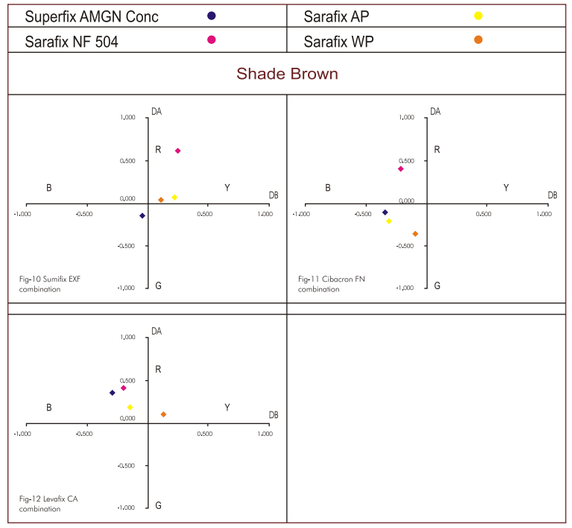

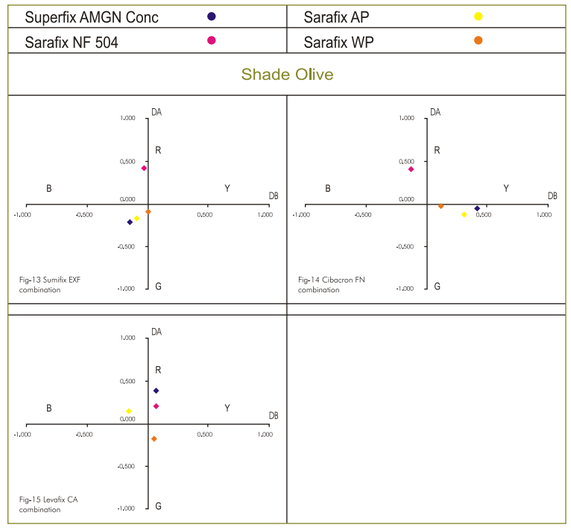

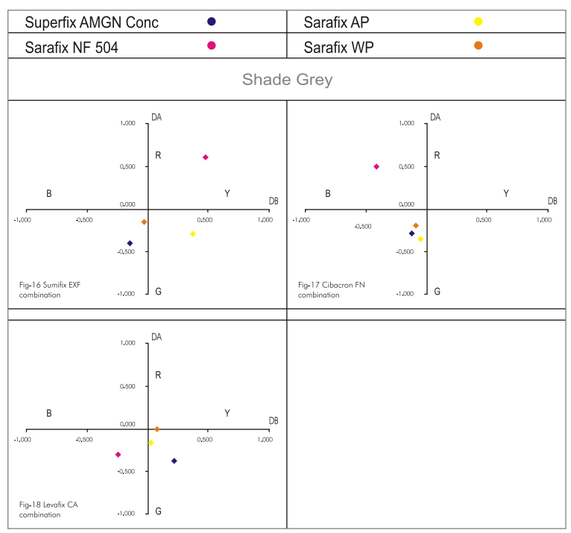

TABLE-5 Shade Brown

No.	Recipe	Dyefixing Agent	DA	DB	DF
1	Sumifix EXF	Superfix AMGN Conc	-0.166	-0.045	0.171
		Sarafix NF 504	0.562	0.244	0.612
		Sarafix AP	0.059	0.228	0.235
		Sarafix WP	0.013	0.118	0.118
2	Cibacron FN	Superfix AMGN Conc	-0.157	-0.324	0.360
		Sarafix NF 504	0.399	-0.222	0.456
		Sarafix AP	-0.287	-0.305	0.418
		Sarafix WP	-0.354	-0.132	0.377
3	Leavfix CA	Superfix AMGN Conc	0.366	-0.320	0.486
		Sarafix NF 504	0.399	-0.222	0.456
		Sarafix AP	0.174	-0.137	0.221
		Sarafix WP	0.103	0.094	0.139

TABLE-6 Shade Olive

No.	Recipe	Dyefixing Agent	DA	DB	DF
1	Sumifix EXF	Superfix AMGN Conc	-0.229	-0.153	0.275
		Sarafix NF 504	0.396	-0.017	0.396
		Sarafix AP	-0.205	-0.088	0.223
		Sarafix WP	-0.106	-0.005	0.106
2	Cibacron FN	Superfix AMGN Conc	-0.073	0.446	0.452
		Sarafix NF 504	0.438	-0.123	0.455
		Sarafix AP	-0.112	0.322	0.340
		Sarafix WP	-0.020	0.111	0.112
3	Leavfix CA	Superfix AMGN Conc	0.380	0.073	0.386
		Sarafix NF 504	0.163	0.070	0.177
		Sarafix AP	0.146	-0.142	0.203
		Sarafix WP	-0.164	0.051	0.171

