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# Dichroism measurements in forensic fibre examination Part 1 - Dyed polyester fibres

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# ABSTRACT

One hundred and twenty dyed polyester samples were examined with plane polarized light on their dichroic behaviour by optical light microscopy (OLM) and microspectrophotometry in the visible range (MSP Vis). It was found that most of these disperse dyed polyester fibres possess a strong dichroism, which fall into two broad categories. Either a decrease of intensity (hypochromic effect) or a change of hue (hypsochromic or bathochromic shift of absorption bands) is noted. These dichroic effects are related to the orientation of the dye structure with respect to the polymer chains.

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## 1. Introduction

Forensic scientists are constantly seeking examination methods that are non-destructive, that are fast in obtaining analysis results and that have a high discrimination power. Optical microscopy and spectroscopic methods are commonly used in forensic fibre examinations. Polarization microscopy is a well established method that allows one to obtain information about the chemical fibre composition simply by observing interference colors. Associated with this method, but fundamentally different, is the observation and measurement of dichroism, which is a well studied method in the field of oriented systems [1,2]. The use of a single polarizer oriented along with or perpendicular to the fibre axis allows one to observe or measure any differences in fibre color when plane polarized light of the two main directions is used. The linear dichroism (LD) spectrum is obtained by subtraction of the absorptions in parallel and perpendicular positions for each of the corresponding wavelengths in the two spectra:

$$LD(\lambda) = A_{para}(\lambda) - A_{perp}(\lambda)$$

For those spectral regions where more light is absorbed when the direction of polarization is parallel to the fibre axis, the resulting part of the LD spectrum will be positive. For other spectral regions where more light is absorbed when the polarization direction is perpendicular to the fibre axis, the resultant LD spectrum will be negative.

The dichroic ratio (or polarization ratio) of a given absorption band is the quotient of the absorptions in parallel and perpendicular positions:

$$R(\lambda) = A_{para}(\lambda) / A_{perp}(\lambda)$$

This parameter reflects the strength of the intensity decrease (hypochromic effect; R>1) or increase (hyperchromic effect; R<1) when using respectively plane polarized light parallel and perpendicular to the fibre axis.

A change in hue should be reflected in the absorption spectrum. The band of highest intensity can shift to either lower wavelengths (hypsochromic shift or blue shift,  $\Delta\lambda_{max}$ >0) or to higher wavelengths (bathochromic shift or red shift,  $\Delta\lambda_{max}$ <0) where

$$\Delta\lambda_{max} = \lambda_{max}(para) - \lambda_{max}(perp)$$

We believe that the observation of dichroism with optical light microscopy (OLM) and its measurement with microspectrophotometry (MSP) is not systematically exploited in most forensic fibre laboratories and that information on this topic is very rare [3,4]. This is rather surprising because both methods are of such high simplicity

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## Table 1

Dye systems of the polyester samples, their dichroic features as observed with microscopy and their spectral characteristics (MSP-PPL).

Fig311480Under Derychan Lample//Walk $R=23$ FES311480Disperse Filler VIII (11155)Disperse VIIII VIII (11155)YellowWeak $R=23$ FES311480Disperse Filler VIII (11155)VerticeWeak $R=23$ $A=15$ JmmFES311480Disperse Filler VIII (11155)VerticeWeak $R=23$ $A=15$ JmmFES511481Disperse Filler VIII (11165)VerticeWeak $R=23$ $A=15$ JmmFES511480Disperse VIIII VIII (11165)Disperse VIIII VIII (11167)VerticeFiller VIIII (11167) $R=12$ $A=15$ JmmFES511480Disperse VIIII VIII (1116)Disperse VIIII VIII (1116)Disperse VIIII VIII (1116) $R=12$ $A=15$ Jmm $R=12$ $A=15$ JmmFES111480Disperse VIIII VIII (1116)Disperse VIIII VIII (1116)Disperse VIIII VIII (1116) $R=12$ $A=15$ Jmm $R=12$ $A=15$ FES111480Disperse VIIII VIII (1116)Disperse VIIII VIII (1116)Disperse VIIII VIII (1116)Disperse VIIII VIII (1116) $R=12$ $A=14$ FES1T1500Disperse VIIII VIII (1116)Disperse VIIII VIII (1116)Disperse VIIII VIII (1116)Disperse VIIII VIII (1116) $R=12$ $R=12$ FES1T1500Disperse VIIII VIII (1116)Disperse VIIII VIII (1116)Disperse VIIII VIII (1116)PilkStrang (1164) $R=12$ FES1T1500Disperse VIIII VIII (1116)Disperse VIIII VIII (1116)Disperse VIIII VIII (1116)Disperse VIIII VIII	Sample	Ref. FRC	Commercial dye name	Chemical dye class	CI generic name (const. number)	Fibre color	Місгоѕсору	MSP-PPL
PES2         11489         Depared Ret Work (19)         Antinaquinose         Depared Ret Work (19)         Wellow         Wellow         Wellow         R = 2.3           R55         1163         Depared Ret Wolkow G (51)         Antinaquinose         Depared Ret Wolkow G (51)         Ret J (51)         No         Ret J (51)         R	PES1	11488	Undyed Perylene sample	/		/	Weak (grey>translucent)	
PES         11480         Dispersi Fait Yellow C (27)         As a manaa         Dispersi Vellow Y (10 1235)         Weak         R = 1, 3, A = 2, 3 and 3 = 1, 3	PES2	11489	Duranol Brilliant Yellow 6 G (8%)	Anthraquinoid	Disperse Yellow 13 (CI 58900)	Yellow	Weak	R=2.3
BFS         11:00         Depared Fart Villow (R 73)         Number of the Villow (R 10)	PES3	11490	Dispersol Fast Yellow G (5%)	Azo monoazo	Disperse Yellow 3 (CI 11855)	Bright yellow	Weak	$R = 1.9$ , $\Delta \lambda = +20$ nm
PESS1142Dispector list Vallow A (108)NitroDispects Vallow Y (12 1025)VallowNoR = 1.2, $\Delta n = +13$ nmPESS1148Dispector Jack Vallow A (108)AntinaquinoreDispector Vallow Y (12 1025)OrangeStrong (carage-carage-yellow)R = 1.6, $\Delta n = +5$ ontPESS11490Dispector Jack Vallow A (108)AntinaquinoreDispector Jack VA (12 1025)OrangeStrong (carage-carage-yellow)R = 1.2, $\Delta n = +13$ nmPESI11497Dispector Jack Vallow A (107)AzonmonazoDispector Jack Vallow A (107)R = 2.2, $\Delta n = +40$ nmPESI11498Dispector Jack Vallow A (107)AzonmonazoDispector Jack Vallow A (107)R = 2.2, $\Delta n = +40$ nmPESI11498Dispector Jack Vallow A (107)AntinaquinoneDispector Stat Vallow A (108)R = 2.2, $\Delta n = +40$ nmPESI11490Dispector Jack Vallow A (107)AntinaquinoneDispector Stat Vallow A (108)R = 2.2, $\Delta n = +40$ nmPESI11502Duranol Ked XB (153)AntinaquinoneDispector Ked 11 (10 (2010))ParkStrong (Fed -pink)R = 1.6PESI11502Duranol Ked XB (153)AntinaquinoneDispector Ked 11 (16 2020)ParkStrong (Fed -pink)R = 2.2PESI11502Duranol Ked XB (153)AntinaquinoneDispector Kel 11 (16 2020)ParkNet Xel	PES4	11491	Dispersol Fast Yellow GR (7%)			Yellow	No	R = 1.3
FS6         11438         Dispersion Fast Orange 16(0)         Archmanuano         Dispersion Ventues         Strong Concage - carange-yellow 2         R = 1, 2, A = - 4 on m           FS7         1149         Dispersion Fast Orange 1 (10 6070)         Orange         Strong (Concage - carange-yellow)         R = 1, 2, A = - 4 on m           FS7         1149         Dispersion Fast Orange 1 (10 6070)         Orange         Strong (Concage - carange-yellow)         R = 1, 2, A = - 4 on m           FS7         1148         Dispersion Fast Orange 1 (10 1000)         Orange- Tast Strande R (43)         Archmanuana         Dispersion Fast Orange 1 (10 1000)         Pate orange         Strong (Core-carange)         R = 1, 2, A = - 4 on m           FS11         1148         Dispersion Fast Orange 1 (10 1000)         Dispersion Fast Orange 1 (10 1000)         Pate orange         Strong (Core-carange)         R = 1, 2, A = -4 of m           FS11         11500         Dispersion Fast Orange 1 (10 1000)         Pate orange         Strong (Core-carange)         R = 1, 2, A = -4 of m           FS11         11500         Dispersion Fast Orange 1 (10 1000)         Pate orange         Strong (Core-carange)         R = 2, A = -4 of m           FS11         Dispersion Fast Orange 1 (10 4001)         Pate orange         Strong (Core-carange)         R = 2, A = -4 of m           FS11         Disparose Nine N	PES5	11492	Dispersol Fast Yellow A (10%)	Nitro	Disperse Yellow 1 (CI 10345)	Yellow	No	$R = 1.2$ , $\Delta \lambda = +15 \text{ nm}$
FES         [1494]         Dutano longer G (105)         Anthraquinone         Dispers l'at Grange A (72)         Res         Strong         Strong         Res         T, Ab = + 5 am           FES         [1486]         Dispersi fat Grange A (73)         Animono conger         Disperse Grange I (1 (1100))         Res         Strong         congerse Grange I (1 (1100))         Disperse Grange I (1 (1100))         Res         Strong         Res         As = 1.6           FES1         [1100]         Dispersi fat Grange A (73)         Anthraquinone         Disperse Res I (1 (1011))         Park         Strong         Res         As = 1.6           FES1         [1100]         Durand Res J (2013)         Anthraquinone         Dispersi Res I (1 (1 (2013))         Park         Strong         Res -1.6           FES1         T100         Durand Res J (2013)         Anthraquinone         Disperse Res I (1 (1 (2013))         Park         Strong (res - pikk)         Res -1.6           FES1         T100         Durand Res J (2013)         Anthraquinone         Disperse Res I (1 (1 (2013))         Park         Res -1.6           FES1         T100         Durand Res J (2013)         Anthraquinone <t< td=""><td>PES6</td><td>11493</td><td>Dispersol Fast Orange B (6%)</td><td>Azo/monoazo</td><td>Disperse Yellow 97 (CI 12055)</td><td>Orange</td><td>Strong (orange&gt;orange-yellow)</td><td><math>R = 1.6</math>, <math>\Delta \lambda = +15 \text{ nm}</math></td></t<>	PES6	11493	Dispersol Fast Orange B (6%)	Azo/monoazo	Disperse Yellow 97 (CI 12055)	Orange	Strong (orange>orange-yellow)	$R = 1.6$ , $\Delta \lambda = +15 \text{ nm}$
Integer         Integer         Integer         Integer         Strong (anage and ange ange and ange ange and ange and ange ange and ange ange ange ang	PES7	11494	Duranol Orange G (10%)	Anthraquinone	Disperse Orange 11 (CI 60700)	Orange	Strong	$R = 1.7$ , $\Delta \lambda = +5$ nm
PESS         11496         Depress of ast Crange A (68)         Actu monozo         Depress of ast Crange A (68)         Actu monozo         Depress of ast Crange A (68)         R = 2.2, Ab = +1 0 tm m           PESI         11490         Depress of ast Crange A (68)         Actu monozo         Depress of ast Crange A (68)         R = 1.2, Ab = +0 1 m m           PESI         11490         Depress of ast Crange A (63)         Actu monozo         Depress Ast Crange A (63)         R = 1.0           PESI         11500         Depress Ast Crange A (53)         Actu monozo         Depress Ast S (15)         R = 2.4           PESI         11500         Derrand Red 28 (105)         Anthraquinone         Depress Ast S (15)         R = 1.8           PESI         11500         Derrand Vold 28 (16)         Anthraquinone         Depress Vold 1 (16 G10)         Violet         Strong         R = 1.8           PESI         I1500         Derrand Vold 28 (16)         Anthraquinone         Depress Vold 1 (16 G10)         Violet         Strong (res-1-me-bine)         R = 1.8           PESI         I1500         Derrand Bite C (16)         Anthraquinone         Depress Vold 1 (16 G10)         Violet         Strong (res-1-me-bine)         R = 1.8           PESI         I1500         Derrand Bite R (10 (24)         Anthraquinone         Depress Vi	PES8	11495	Dispersol Fast Orange G (7%)			Orange	Strong (orange>orange-yellow)	$R = 1.2$ , $\Delta \lambda = +60$ nm
Physion         11467         Depresend hast Grange Novem RM (72)         And monanza         Depresend hast Grange Novem RM (72)         R = 1, 2, A = ± 6 to m           1151         Lindow Depresend hast Grange Novem RM (72)         Anomanaza         Depresend hast I (11111)         Pate arrange A	PES9	11496	Dispersol Fast Orange A (6%)	Azo/monoazo	Disperse Orange 1 (CI 11080)	Orange	Strong	$R = 2.2$ , $\Delta \lambda = +10$ nm
PES11         11-49         Depresol Fast Scarle B (48)         Azon monosco         Disperso Red 1 (111)         Paic orage         Strong (red pink)         R = 1.9           1512         11-40         Durana R (60 (108)         Anthraquinone         Disperso R ed 1 (0170)         Parial         Strong (red pink)         R = 1.0           19513         11500         Durana N (60 (108)         Anthraquinone         Disperso Red 1 (10 (107))         Purple         Strong (red pink)         R = 1.0           19513         11500         Durana N (60 (21 (015))         Anthraquinone         Disperso Red 1 (10 (1070))         Wolet         Strong (red -pink)         R = 1.0           19513         11500         Durana N (61 RN (7.53)         Anthraquinone         Disperso Volet 8 (1 (10 (200))         Wolet         Strong (red -buc-blue)         R = 2.0           1953         Dirana M (61 RN (530)         Anthraquinone         Disperso Volet 8 (1 (10 (200))         Wolet         Strong (red -buc-blue)         R = 1.5           1953         Dirana M (61 RN (50)         Anthraquinone         Disperso Rue 1 (0 (650)         Paic blue         Wolet         Strong (red -buc-blue)         R = 1.5           1953         Dirana B (10 (10 (150))         Anthraquinone         Disperso Rue 1 (0 (650)         Paic blue         Notocc         Notocc<	PES10	11497	Dispersol Fast Orange Brown RN (7%)	Azo/monoazo	Disperse Orange 5 (CI 11100)	Orange-brown	Strong (red>orange)	$R = 1.2$ , $\Delta \lambda = +60$ nm
PES12       11490       Duranol Red CN (103)       Anthraquinone       Depress Red 9 (Cloby)       Pink       Strong (volet-red-pink)       R=16         PES13       11500       Dispersi Red 9 (Cloby)       Purp 8       Strong (volet-red-pink)       R=24         PES14       11501       Duranol Volet RN (733)       Anthraquinone       Depress Red 13 (Cloby)       Purp 8       Strong (volet-red-pink)       R=20         PES14       11500       Duranol Volet RN (733)       Anthraquinone       Depress Volet 1 (Clo1100)       Volet       Strong (volet-red-pink)       R=2.0         PES19       11506       Duranol Volet RN (733)       Anthraquinone       Depress Volet 8 (Cl 2030)       Volet       Strong (volet-nebus-blue)       R=1.5         PES19       11506       Duranol Volet RN (733)       Anthraquinone       Disperse Rue 1 (Cl 6203)       Pale volet       Weak New       R=1.7         PES21       11500       Duranol Mrillinat Blue G (8)       Anthraquinone       Disperse Blue 1 (Cl 6200)       Pale volet       Weak New       R=1.4         PES21       11500       Duranol Mrillinat Blue G (753)       Anthraquinone       Disperse Blue 1 (Cl 6200)       Pale volet       Weak New       R=1.4         PES22       11510       Duranol Dr Brillinat Blue G (8)       Anthraquinone	PES11	11498	Dispersol Fast Scarlet B (4%)	Azo/monoazo	Disperse Red 1 (CI 11110)	Pale orange	Strong	R=1.9
Phi is Phi i	PES12	11499	Duranol Red GN (10%)	Anthraquinone	Disperse Red 9 (CI 60505)	Pink	Strong (red>pink)	R = 1.6
PE34     11301     Daranal & 6d. 24 (103)     Anthraquinone     Daparale Kel 24 (103)     Purple     Strong     K = 1.3       PE35     1130     Daranal Med XS (155)     Anthraquinone     Daparas Rel 11 (10 80710)     Yuple     Strong     K = 1.3       PE31     1130     Daranal Med XS (153)     Anthraquinone     Daparas Rel 11 (10 80710)     Yuple     Strong     K = 1.3       PE31     11505     Daranal Med XS (153)     Anthraquinone     Disperse Violet 8 (10 30)     Yuple     Strong (green-blue-blue)     R = 1.6       PE31     11505     Daranal Milas Cl (63)     Anthraquinone     Disperse Bile 1 (10 64500)     Pale blue     Weak klue     R = 1.3       PE32     11500     Daranal Bilinat Word (R (24))     Anthraquinone     Disperse Bile 1 (10 64500)     Pale blue     Weak klue     R = 1.3       PE32     11510     Daranal Bilinat Biline Cl (63)     Anthraquinone     Disperse Bile 1 (10 64500)     Pale blue     Weak     R = 1.4       PE32     11511     Daranal Biling Klue Cl (23)     Anthraquinone     Disperse Bile 1 (10 64500)     Pale blue     No     R = 1.3       PE32     11511     Daranal Biling Klue Cl (23)     Anthraquinone     Disperse Bile 1 (10 64500)     Pale blue     No     R = 1.2       PE34     Darana Biling Klue Cl (23)	PES13	11500	Dispersol Fast Crimson B (3%)	Azo/monoazo	Disperse Red 13 (Cl 11115)	Pink	Strong (violet-red>pink)	R = 2.4
PES1611302Duranal ked X88 [153)AnthraquinoneDappers ked 11 (1G k010)YunpleStrongK = 1.8PES1611304Duranal Vide RN (753)KKK <td>PES14</td> <td>11501</td> <td>Duranol Red 2B (10%)</td> <td>Anthraquinone</td> <td>Disperse Red 15 (CI 60/10)</td> <td>Purple</td> <td>Strong</td> <td>R = 2.0</td>	PES14	11501	Duranol Red 2B (10%)	Anthraquinone	Disperse Red 15 (CI 60/10)	Purple	Strong	R = 2.0
Hold         Unitable View RA (7.5)         Antibulguinone         Disperse Viole I (CI 51100)         Voidet         Stong         R = 2.0           PES17         11506         Durnand Vislet RN (7.5)         Name	PES15	11502	Duranol Red X3B (15%)	Anthraquinone	Disperse Red 11 (CI 62015)	Purple	Strong	R=1.8
PES1811504Durinal Violet NK (252)Violet NK (252)Violet NK (252)Violet NK (252)Violet NK (252)NK<	PES16	11503	Duranol Violet 2R (6%)	Anthraquinone	Disperse Violet 1 (Cl 61100)	Violet	Strong	R = 2.0
Haise Hasse <td>PEST/</td> <td>11504</td> <td>Duranol Violet RN (7.5%)</td> <td></td> <td></td> <td>Violet</td> <td>Strong</td> <td>R = 2.0</td>	PEST/	11504	Duranol Violet RN (7.5%)			Violet	Strong	R = 2.0
Habb HS30Habb LogenceWeakNoR=1.5HS30H360Durand Buc CA (S3)AnthraquinoneDisperse Violer 8 (L1 64500)Pale blueWeakR=2.1HS31H360Durand Buc CA (S3)AnthraquinoneDisperse Buc 1 (C1 64500)Pale blueWeakR=1.6HS32H151Durand Buc CA (S4)AnthraquinoneDisperse Buc 1 (C1 64500)Pale blueWeakR=1.6HS32H151Durand Buc CA (S4)AnthraquinoneDisperse Buc 1 (C1 64500)Pale blueWeakR=1.6HS32H151Durand Buc CA (S1)AnthraquinoneDisperse Buc 1 (C1 64500)Pale blueWeakR=1.6HS32H151Durand Buc CA (S1)AnthraquinoneDisperse Buc 1 (C1 64500)Pale blueWeakR=1.6HS32H151Durand Dark Buc TG (7.53)Buc CA (S1)Buc CA (S1)Buc CA (S1)R=1.2HS33H515Durand Carry TA (25)Buc CA (S1)Buc CA (S1)R=2.6HS33H516Diano Back 2B, S3 + Frentoly B, S5Developed azoBuc CA (S1)Buc CA (S1)HS33H516Diano Back 2B, S4 + Frentosy B, S5Developed azoBright pinkNoR=1.2HS33H512Brentamine Fast Red (L Back, S4 + Brentosy B, S5Developed azoBright pinkNoR=1.2HS33H524H524Back CA (H Bertosy B, S5Developed azoBright pinkNoR=1.2HS33H524Brisk Red (L Back, S4 + Brentosy B, S5Developed azoBright	PESIS	11505	Duranoi Violet KN (30%)	A	Discuss Walst 0 (CL C2020)	VIOIET	Strong	R = 1.6
PESD11.50Durand Buike GV (68) $K = 2.1$ PESD11.50Durand Buike GV (68)AnthraquinoneDisperse Blue 1 (CI 64500)Pale blueStorng (green-blue-blue)R=1.8PESD11.51Durand Buikar Blue CO (26)AnthraquinoneDisperse Blue 1 (CI 64500)Pale blueWeakR=1.7PESD11.51Durand Blue 2 (26)AnthraquinoneDisperse Blue 1 (CI 64500)Pale blueWeakR=1.6PESD11.51Durand Blue 2 (26)AnthraquinoneDisperse Blue 7 (CI 62500)Pale blueNoR=1.6PESD11.51Durand Blue 2 (75)AnthraquinoneDisperse Blue 7 (CI 62500)Pale blueNoR=1.6PESD11.51Durand Blue 2 (26)Durand Blue 2 (26)R=1.6R=1.6R=1.6PESD11.51Durand Blue 2 (26)Durand Blue 2 (26)R=1.6R=1.6R=1.6R=1.6PESD11.51Durand Blue 2 (26)Durand Blue 2 (26)R=1.6R=1.	PES19	11506	Duranol Brilliant Violet BR $(6\%)$	Anthraquinone	Disperse violet 8 (CI 62030)	Pale Violet	Weak Strong (groop, blues, blue)	R = 1.5
LabDatability line (Nob.)AnthraquinoneDisperse Blue 1 (Cl 64500)Pate blueWeakR=1.7PES211510Duranol Brilliant Blue (B (6K))AnthraquinoneDisperse Blue 1 (Cl 64500)Pale blueWeakR=1.7PES311510Duranol Brilliant Blue (C (24K))AnthraquinoneDisperse Blue 1 (Cl 64500)Pale blueWeakR=1.4PES311512Duranol Blue C (7.3)AnthraquinoneDisperse Blue 7 (Cl 62500)Pale blueWeakR=1.4PES311513Duranol Dark Blue T (153)Fale blueStrongR=2.0BlueStrongR=2.0PES311513Duranol Dark Blue T (153)Eveloped azoBrown-orangeR=1.4R=2.0PES311513Duranol Grey TN (103)Eveloped azoBrown-orangeR=1.4R=1.2PES311513Brentamine Fast Red C Stase, 63+ Frentony BB, 63Developed azoBrown-orangeR=1.2R=1.2PES311520Brentamine Fast Red Stase, 63+ Frentony BB, 63Developed azoBright pinkNoR=1.2PES311521Brentamine Fast Red Stase, 63+ Frentony BB, 63Developed azoBright pinkNoR=1.2PES311522Brentamine Fast Red Stase, 63+ Frentony BB, 63Developed azoBrueStrong (parple-shuc)R=1.3, $\Delta = -20$ nmPES311523Brentamine Fast Rue B Base, 34+ Brentony BB, 63Developed azoBlueStrong (parple-shuc)R=1.3, $\Delta = -20$ nmPES311524Brentamine Fast Rue B Base, 34+ Brentony B	PES20 DES21	11507	Duranol Plue $CN$ (6%)			Palo bluo	Strong (green blue>blue)	R = 2.1 P = 1.9
LatestIt is an intraction build bu	PESZ I DES22	11500	Duranol Prilliant Plus CP (6%)	Anthraquinono	Disperse Plue 1 (CI 64500)	Pale blue	Mosk	R = 1.0 P = 1.7
PES31151 1151Duranol Blue 2.6 (35) (37)Intrinue durance pressDisperse fails (1 C 92000) pate bluePate blue Pate blueNotaR = 1.6PES311512 11512Duranol Blue 2.6 (35)AnthraquinoneDisperse Blue 7 (16 2500)Pate blue Pate blueWeakR = 1.4PES311512 11514Duranol Dark Blue TC (153)AnthraquinoneDisperse Blue 7 (16 2500)Pate blue Pate blueStrongR = 2.0PES311515Duranol Carey IN (135)StrongR = 2.6StrongR = 3.02.0PES311516Duranol Grey IN (103)Developed azoBitweBitweNoR = 1.4PES311518Brentamine Fast Red 3C Base, 63 + Brentosyn B6, 65Developed azoBright red Portoged azoNoR = 1.4PES311520Brentamine Fast Red 5G Base, 63 + Brentosyn B6, 65Developed azoBright red Portoged azoNoR = 1.2PES311522Brentamine Fast Red 5G Base, 63 + Brentosyn B6, 65Developed azoBitweStrong (deep red > fuchsia)R = 1.3PES311523Brentamine Fast Red 5G A Base, 63 + Brentosyn B6, 65Developed azoBitweStrong (deep red > fuchsia)R = 1.4PES311524Brentamine Fast Red Fast, 48 + Brentosyn B6, 65Developed azoBitweStrong (deep red > fuchsia)R = 1.4PES311525Disperso Fast Orange 6, 64 + Brentosyn B6, 65Developed azoBitweStrong (deep red > fuchsia)R = 1.4PES311524Brentamine	PES22 DES23	11510	Duranol Brilliant Blue CB $(0\%)$	Anthraquinone	Disperse Blue 1 (CI 64500)	Pale blue	Weak	R = 1.7 R = 1.8
Inclusion PES25Instruction Instruction PES25Instruction Instruction PES26Instruction Pes26Instruction 	DES24	11510	Duranol Blue 2 C $(24\%)$	Antinaquinone	Disperse blue 1 (el 04500)	Pale blue	No	R = 1.6
$ \begin{array}{cccccccccccccccccccccccccccccccccccc$	PES25	11512	Duranol Blue Creen B (8%)	Anthraquinone	Disperse Blue 7 (CI 62500)	Pale blue	Weak	R = 1.0 R = 1.4
PES2711514 PES28Darasio Dark Blue TC (15%)Blue StrongF = 1.9PES2811515Duranol Grey TN (2.5%)CreyStrongR = 2.6PES2911516Duranol Grey TN (10%)Dark greyStrong (khaki>grey)R = 3.0; 2.0PES3011517Dispersol Dazo Black 28, 5% + Brentosyn B8, 6%Developed azoBright pinkNoR = 1.4PES3211519Brentamine Fast Red G. Base, 6% + Brentosyn B8, 6%Developed azoBright pinkNoR = 1.2PES3311520Brentamine Fast Red G. Base, 6% + Brentosyn B8, 6%Developed azoBright pinkNoR = 1.2PES3411521Brentamine Fast Red Base, 6% + Brentosyn B8, 6%Developed azoFuchsiaStrong (per d>^fuchsia)R = 1.3, $\Delta = +20$ nmPES3511522Dispersol Fast Orange (6% + Brentosyn B8, 6%Developed azoBlueStrong (purple>blue)R = 1.3, $\Delta = +20$ nmPES3611523Brentamine Fast Blue B Base, 34 + Brentosyn B8, 6%Developed azoBlueStrong (purple>blue)R = 1.3, $\Delta = +20$ nmPES3711525Dispersol Fast Orange (6% + Brentosyn B8, 6%Developed azoBlueStrong (purple>blue)R = 1.5, $\Delta = -20$ nmPES3811525Dispersol Daza Black 8, 754 + Brentosyn B8, 6%Developed azoBlueStrong (purple>blue)R = 1.2, $\Delta = -20$ nmPES3911526Dispersol Fast Orange B(K 4, 754 + Brentosyn B8, 6%Developed azoBlueStrong (purple>blue)R = 1.2, $\Delta = -20$ nmPES4011527Dispersol Fast	PES26	11512	Duranol Dark Blue TC (7.5%)	Antinaquinone	Disperse blue 7 (el 02500)	Pale blue	Strong	R = 1.4 R = 2.0
PES28 PES2911515 11517Duranol Grey TN (1/2, 8)Grey NStrong 	PES27	11514	Duranol Dark Blue TG (15%)			Blue	Strong	R = 1.0 R = 1.9
PES2911516Duranol Grey TN (102)Dark greyStrong (khaki> grey)R = 30; 2.0PES3011517Dispersol Diazo Black 28, 5% + Brentosyn B8, 6%Developed azoBrown-orangeStrong (orange-brown>orange)R = 1.4, 1.7, $\Delta h = + 20$ nmPES3111518Brentamine Fast Red GC Base, 6% + Brentosyn B8, 6%Developed azoBright pinkNoR = 1.4PES3211520Brentamine Fast Red GC Base, 6% + Brentosyn B8, 6%Developed azoBright pinkNoR = 1.2PES3411521Brentamine Fast Red GC Base, 6% + Brentosyn B8, 6%Developed azoBright pinkNoR = 1.2PES3511522Dispersol Fast Orange 6, 6% + Brentosyn B8, 6%Developed azoFuchsiaWeakR = 1.3, $\Delta h = -20$ nmPES3511523Brentamine Fast Bue B Base, 3% + Brentosyn B8, 6%Developed azoBlueStrong (purple>blue)R = 1.3, $\Delta h = -20$ nmPES3611523Brentamine Fast Bue B Base, 3% + Brentosyn B8, 6%Developed azoBlueStrong (purple>blue)R = 1.3, $\Delta h = -20$ nmPES3711526Dispersol Diazo Black 28, 4% + Brentosyn B8, 6%Developed azoBlueStrong (purple>blue)R = 1.2PES3911526Dispersol Diazo Black 28, 4% + Brentosyn B8, 6%Developed azoBlueStrong (back>dark violet)R = 1.2PES3911526Dispersol Diazo Black 28, 4% + Brentosyn B8, 6%Developed azoDark greyStrong (back>dark violet)R = 1.2PES4111528Dispersol Diazo Black 28, 4% + Brentosyn B8, 6%Developed azo<	PES28	11515	Duranol Grev TN (2.5%)			Grev	Strong	R = 2.6
PES3011517Dispersol Dizzo Black 2B, 5X + Brenthol BT, 4SXDeveloped azoBrom—orangeBrom_orangeBrom_orangeBrom_orangeR = 1,4 : 17, $\Delta \lambda = +20 \text{ nm}$ PES3111518Brentamine Fast Red 3C, Base, 6X + Brentosyn BB, 6XDeveloped azoBright redNoR = 1,4PES3311520Brentamine Fast Red 3C, Base, 6X + Brentosyn BB, 6XDeveloped azoBright pinkNoR = 1,2PES3411520Brentamine Fast Red 3G, Base, 6X + Brentosyn BB, 6XDeveloped azoBright pinkNoR = 1,2PES3511522Dispersol Fast Orange C, 6X + Brentosyn BB, 6XDeveloped azoBruchsiaStrong (deep red-fuchsia)R = 1,3, $\Delta A = -20 \text{ nm}$ PES3511522Dispersol Fast Orange C, 6X + Brentosyn BB, 6XDeveloped azoBlueStrong (purple-blue)R = 1,3, $\Delta A = -20 \text{ nm}$ PES3711524Brentamine Fast Blue B Base, 4X + Brentosyn BB, 6XDeveloped azoBlueStrong (purple-blue)R = 1,5, $\Delta A = -20 \text{ nm}$ PES3811525Dispersol Diazo Black 8, 75 + Brentosyn BB, 6XDeveloped azoBlueStrong (purple-blue)R = 1,5, $\Delta A = -20 \text{ nm}$ PES3911526Dispersol Diazo Black 8, 4X + 8 fremtosyn BB, 6XDeveloped azoBlueStrong (black-klue)R = 1,2Dispersol Diazo Black 8, 4X + 8 fremtosyn BB, 6XDeveloped azoBlueStrong (black-klue)R = 1,2Dispersol Diazo Black 8, 4X + 8 fremtosyn BB, 6XDeveloped azoBlueStrong (black-klue)R = 1,2Dispersol Diazo Black 8, 4X + 8 fremtosyn BB, 6X <td>PES29</td> <td>11516</td> <td>Duranol Grev TN (10%)</td> <td></td> <td></td> <td>Dark grev</td> <td>Strong (khaki&gt;grev)</td> <td>R = 3.0: 2.0</td>	PES29	11516	Duranol Grev TN (10%)			Dark grev	Strong (khaki>grev)	R = 3.0: 2.0
PES3111518Brentamine Fast Red GC Base, 6X + Brentosyn BB, 6XDeveloped azoBright redNoR = 1.2PES3211520Brentamine Fast Red GL Base, 6X + Brentosyn BB, 6XDeveloped azoBright pinkNoR = 1.2PES3311521Brentamine Fast Red G Base, 6X + Brentosyn BB, 6XDeveloped azoBright redNoR = 1.2PES3411521Brentamine Fast Red G Base, 6X + Brentosyn BB, 6XDeveloped azoFuchsiaWeakR = 1.2PES3511522Dispersol Fast Orange C, 6X + Brentosyn BB, 6XDeveloped azoBlueStrong (deep red>fuchsia)R = 1.3, $\Delta h = +20$ nmPES3511523Brentamine Fast Bue Base, 4X + Brentosyn BB, 6XDeveloped azoBlueStrong (purple>blue)R = 1.3, $\Delta h = -20$ nmPES3711524Brentamine Fast Bue Base, 3X + Brentosyn BB, 6XDeveloped azoBlueStrong (purple>blue)R = 1.7, $\Delta h = -20$ nmPES3811525Dispersol Diazo Black BA, 7.5X + Brentosyn BB, 6XDeveloped azoBlueStrong (purple>blue)R = 1.2, $\Delta h = -20$ nmPES4011527Dispersol Diazo Black B, 4X + Brentosyn BB, 6XDeveloped azoBlueStrong (purple>blue)R = 1.2, $\Delta h = -20$ nmPES4111528Dispersol Diazo Black B, 4X + Brentosyn BB, 6XDeveloped azoBlueStrong (purple>blue)R = 1.2, $\Delta h = -20$ nmPES4411527Dispersol Diazo Black B, 4X + Brentosyn BB, 6XDeveloped azoBlueStrong (purple>blue)R = 1.2, $\Delta h = -20$ nmPES4211528Dispersol Fast Orange	PES30	11517	Dispersol Diazo Black 2B, $5\%$ + Brenthol BT, 4.5%	Developed azo		Brown-orange	Strong (orange–brown>orange)	$R = 1.4; 1.7, \Delta \lambda = +20 \text{ nm}$
PE532       11519       Brentamine Fast Red 3C Base, 6% + Brentosyn B8, 6%       Developed azo       Bright red       No       R=1.4         PE533       11521       Brentamine Fast Red 3C Base, 6% + Brentosyn B8, 6%       Developed azo       Fuchsia       Weak       R=1.2         PE535       11522       Dispersol Fast Orange 6, 6% + Brentosyn B8, 6%       Developed azo       Fuchsia       Weak       R=1.2         PE536       11523       Brentamine Fast Rule Base, 4% + Prentosyn B8, 6%       Developed azo       Blue       Strong (deep red>fuchsia)       R=1.3, Ab = -20 nm         PE537       11524       Brentamine Fast Blue Base, 4% + Prentosyn B8, 6%       Developed azo       Blue       Strong (purple>blue)       R=1.7, Ab = -20 nm         PE539       11526       Dispersol Diazo Black R, 7.5% + Brentosyn B8, 6%       Developed azo       Blue       Weak       R=1.7, Ab = -10 nm         PE540       11527       Dispersol Diazo Black R, 4% + