach the boil. Stir carefully to avoid tangling of the fibre.

3. Still with frequent stirring, sprinkle the salt into the boiling liquor taking about 15 - 30 minutes to add it all. Use small amounts at first, then larger amounts.

Check the water level with the dipstick periodically and replace water lost through evaporation.

4. Leave the fibre in the boiling liquor for a further 45 - 60 minutes with occasional stirring.

Periodically check the water level and replace the water lost through evaporation.

Do not be tempted to remove the fibre earlier since penetration of dye into the fibre will be inadequate.

5. Remove the fibre from the dyebath. (Since the fibre may adsorb more dye from a cooling liquor it may be beneficial to leave the fibre in the liquor until it has cooled to about 60°C).

6. Rinse the fibre in cold running water until the rinsing water remains free from colour. (See below for after-treatment if necessary).

7. Hang the fibre in the shade to dry.

After-treatment

Using commercial cationic dye fixing agents

The water fastness of most direct dyes can be improved by after-treatment. These dyes have an affinity for and are able to complex (see Glossary) with basic or 'cationic' (see Glossary) substances. The molecules (see Glossary) of the complex are larger than those of the dye and therefore are held more firmly within the fibre structure. Most dyestuff manufacturers market a range of chemicals, known as cationic fixing agents (e.g. Matexil FC-PN, Levogen WW) specifically for improving water fastness. They are used after the dye has been applied to the fibre. However, the colour produced is

often less light fast than that of the untreated dye.

Table 4 lists the dyes already mentioned and indicates at which depth of shade the use of after-treatments is beneficial.

Percentage shade of dye on fibre	Dyestuff	Colour Index Generic Name
2.0 and above	Chlorazol Black GF	(CI Direct Black 22)
	Chlorazol Black BV*	(CI Direct Black 19)
1.0 and above	Durazol Yellow 6G*	(CI Direct Yellow 46)
0.5 and above	Durazol Green 5G*	(CI Direct Green 28)
	Durazol Yellow F	(CI Direct Yellow 50)
0.2 and above	Chlorazol Scarlet 4B	(CI Direct Red 23)
0.1 and above	Durazol Orange 2G	(CI Direct Orange 34)
All shades	Durazol Red 2B	(CI Direct Red 81)
	Durazol Violet R*	(CI Direct Violet 51)
	Durazol Blue 4R*	(CI Direct Blue 67)

Table 4: Shades of direct dyes needing after treatment

ICI recommend their Matexil FC-PN for the after-treatment of direct dyes and Bayer recommend Levogen WW or one of their other Levogen brands. However, craft workers using reactive dyes might well find that the after-treatment agents recommended for reactive dyes are also suitable for direct dyes.

The after-treatments are applied to the still wet, dyed and rinsed fibre by a process similar to exhaust dyeing. The agent is mixed into sufficient water to give a liquor to fibre ratio of 20:1 and the fibre is immersed in the solution and stirred. The bath is then warmed to about 50°C, with stirring, at which temperature the fibre is treated. for a further 30 minutes. The fibre is then removed from the bath, rinsed in clean water until free from surplus chemical, and hung to dry.

The amount of agent needed in the bath varies from dye to dye and, also, with the depth of colour. In general. 0.5 - 2 per cent on the weight of air-dry fibre is used, with the larger amount being used mainly for deep colours which bleed heavily.

An example procedure, using 1 per cent on weight of fibre of after-treating agent on 3.5 kg (air-dry weight of fibre: i.e. weight before dyeing) of freshly-dyed fibre, is:

1. Read section on Safety precautions and first aid treatment. Weigh out 35 9 of Matexil FC-PN (1 per cent of 3.5 kg) into a beaker or other suitable vessel.

2. Pour 70 litres of cold water into the empty, clean dyeing vessel, or other suitable container.

3. Rinse the 35 9 of Matexil FC-PN into the 70 litres of water and stir well.

4. Take the 3.5 kg (air-dry weight) of freshly-dyed wet fibre and ensure that it is rinsed free from loose colour (the presence of loose colour on the surface of the fibre will lead to poor rub fastness of after-treated shades).

5. Place the wet fibre in the Matexil solution and stir well for about 5 minutes.

6. Slowly heat the after-treatment liquor to 40 - 60°C (just too hot to touch) with frequent stirring.

7. Remove the heat and leave the fibre in the hot liquor for 20 minutes with occasional stirring.

8. Remove the fibre from the liquor and rinse well in clean cold water.

9. Hang the fibre in the shade to dry.

10. Pour the used liquor away where it will not contaminate food or water.

Using copper sulphate

Certain dyes will form complex molecules with copper. These dyes can be aftertreated with copper sulphate to improve not only their water fastness, but their light fastness also. Dyestuff manufacturers often market these dyes as a separate range (e.g. gayer's 'Benzo Cuprol' dyes) but this is not always the case. Therefore it is recommended that the dye supplier is consulted as to whether the dyes being used will respond to this treatment, or that some experimental dyeing and after-treating is carried out.

The amount of copper sulphate needed is, as with cationic after-treatments, dependent on the dye and its depth of shade. However, Bayer recommend that between 1 per cent and 3 per cent (on the air-dry weight of fibre) of the blue, crystalline copper sulphate is used with 'Benzo Cuprol' dyes.

The dyed, rinsed, still wet fibre is placed in a fresh bath containing

the appropriate amount of copper sulphate and 0.5 - 1 per cent (on the air-dry weight of fibre) of 60% acetic acid. This bath is heated to 80 - 90°C (near the boil) at which temperature the fibre is treated for a further 20 - 30 minutes. The fibre is then removed from the bath and rinsed well with cold water. In order to ensure uniform treatment, the after-treatment bath must be stirred.

Acid dyes

Introduction

Acid (or anionic) dyes have a coloured component carrying a negative electrical charge which is attracted by positive charges on the fibre. Basic (or cationic) dyes have a positive charge and therefore must not be mixed with acid dyes since they will neutralise each other to form an insoluble complex.

The acid dyes were designed for use on wool. However, there are many which will dye sisal in attractive, bright and inexpensive colours. In light fastness they vary between high and very low. Although they tend to be less light fast on sisal than on wool, craft workers should have no difficulty in finding acid dyes of adequate

light fastness. However, the brighter colours tend to be least light fast.

Generally the water fastness of acid dyes is not very high. However, the 1:2 metal complex dyes (see Glossary), developed to give better fastness on wool, also give shades of good light and water fastness on sisal. These dyes have similar properties to a group of acid dyes known as the 'Acid Milling dyes' which have better than average water fastness for the class. However, they penetrate the fibre less readily than do ordinary acid dyes. Also, with the 1:2 metal complex dyes colours tend to be less bright than with ordinary acid dyes.

Manufacturers' trade names

Acid dyes are made by a large number of manufacturers*; some examples of names used are:

'Lissamine', 'Nylomine', 'Coomassie' and 'Carbolan' (ICI)
'Acilan', 'Alizarine', 'Supramin' end 'Supranol' (BAY)
'Erio', 'Erionyl', end 'Eriosin' (COY)

The 1:2 metal complex dyes are less widely manufactured and are often marketed in ranges separate from ordinary acid dyes.

Examples of ranges which are composed largely of 1:2 metal complex dyes are:

'Irgalan'(CGY)
'Isolan' (BAY)
'Lanasyn' (S)
'Ortolan'(BASF)
'Remalan' (HOE)

Choice of dyes

Most acid dyes penetrate well and, provided that light and water fastness properties are not of prime importance, the craft worker has a wide variety of dyestuffs from which to choose. However, if these properties are important, it is suggested that the craft worker uses the following dyestuffs, although the list is by no means comprehensive:

Supranol Fast Yellow 4GL	(CI Acid Yellow 79)
Supranol Fast Scarlet GN	(CI Acid Red 85)
Supranol Fast Brown 5R	(CI Acid Orange 51)
Supranol Blue BL	(CI Acid Blue 59)

Supranol Blue BL	(Cl Acid Blue 59)
Supranol Blue GL	(Cl Acid Blue 102)
Supranol Brown B	(Cl Direct Brown 30)
Supramin Yellow RN	(Cl Acid Yellow 143)
Alizarin Fast Grey BBLW	(not listed in the Colour Index)
Nylomine Yellow A-G	(Cl Acid Yellow 135)
Coomassie Green G	(Cl Acid Green 25)

When used in pale shades, the water fastness of these dyes will be adequate for most craft purposes. When good light and water fastness are more important than good penetration, the use of 1:2 metal complex dyes is recommended. Many 'Isolan' dyes give good fastness properties on sisal; however, when applied in heavy shades their water fastness is generally inferior to that of the reactive dyes or after-treated direct dyes.

Dyes based on triaryl methane are the best choice when the sole requirement is brightness of shade. Bayer's 'Acilan' ayes are of this type and examples of similar products are:

Coomassie Violet R	(Cl Acid Violet 17)

Coomassie Blue FF	(CI Acid Blue 15)
Lissamine Turquoise AN	(CI Acid Blue 7)
Lissamine Green G.	(CI Acid Green 3)

Most of these dyes tend to be of violet, green or blue hues but there are many bright reds, oranges and yellows amongst the acid dyes. Since these bright acid colours often have poor light and water fastness, craft workers who need light and water fast bright colours should consider using the reactive dyes.

Application of dyes

Use of chemical dyeing assistants

Choice of acid

When using acid dyes an acid is generally added to the dyebath in order to create an affinity (see Glossary) between the fibre and the dye. Often the acid is added at the start of dyeing, but adding it in portions throughout the dyeing can control exhaustion and thus assist levelling.

The three acids usually employed are acetic acid, formic acid and sulphuric acid. The type and strength of acid are usually given in dyeing instructions. The experienced dyer will adapt the recipe according to the acid available-however, a weak acid cannot be used in place of a stronger one.

Some dyes can only be applied using a strong acid, such as sulphuric. This acid is corrosive and unpleasant to handle. It is also non-volatile and traces of acid which remain on the fibre will subsequently cause tendering of sisal. Dyestuffs which have to be applied from a stronqly acid bath should therefore be avoided. If. however. there is no acid other than suiphuric available, the craft worker should steep the dyed fibre in a bath of sodium acetate before drying-this converts the non-volatile sulphuric acid into acetic acid.

Formic acid, being stronger than acetic acid but less corrosive than sulphuric acid and volatile, is recommended for general use. Between 0.5 per cent and 5 per cent on the air-dry weight of the fibre of the 85% strength acid is used in the dyebath.

For some dyes the weaker acetic acid is sufficiently strong and 2 per

cent on the airdry weight of fibre of the 6096 strength acid is recommended for use with the 1:2 metal complex dyes (e.g. Bayer's 'Isolan' dyes).

Wetting and penetrating agent

The wetting and penetrating agent is added to the dyebath at a rate of about 1 g/l to improve the solubility of the dye and to speed the entry of water into the fibre.

Recipe for producing a pale olive green shade on 2.5 kg of sisal

This recipe is based on an exhaust method. Experienced dyers may be able to reduce chemical costs by using an alternative technique known as the standing bath. With the 1:2 metal complex acid dyes (e.g. 'Isolan' ayes) it is preferable to commence dyeing in a neutral bath and add acid later. This technique, which assists penetration and levelling of the dye, cannot be used with a standing bath because of residual acidity left from previous batches of fibre.

Materials and equipment required

Sisal		2.5 kg

Supramin Yellow RN	17.5 g	(0.7 per cent on fibre)
Supranol Blue BL	1.25 g	(0.05 per cent on fibre)
Synperonic BD	50 g	(1 g/l)
Formic acid (85%)	100 g	(4 per cent on fibre)

Spring balance	
Laboratory balance	
Beakers (or similar containers)	4
Buckets	2
Dye vat	(minimum capacity about 70 litres)
Measuring cylinder or dipstick	
Stirring rods	1 short for use in buckets; 1 long for use in dye vat
Water	50 litres (Liquor ratio 20:1)
Drying lines	
Fuel	

Burner	

Preparing for dyeing

1. Weigh out 2.5 kg of sisal.

2. Weigh out in beakers and place to one side the following:

17.5 g	Supramin Yellow RN
1.25 g	Supranol Blue B L
50 g	Synperonic BD
100 g	Formic acid (85%)

3. Pour 15 litres of water (about one third of the total needed) into the dyebath and start heating it to save time later. A dipstick is useful for measuring the water.

4. Take about three-quarters of a bucket of water from the dyebath (be careful not to scald yourself since the water may be hot).

5. Empty the weighed dye powders into a clean dry bucket (taking

care not to breathe the dust).

6. Using a little of the water taken from the dyebath at step 4 rinse the beakers which contained dye. Do not throw away the rinsings since they contain some of the weighed dye

7. Add about 40 ml water taken from the dyebath at step 4 to the dye powder.

8. Mix the dye powder to a smooth paste with the water (there should be no lumps).

9. Pour the rinsing water from the beakers which contained dye into the dye paste. Repeat rinsing of the beakers with water taken from the dyebath at step 4 until they are clean.

10. Add water taken from the dyebath at step 4 to the pasted dye (use about half a bucket but save some for rinsing). Stir until all the dye powder is dispersed into the water.

11. Pour the dye dispersion into the dyebath. Then rinse the bucket into the dyebath using water taken from the dyebath at step 4.

12. Rinse the Synperonic BD into the dyebath using water taken at step 4.

13. Stir the dyebath well then bring it to the boil with occasional stirring. Boil it for a few minutes to dissolve the dye.

14. Using the remaining water taken at step 4 rinse the acid into the dyebath. (If the acid is to be added portion-wise later to assist levelling just add the remaining water to the dyebath).

15. Bring the dyebath to its full volume (50 litres) by adding 35 litres of cold water. Stir well.

The bath will now be at about 50°C-the maximum temperature at which dyeing should be started.

Dyeing

1. Put the sisal in the dyebath and press it below the surface of the dve liquor.

2. Slowly heat the dyebath, with stirring, taking about 30 minutes to reach the boil. Stir carefully to avoid tangling of the fibre.

3. Leave the fibre in the boiling liquor for a further hour with occasional stirring.

If acid has been saved to assist levelling add it to the bath portionwise throughout the period at the boil.

Check the water level with the dipstick periodically and replace water lost through evaporation.

Do not be tempted to remove the fibre earlier since penetration of dye into the fibre will be inadequate.

4. Remove the fibre from the dyebath. (Since the fibre may adsorb more dye from a cooling liquor it may be beneficial to leave the fibre in the liquor until it has cooled to about 60° C).

5. Rinse the fibre in cold running water
6. Hang the fibre in the shade to dry until the rinsing water remains free from colour.

Basic dyes

Introduction

Basic (or cationic) dye molecules have a coloured component carrying a positive electrical charge which is attracted by negative charges on the fibre. Basic dyes must not be: (i) mixed with the negatively charged acid dyes since they will neutralise each other to form an insoluble complex; or (ii) used under alkaline conditions since many of the dyes will decompose to form the colourless dye base which is insoluble in water.

The basic dyes, like the acid dyes, unite chemically with the fibre. They do not take directly on cotton but they do on ligno-cellulosic fibres such as sisal, jute and coin For brightness and clarity of colour the basic dyes cannot be matched by any other class of dyestuff. Also, since the dyestuffs produce intense colours, quite small quantities of dye will produce deep hues.

Although they produce bright colours cheaply, the light and water fastness properties of the colours are generally poor and for many textile purposes these dyes have been largely displaced by the more modern acid, direct, and reactive dyes.

Nowadays the traditional basic dyes are mainly used on non-durable items. However, new basic dyes specifically developed for acrylic

fibres are appearing on the market. Some of these dyes have light fastness properties on sisal that are superior to those obtained with traditional basic dyes such as Safranine, Magenta, Methyl Violet and Methylene Blue. Although water fastness tends to be low it can be improved substantially by the use of a 'back-tanning' after-treatment.

Manufacturers' trade names

A wide variety of names, often ending in 'cryl' , are used for dye ranges of basic dyes*, e.g.:

'Astrazon' (BAY)
'Basacryl' (BASF)
'Maxilon' (COY)
'Sandocryl' (S)
'Synacril' (ICI)

Choice of dyes

The following observations are based on limited trials on ICI's 'Synacril' ayes, gayer's 'Astrazon' dyes, Sandoz's 'Sandocryl' ayes and Dupont's 'Sevron' dyes:

Yellow

Astrazon Yellow 7GLL (Cl Basic Yellow 21) and Yellow 8GL (Cl Basic Yellow 13), Sandocryl Brilliant Yellow B-5GL (Cl Basic Yellow 61), and Synacril Yellow 8G (Cl Basic Yellow 13) give clear yellow shades. These dyes have fairly good light fastness on sisal but, when wet, they tend to mark off onto sisal, cotton and wool. In this respect the dyes have similar properties to many of the untreated direct dyes.

Sevron Yellow 3RL (Cl Basic Yellow 15) and Astrazon Golden Yellow GL (Cl Basic Yellow 28) give more of an orange hue. Of these the Synacril Yellow is the most orange and the most water fast, but it is only in the paler shades that it ranks amongst the better dyes for sisal. The Sevron dye is the least light fast but both dyes give light fastness ratings of a high order. Possibly blends of these dyes with the pure yellow dyes mentioned earlier will give a wide range of yellow hues with good light and water fastness properties with suitable after-treatment. However, there are reddish yellows of high light fastness available as single dyestuffs, e.g. Sandocryl Golden Yellow B-GRL (Cl Basic Yellow 82) and Sandocryl Yellow BLE (Cl Basic Yellow 56).

Orange

Only Astrazon Orange 3RL (CI Basic Orange 27) of the available orange dyes has been examined. This dye is of a reddish orange hue and has high light fastness. Possibly blends of this dye with one of the pure yellows mentioned earlier will give a wide range of orange hues with moderate fastness properties. The dye has fair fastness to water.

Red

The basic reds are, in general, less light fast than the yellow and orange dyes already mentioned.

Astrazon Red RL (CI Basic Red 25) has fairly good light fastness but poor water fastness. It is an orangish red and not particularly bright. This dye will be useful for mixing with yellow to make orange but it is doubtful that it will make satisfactory purples when mixed with blue. Astrazon Red F3BL (CI Basic Red 22) and Astrazon Brilliant Red RTL (not listed in the Colour Index) are more appropriate colours for mixing with either yellow or blue, and are only marginally less light fast than the Astrazon Red RL.

Bright, magenta coloured dyes such as Sandocryl Brilliant Pink B-5B (Cl Basic Red 75) and Astrazon Red 6B (Cl Basic Violet 7) have low light fastness but they may be found to be a little better than traditional basic dyes. Sandocryl Brilliant Red BF (Cl Basic Red 27) is a little more light fast but is less blue than magenta.

Other reds evaluated include some with moderate fastness to light but are in general dull colours. These include Synacril Red 2G (Cl Basic Red 18:1), Astrazon Red GTL-N (Cl Basic Red 18:1), Astrazon Red 5BL (Cl Basic Red 24) and Astrazon Red BBL (Cl Basic Red 23).

Blue

Many of the blue dyes examined have only moderate light or water fastness- Astrazon Blue 3RL (Cl Basic Blue 47) and Astrazon Blue 5GL (Cl Basic Blue 45) being the most promising. Of these the Blue 5GL is the better colour for blending but the Blue 3RL is a stronger colour and has slightly better light fastness. Astrazon Blue 3RL will be suitable for producing purple by mixing with red.

Other dyes examined include Synacril Blue R (Cl Basic Blue 22), Astrazons Blue RL (Cl Basic Blue 46) and Blue FGL (Cl Basic Blue

22), and Sandocryl Brilliant Blue B-BLE (Cl Basic Blue 77). Of these, Astrazon Blue RL cannot be recommended for sisal on account of poor colour strength.

Green

Only Sandocryl Brilliant Green B-NLE (Cl Basic Green 12) has been examined. This gives a weak colour of poor fastness. Astrazon Blue 5GL or Sandocryl Brilliant Blue B-BLE blended with a pure yellow dye may produce greens with slightly better light fastness. The red component of Astrazon Blue 3RL may give rise to dull green in blends with yellow.

Craft workers wishing to use the new basic dyes should base their shade range on Synacril Yellow 8G (or Astrazon Yellow 8GL), Astrazon Red F3BL (or Astrazon Brilliant Red RTL) and Astrazon Blue 5GL (or Sandocryl Brilliant Blue B-BLE). Blending of these dyes with others of similar light fastness properties should produce a fairly wide range of shades with moderately good light fastness. A back-tanning after-treatment may be needed to obtain satisfactory fastness to water.

Only a few of the wide range of available basic dyes have been evaluated. There may well be other suitable dyes included either in the ranges evaluated, or those offered by other dyestuff manufacturers.

Application of dyes

Use of chemical dyeing assistants

Acid

Acid (usually acetic) is used in the dyebath:

(i) To prevent precipitation of the dye base. Tap, spring and river water is usually alkaline and, as there is some risk of the free dye base precipitating in the dyebath, the water used to prepare the dye liquor must be neutralised with acid (e.g. acetic acid) before introducing the dyestuff. The acid is added with stirring until the water causes blue or neutral litmus paper to just turn red when dipped. Litmus paper can be purchased from some pharmacies.

(ii) Jo help dissolve the dye. If water alone is used a sticky tar is sometimes formed.

(iii) Jo retard exhaustion of the dye. The affinity between basic dyes and the material being dyed is usually so strong that the dye deposits too rapidly for the dyer to obtain even distribution of the dyestuff. By adding acid to the dyebath adsorption of the dye is slowed down enabling the dyer to control the dyeing. More acid is used with pale colours since they are more difficult to level than deep colours.

Wetting and penetrating agent

A wetting and penetrating agent is added to improve the solubility of the dye and to speed the entry of water into the fibre.

Recipe for producing a lime green shade on 1.5 kg of sisal
This recipe is based on the exhaust method. Extremely competent dyers may be able to reduce chemical costs by using an alternative technique known as the standing bath.

Materials and equipment required

Sisal		1.5 kg
Astrazon Yellow 7GLL	28.5 g	(1.9 per cent on fibre)

Astrazon Blue 3RL	1.5 g	(0.1 per cent on fibre)
Synperonic BD	30 g	(1 g/l)
Acetic acid (30%)	60 g	(4 per cent on fibre)
Spring balance		
Laboratory balance		

Beakers (or similar containers)	5
Buckets	2
Dye bath	(minimum capacity about 50 litres)
Measuring cylinder	
Stirring rods	1 very short for beakers; 1 short for bucket,
	1 long for bath
Water	30 litres (Liquor ratio 20:1)
Drying lines	
Fuel	
Burner	

Preparing for dyeing

1. Weigh out 1.5 kg of sisal.

2. Weigh out in beakers and place to one side the following: 28.5 9 Astrazon Yellow 7GLL 1.5 9 Astrazon Blue 3RL 30 9 Synperonic BD 60 9 Acetic acid (30%)

3. Pour 10 litres of water (about onethird of the total needed) into the dyebath and start heating it to save time later. A dipstick is useful for measuring the water.

4. Take about half a bucket of water from the dyebath (be careful not to scald yourself since the water may be hot).

5. Empty the weighed dye powders into a clean dry bucket (taking care not to breathe the dust). Put the beakers to one side-they must be rinsed later.

6. Dilute the acetic acid to 15% strength by pouring 60 mls of water into a beaker then add carefully, with stirring, the 60 9 of acid.

7. Pour about 40 ml of the diluted acid onto the dye powders in the

bucket.

8. Mix the dye powders to a smooth paste with the acid (there should be no lumps). Then stir more acid into the paste until about half the acid remains.

9. Wet the beakers which contained dye with a little of the diluted acid then rinse them with water taken from the dyebath at step 4. Add the rinsings to the dye paste.

Continue rinsing the beakers with acid and water until they are clean -save some acid to rinse the bucket later.

10. Add more water taken from the dyebath at step 4 to the dye paste and stir well to disperse the dye powders. Save some of the water to rinse the bucket later.

11. Whilst stirring the dyebath pour in the dye dispersion.

12. Rinse the bucket with a little of the water taken from the dyebath at step 4. Add the rinsings to the dyebath then wet the bucket with some of the remaining acid solution and rinse with water.

Continue rinsing with acid and water until the bucket is clean. Pour any remaining acid into the dyebath but save some water.

13. Using the remainder of the water taken from the dyebath at step 4, rinse the Synperonic BD into the dyebath.

14. Stir the dyebath well then bring it to the boil with occasional stirring. Boil it for a few minutes to dissolve the dye.

15. Bring the dyebath to its full volume (30 litres) by adding 20 litres of cold water. Stir well.

The dyebath will now be at about 50°C–the maximum temperature at which dyeing should be started.

Dyeing

1. Put the sisal in the dyebath and press it below the surface of the dye liquor.

2. Slowly heat the dyebath, with stirring, taking about 30 minutes to reach the boil. Stir carefully to avoid tangling of the fibre.

3. Leave the fibre in the boiling liquor for a further 60 - 90 minutes stirring frequently at first, then occasionally.

Do not be tempted to remove the fibre from the dyebath earlier since penetration of dye into the fibre will be inadequate.

Check the water level with the dipstick periodically and replace water lost through evaporation.

4 Remove the fibre from the dyebath.

Note: the fibre may adsorb more dye if:

(i) it is left in the liquor whilst it cools.

(ii) the dyebath is neutralised with, for example, soda ash towards the end of dyeing. The bath must not be made alkaline.

5. Rinse the fibre in cold running water until the rinsing water remains free from colour. (See below for after-treatment if necessary).

6. Hang the fibre in the shade to dry.

After-treatment

Water fastness can be improved by after-treatment ('back-tanning') with tannic acid and tartar emetic (potassium antimony tartrate) as follows:

1. Steep the freshly-dyed fibre in a solution containing 1 9/l of tannic acid and leave in the solution for 30 minutes at room temperature. Use a liquor to fibre ratio of 20:1 (for 1.5 kg of fibre use 33 9 of tannic acid dissolved in 30 litres of water).

2. Remove the fibre from the solution and shake the excess tannic acid from it.

3. Immerse the fibre in a solution containing 0.3 g/l of tartar emetic using a liquor ratio of 20:1 (for 1.5 kg of fibre use 9 9 of tartar emetic dissolved in 30 litres of water). Leave in the solution for 30 minutes.

4. Remove the fibre from the solution and rinse it in a drum of cold water.

5. Place the fibre on a line to dry.

Safety note: Tartar emetic is poisonous. Use with great care (see Safety precautions and first aid treatment).

Disperse dyes

Introduction

The disperse dyes were developed for man-made fibres (such as cellulose acetate) which do not take up ionic dyes (see Glossary). The dyes are in the form of a suspension of particles which, for reasons not fully understood, are adsorbed onto the surface of ligno-cellulosic fibres such as sisal, abaca and fique. On these fibres they are easy to use and, where good penetration is needed, are the best choice of dyestuff. There are, however, some disadvantages in using disperse dyes. Of these the most important to the craft worker are:

(i) Many of the dyes are not fast to heat. When ironing or when blocking hats, some of the dyes vaporise, staining adjacent materials and reducing the depth of colour on the fibre. However, this is important only when hot processes are used after dyeing.

(ii) Sisal has a low capacity for adsorbing disperse dyes sometimes giving only pastel shades.

(iii) Only a few disperse dyes give good light and water fastness on sisal.

There is no simple method of overcoming the poor light and water fastness of the dyes but where hot processes are used after dyeing, loss of colour can sometimes be compensated for by using extra dye.

Disperse dyes will probably only be obtainable directly from the dyestuff manufacturers or their agents. Some multi-purpose dyes (see Glossary) include disperse dyes in blends with other classes of dyes.

Manufacturers' trade names

Many dyestuff manufacturers* market a range of disperse dyes, some examples are:

'Cibacet' (COY)
'Dispersol' (ICI}
'Resolin' (BAY)
'Artisil' end 'Foron' (S)

The ICI 'Procinyl' range of dyes are reactive disperse dyes for nylon but they can also be used as ordinary disperse dyes and are included here.

Choice of dyes

Since many of the limited number of disperse dyes investigated gave poor light and water fastness on 'straws" only a few selected dyes were evaluated on sisal. Of these the following could form the basis of a shade range:

Yellow

Procinyl Yellow G (Cl Reactive Yellow 5) has moderately good light and water fastness properties and builds up to fairly deep shades. Its fastness properties are similar to the reds and blues recommended for blending (see later). Dispersol Yellow AG (Cl Disperse Yellow 3), although of similar light fastness, tends to stain cotton, wool and sisal heavily when wet.

Artisil Brilliant Yellow 6GFL (Cl Disperse Yellow 49) and Foron Brilliant Yellow 5GL (Cl Disperse Yellow 126) both build up to deep, bright greenish yellows suitable for blending. They have better light

fastness than the Procinyl Yellow and stain cotton less deeply when wet. However, the deeper shades tend to mark off onto wool a little more heavily than the Procinyl dye.

Resolin Yellow GRL (Cl Disperse Yellow 66) and Artisil Yellow FL (Cl Disperse Yellow 42) also have high light fastness and moderately good water fastness, but do not build up to such intense colours as the dyes just mentioned.

Red

Trials to date have failed to identify a dye which will produce intense, colour fast, bright magenta hues: the range of fast colours that craft workers will be able to produce will therefore be restricted. However, Resolin Brilliant Red BLS (Cl Disperse Red 159) comes nearest in its properties. Although Dispersol Red B-2B (Cl Disperse Red 60) is similar in hue and fastness properties it only builds up to a pale pink colour and it would therefore be wasteful to use more than 0.5 per cent on weight of fibre of this dye. Another promising alternative is Dispersol Red C-B (Cl Disperse Red 91). This also gives weak, fast colours but is less blue than magenta.

In order to extend their shade range it is suggested that craft workers add one of the following colours: Foron Yellow Brown S-2RFL (Cl Disperse Orange 30) or Foron Brilliant Orange S-FL (Cl Disperse Orange 96). These are oranges with good light and water fastness which could be used to blend reddish yellows. Other potentially useful dyes either as single dyes or in blends include:

Foron Brilliant Red S-RGL	(Cl Disperse Red 202)
Foron Brilliant Scarlet S- RL	(Cl Disperse Red 210)
Foron Scarlet S-3G FL	(Cl Disperse Red 54)
Foron Rubine S-2G FL	(Cl Disperse Red 167)
Dispersol Scarlet C-G	(not listed in the Colour index)
Resolin Red B RL	(Cl Disperse Red 134)

Blue

Of the few dyes investigated, Dispersol Blue DOG (Cl Disperse Blue 296) was closest to the primary hue of cyan. Although a weak dye, it builds up to a medium depth of colour using about 4 per cent dye on weight of fibre. It has good water fastness and although its light fastness is a little lower than that of the suggested red and yellow

dyes it could nevertheless be a useful dye for blending.

Artisil Blue BGL (Cl Disperse Blue 73) is a stronger blue with better light fastness and good water fastness. Although a greener blue would be preferable, it will nevertheless produce a useful range of fast colours. An alternative blue of similar qualities is Cl Disperse Blue 56 (Dispersol Blue BR, Resolin Blue FBL and other equivalents).

Trials which led to the above selection of dyes were not exhaustive and it is recognised that there may well be other disperse dyes which give light and water fast colours on sisal.

Application of dyes

Use of chemical dyeing assistants

Unlike other classes of dyes only water and the dyestuff are needed when applying these dyes. However, a wetting agent (e.g. 1 9/l Synperonic BD) in the dyebath can be used to improve the stability of the dye suspension and to assist the transfer of dye to the fibre.

Recipe for producing a lilac shade on 3 kg of sisal

This recipe is based on the exhaust method . The initial preparation of the dye liquor needs special care as the method for dispersing the dye into water differs from the methods used for dissolving dyes of other classes. Extremely competent dyers may be able to reduce chemical costs on dyes that do not exhaust well by using an alternative technique known as the standing bath.

In the authors' experience, the disperse dyes can be used together with acid or basic dyes to blend preferred hues. The dyeing method used with such blends should conform to that used with acid or basic dyes, and the disperse dyestuff should be dispersed into water separately as described here before it is added to the dyebath. There is no apparent reason why disperse dyes should not be used with direct dyes also.

Materials and equipment required

Sisal	3 kg	
Dispersol Blue BR	18 g	(0.6 per cent on fibre)
Dispersol Red B-2B	12 g	(0.4 per cent on fibre)
Synperonic BD	60 g	(1 g/l)

Spring balance		
Laboratory balance		

Beakers (or similar containers)	3
Buckets	2
Dye vat	(minimum capacity about 90 litres)
Measuring cylinder	
Stirring rods	1 short for use in bukets, 1 long for use in the dye vat
Water	60 litres (Liquor ratio 20:1)
Drying lines	
Fuel	
Burner	

Preparing for dyeing

1. Weigh out 3 kg of sisal.

2. Weigh out in beakers and place to one side the following: 18 9

Dispersol Blue BR 12 g Dispersol Red B-2B.

3. Pour 60 litres of water into the dyebath and heat it to 50°C. A dipstick is useful for measuring the water.

4. Take about three-quarters of a bucket of the warm water from the dyebath.

5. Pour 300 ml of the warm water taken from the dyebath into another bucket.

6. Stir the 300 ml of water in the bucket and sprinkle the weighed dye powders into the moving water (be careful not to breathe the dust). Do not continue stirring.

7. Using a little of the water taken from the dyebath at step 4 rinse the beakers which contained dye. Do not throw away the rinsings since they contain some of the weighed dye.

8. With dye 'powders' periodically stir the mixture in the bucket over about the next 10 minutes. With 'grains' stir the mixture for the first time after 5 minutes, then periodically. The mixture is ready when no dye settles to the bottom of the bucket.

9. Pour rinsing water from the emptied dye beakers into the dye mixture. Continue rinsing the beakers with water taken from the dyebath at step 4 until they are clean.

10. Add water taken from the dyebath at step 4 to the dispersed dye (use about half a bucket but save some for rinsing) and stir.

11. Pour the dye dispersion into the dyebath. Then rinse the bucket into the dyebath using water taken from the dyebath at step 4.

12. Rinse the Synperonic BD into the dyebath using the remainder of the water taken at step 4.

13. Stir the dyebath well. (Since disperse dyes do not dissolve the bath will remain cloudy).

Dyeing

1. Put the sisal in the dyebath and press it below the surface of the dye liquor.

2. Slowly heat the dyebath, with stirring, taking about 30 minutes to reach the boil. Stir carefully to avoid tangling of the fibre.

3. Leave the fibre in the boiling liquor for a further hour with occasional stirring.

Check the water level with the dipstick periodically and replace water lost through evaporation.

Do not be tempted to remove the fibre earlier since penetration of dye into the fibre will be inadequate.

4. Remove the heat from the dyebath and leave the fibre in the liquor until it has cooled to 50°C.

5. Remove the fibre from the dyebath.

6. Rinse the fibre in cold running water until the rinsing water remains free from colour.

7. Hang the fibre in the shade to dry.

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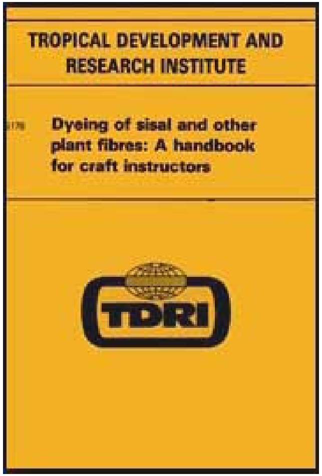

Dyeing of Sisal and other Plant Fibres: A Handbook for Craft Instructors (NRI)

References

BRITISH STANDARDS INSTITUTION (1978) BS1006: 1978 Methods of test for colour fastness of textiles and leather. London: BSI.

CANNING, A. J. and JARMAN, C. G. (1974) Procion MX dyes for the

craft dyeing of sisal. Tropical Science, 16, 121 - 147.

CANNING, A. J. and JARMAN, C. G. (1983). A handbook for craft instructors: Supplement: Properties of selected dyes on sisal. Report of the Tropical Development and Research Institute, G 177, iii + 22pp.

CANNING, A. J., JARMAN, C. G. and MYKOLUK, S. (1977) Pad-batch dyeing of plant fibres. Rural Technology Guide, Tropical Products Institute, No. 2, 53pp.

EDWARDS, M. and CANNING, A. J. (1981) The evaluation of some Procion MX dyes for the dyeing of sisal. Report of the Tropical Products Institute, L56, 10pp.

CROUCH, M. (1981) Natural dye production may mean more work for an inferior product. VITA News, April, 8 - 9.

DEMPSEY, J. M. (1975) Fiber crops. Gainesville: University of Florida Press, 457pp.

IMPERIAL CHEMICAL INDUSTRIES plc (undated) Procion dyes: Cotton dyeing, Pattern card 25667. Manchester: ICI.

JARMAN, C. G. and JAYASUNDERA, D. S. (1975) The extraction and processing of coconut fibre. Report of the Tropical Products Institute, G94, 25pp.

JARMAN, C. G., MYKOLUK, S., KENNEDY, L. and CANNING, A. J. (1977) Banana fibre: a review of its properties and small scale processing. Tropical Science, 19, 173 - 185.
KIRBY, R. H. (1963) Vegetable fibres London: Leonard Hill, 464pp.

LOCK, G. W. (1969) Sisal, Second Edition. London: Longmans, 365pp.

LOMAS, B. and SIMMENS, S. C. (1970) Preparation of cross-sections of textile materials by grinding. Journal of Microscopy, 92 (1), 37 - 45.

SOCIETY OF DYERS AND COLOURISTS/AMERICAN ASSOCIATION OF TEXTILE CHEMISTS AND COLORISTS (1982) Colour Index, Third Edition (Second Revision (1982)), Volume 5, and Additions and Amendments Nos 37 (October 1980) to 43 (April 1982). Bradford and London: Lund Humphries.

TROTMAN, E. R. (1975) Dyeing and chemical technology of textile

fibres, Fifth Edition. London and High Wycombe: Charles Griffin, 709pp.

WHITE, B . K. (1981) Weaving Guide Lesotho Project Primer, No. 2. Geneva: International Labour Office, 124pp.