TABLE-7 Shade Grey

No.	Recipe	Dyefixing Agent	DA	DB	DF
1	Sumifix EXF	Superfix AMGN Conc	-0.381	-0.154	0.410
		Sarafix NF 504	0.552	0.474	0.727
		Sarafix AP	-0.283	0.334	0.437
		Sarafix WP	-0.134	-0.025	0.136
2	Cibacron FN	Superfix AMGN Conc	-0.295	-0.144	0.328
		Sarafix NF 504	0.508	-0.408	0.651
		Sarafix AP	-0.348	-0.074	0.355
		Sarafix WP	-0.167	-0.121	0.206
3	Leavfix CA	Superfix AMGN Conc	-0.396	0.156	0.425
		Sarafix NF 504	-0.315	-0.221	0.385
		Sarafix AP	-0.138	0.025	0.140
		Sarafix WP	-0.011	0.041	0.042

Effect of Dye-fixing Agents on Shades of Cotton Dyed with Reactive Dyes

By Dr Naresh M. Saraf and Deepak V. Alat, of Sarex Overseas, India

Reactive dyes are the most popular class of dyes for dyeing cotton, and batch operation is still the most widely used method for processing of cotton knits. Among reactive dyes, bi-functional dyes are a commonly used subclass, though simple vinylsulphones are used for dyeing of turquoise, turquoise-based green, bright blues and blacks.

In order to make a compact recipe and achieve consistency of shade or reproducibility, different dyestuff manufacturers recommend different combinations for dyeing pale, medium and dark shades. Thus the dyer can use two or three different sets of dyes, from the same manufacturer, for dyeing different shades. Also, these dyes may not necessarily be homogeneous dyes but could be proprietory mixtures, made with the aim of producing reproducible dyeings with better exhaustion.

As all of us are aware, post-dyeing operation is most important part of reactive dyeing to achieve the required fastness properties and a survey indicated that about 30-35% of processing time for cotton knits is accounted for by the post-dyeing treatment, which includes rinsing, neutralisation, washing, soaping, rinsing and dyefixation. Ideally, in order to meet the end user's fastness requirement, the material should be totally free from unfixed hydrolysed dyestuff. But this may require additional soaping/rinsing/washing operations, which not only increase process time but also increase water consumption substantially.

As water is becoming scarce resource today, this route is not practicable and increase in effluent volume is another drawback. Thus, in order to achieve the required wet fastness with optimum use of water, generally after one or two soapings at boil, many dyers use dyefixing agents to 'fix' unwashed hydrolysed dyestuff, which then cannot interfere in wet fastness evaluation. Also, aftertreatment with a cationic dyefixing agent will guard against staining due to hydrolysis during prolonged storage under unfavourable storage conditions.

Cationic dyefixing agents used for reactive dyes are these days 'eco-friendly', ie. They are not based on formaldehyde condensation products, but on different chemistry. As the formulation of each dyefixing agent varies, so also does the performance. One of the undesirable side-effects of dyefixing agents is a change in the shade or tone of the treated material. Though suppliers of dyefixing agents claim 'minimum effect' on the shade of treated material, it is difficult to predict the exact shade after dyefixation.

We at Sarex have done this initial study to find a correlation between chemistry of dyefixing agent and tonal variation. In this preliminary study, we dyed two sets of shades – dark shades like Navy, Maroon, Forest Green, and medium shades like Grey, Olive and Brown – to study the effect on the tone of the dyed shade after fixation with four dyefixing agents, based on different chemistry. Experimental details are given below:

Material – Scoured, bleached 100% cotton single jersey, obtained from production lot, rewashed in the lab and neutralized to pH 6.5

Dyes – Sumifix HF, Remazol RR and Remazol RGB for dark shades; and Sumifix E-XF, Cibacron FN and Levafix CA for medium shades. All dyestuff samples were obtained from the respective manufacturers for the lab work. Though shades dyed with an individual range may not exactly match in tone, care is taken to maintain similar visual depth to study effect of dyefixing.

Dyeing – Carried out in a laboratory beaker dyeing machine at MLR 1:10 as per the standard procedure recommended by the dyestuff manufacturer.

Soaping – After alkali fixation, rinse under running water for 5 mins, with intermediate squeezing. Neutralise to pH6 using acetic acid and wash at 95°C for 10 mins at this pH. Rinse under running tap water for 5 mins, soap with 2% Kalium NNS and 2% Sarakol PS at 98°C for 10 mins. Repeat soaping in fresh bath for dark shades. Rinse at 95°C for 10 mins, rinse under running tap water, and neutralise to pH 6. For rinsing and soaping, soft water at pH6.5 was used and MLR maintained at 1.10. The efficiency of soaping was tested in pretrials to ensure hydrolysed dyestuff was removed completely before dyefixing.

Dyefixing – Using each dyefixing agent at 1% owf, MLR 1:10, pH 6, treat dyeings at 40°C for 15 mins, squeeze through padding mangle for uniformity of moisture and dry at 110°C. condition before evaluation.

Evaluation – Using colour computer and CIE LAB equation to assess DA & DB values compared to unfixed dyeing.

Dyefixing agents used –

Superfix AMGN Conc
- DCDA formaldehyde condensation product

Sarafix NF 504
- polyamine epichlorohydrine condensation product.

Sarafix – AP
- polyethylene polyamine condensate product

Sarafix – WP
- proprietory formulation, which is ultra-low formaldehyde and stable up to 70°C wash fastness test (AATCC 61-3A)

Results and Discussions: Results are

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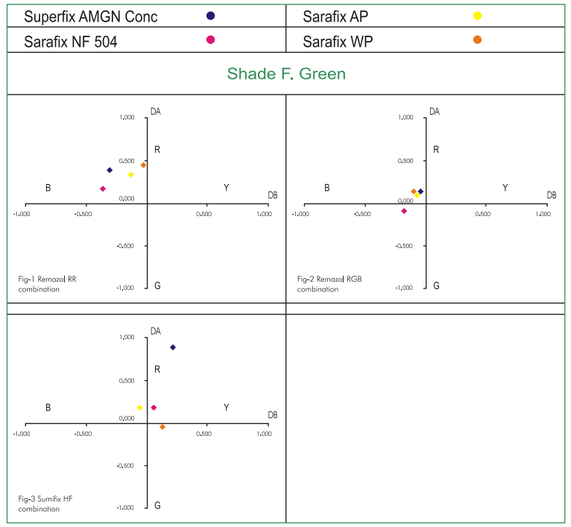

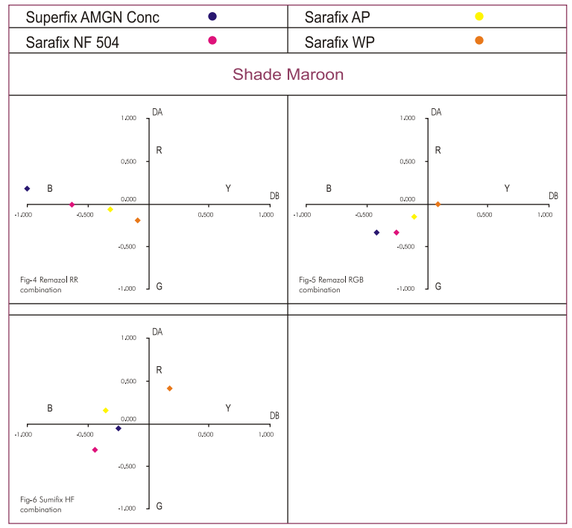

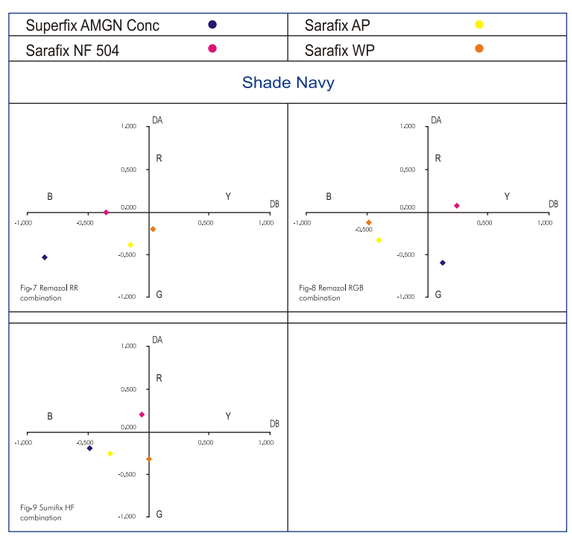

TABLE-2 Shade F.Green

No.	Recipe	Dyefixing Agent	DA	DB	DF
1	Remazol RR	Superfix AMGN Conc	0.381	-0.307	0.489
		Sarafix NF 504	0.166	-0.347	0.384
		Sarafix AP	0.335	-0.115	0.354
		Sarafix WP	0.450	-0.010	0.450
2	Remazol RGB	Superfix AMGN Conc	0.120	-0.036	0.125
		Sarafix NF 504	-0.104	-0.126	0.163
		Sarafix AP	0.090	-0.082	0.121
		Sarafix WP	0.113	-0.089	0.143
3	Sumixix HF	Superfix AMGN Conc	0.686	0.212	0.718
		Sarafix NF 504	0.133	0.058	0.250
		Sarafix AP	0.141	-0.030	0.144
		Sarafix WP	-0.034	0.156	0.159

TABLE-3 Shade Maroon

No.	Recipe	Dyefixing Agent	DA	DB	DF
1	Remazol RR	Superfix AMGN Conc	0.148	-0.976	0.990
		Sarafix NF 504	-0.005	-0.608	0.608
		Sarafix AP	-0.112	-0.292	0.312
		Sarafix WP	-0.221	-0.106	0.245
2	Remazol RGB	Superfix AMGN Conc	-0.316	-0.435	0.537
		Sarafix NF 504	-0.319	-0.294	0.433
		Sarafix AP	-0.182	-0.140	0.229
		Sarafix WP	-0.002	0.036	0.036
3	Sumixix HF	Superfix AMGN Conc	-0.076	-0.261	0.271
		Sarafix NF 504	-0.282	-0.401	0.490
		Sarafix AP	0.131	-0.335	0.359
		Sarafix WP	0.328	0.193	0.380

TABLE-4 Shade Navy

No.	Recipe	Dyefixing Agent	DA	DB	DF
1	Remazol RR	Superfix AMGN Conc	-0.456	-0.820	0.938
		Sarafix NF 504	-0.015	-0.327	0.327
		Sarafix AP	-0.358	-0.114	0.375
		Sarafix WP	-0.312	0.039	0.314
2	Remazol RGB	Superfix AMGN Conc	-0.554	0.116	0.566
		Sarafix NF 504	0.079	0.242	0.254
		Sarafix AP	-0.372	-0.431	0.569
		Sarafix WP	-0.182	-0.470	0.504
3	Sumixix HF	Superfix AMGN Conc	-0.182	-0.474	0.507
		Sarafix NF 504	0.165	-0.041	0.170
		Sarafix AP	-0.236	-0.304	0.384
		Sarafix WP	-0.332	0.008	0.332

given in Table 2-7 and in graphical form Fig. 1-12.

In the case of the Forest Green shade, for the Remazol RR combination, Superfix AMGN Conc showed maximum tonal variation whereas Sarafix WP showed the least. All dyefixing agents made the shade redder and bluer after the treatment, though the extent of tonal variation was not the same (Fig. 1). In the case of the Remazol RGB combination, the tonal variation was much less than for the Remazol RR combination (Fig. 2) but towards the greener side. In the case of the Sumifix HF combination, Superfix AMGN Conc showed the maximum tonal variation compared to the other three. In this case, treated dyeings were found to by yellower, or less blue, than the Remazol RR or RGB combinations (Fig. 3).

In the case of the Maroon shade, for the Remazol RR combination, the tonal variation was much bluer, and highest in the case of Superfix AMGN Conc, followed by Sarafix NF 504, Sarafix AP and, least, with Sarafix WP (Fig. 4). In the case of the Remazol RGB combination the extent of blueing was less than for Remazol RR but the shade also became greener. In this case, Superfix AMGN Conc and Sarafix NF 504 gave more tonal variation, whereas Sarafix WP showed least variation in tone (Fig. 5). In the case of the Sumifix HF combination, Sarafix WP gave maximum shade change but the shade became redder and yellower than for the RR and RGB combinations. The other three dyefixing agents showed more or less the same results. (Fig. 6).

In the case of the Navy shade, for the Remazol RR combination, Superfix AMGN Conc gave maximum tonal variation and the shade became bluer and greener. The other three dyefixing agents gave more or less similar results. Sarafix AP and Sarafix WP made the shade greener, whereas Sarafix NF 504 made it bluer (Fig. 7). In the case of Remazol RGB, Superfix AMGN Conc made the shade much greener and a trace yellower, whereas Sarafix NF 504 made it redder and yellower – totally the opposite to the Remazol RR Navy treated with Sarafix NF 504! However, in this case, both Sarafix AP and Sarafix WP behaved more or less the same (Fig. 8). For the Navy shade dyed with Sumifix HF dyes, Superfix AMGN Conc made the shade bluer and greener, Sarafix AP greener but less clearly bluer, Sarafix WP greener. Surprisingly, in this case Sarafix NF 504 made shade redder! This tonal difference is markedly different from the other three dyefixing agents (Fig. 9).

In the case of the Brown shade dyed with Sumifix EXF dyes, Sarafix NF 504 made the shade much redder and yellower, the highest tonal difference. Sarafix AP and Sarafix WP made it yellower, without much change in DA value, whereas Superfix AMGN Conc made it a trace bluer and greener, an altogether different tone than the other three dyefixing agents (Fig. 10). In the case of Cibacron FN Brown shade, Sarafix NF 504 was the only dyefixing agent that made the shade redder, whereas the other three agents made the shade greener. All dyefixing agents made this shade bluer, and DB value was highest with Superfix AMGN Conc and least with Sarafix WP (Fig. 11). In the case of the Brown shade dyed with Levafix CA dyes, all dyefixing agents made the shade redder. Sarafix WP showed least tonal variation and it is the only dyefixing agent that made the shade a trace yellower (Fig. 12).

In the case of the Olive shade dyed with Sumifix EXF dyes, Sarafix NF 504 made the shade redder, while the other three agents made it greener. Except for Superfix AMGN Conc, DB value was not affected much by any of the dyefixing agents. Superfix AMGN Conc made the shade much bluer compared to other three dyefixing agents (Fig. 13). For the Cibacron FN Olive combination, Sarafix NF 504 shifted tone to the redder side again, whereas the other three agents changed it a trace to the greener side. Superfix AMGN Conc, Sarafix AP and Sarafix WP made the shade yellower, while only Sarfix NF504 made it bluer (Fig. 14). In the case of the Olive shade dyed with the Levafix CA combination, except for Sarafix WP, all agents made the tone redder. Only sarafix WP made the shade greener. Except for Sarafix AP, all the dyefixing agents showed hardly any change in DB value (Fig. 15).

In the case of the Grey shade dyed with Sumifix EXF dyes, except for Sarafix NF 504 all the agents made the shade greener, whereas Sarafix NF 504 made shade redder. Sarafix NF 504 and Sarafix AP made the shade yellower, while Superfix AMGN Conc made it bluer. In the case of Sarafix WP, hardly any change in DB value was noticed (Fig. 16). In the Cibacron FN Grey shade, Sarafix NF 504 also made the shade redder while the other three agents made it greener. In this case all four agents made the shade bluer. Sarafix AP showed least change in DB value (Fig. 17). For the Levafix CA Grey combination, except for Sarafix WP the agents made the shade greener, while Sarafix WP showed hardly any variation.

To understand the trend we also tried another approach. We created a factor DF, which is equal to $\sqrt{DA^2 + DB^2}$. We used the logic that the total colour difference in CIE LAB equation is

$$DE = \sqrt{DL^2 + DA^2 + DB^2}$$

Therefore $DF^2 = DA^2 + DB^2$, which is a contribution towards DE due to tonal variation. DF values are given in the Tables 2-7, along with DA & DB values.

For medium shades, Sarafix WP gave the least value of DF for the combination, irrespective of shade or recipe. This indicates that the formulation of Sarafix WP is well balanced and can give the least tonal variation, which is an important factor for critical shades like Olive, Grey and Brown. However such a clear-cut trend was not noticed in the case of dark shades.

For medium shades, Sarafix NF 504 consistently gave a redder tone for almost all combinations irrespective of the recipes.

From the study it can be concluded that, for medium and dark shades, formaldehyde-free dyefixing agents are better than classical DCDA formaldehyde condensation products to reduce tonal variation. Based on the above study, a dyer can select the required dyefixing agent to adjust final tone of the treated shade, provided further tonal variation does not take place in chemical and mechanical finishing.

To avoid unpleasant surprises in shade variation after dye fixation, a dyer can also prepare his database for different recipes and study the effect of various dyefixing agents on tone, so that the information can also be used to adjust the tone of the final shade. However, if the exent of unfixed dyestuff on the substrate varies before dyefixation, the variation may not be easily predictable, as hydrolysed dye with the highest affinity can determine the final tone.

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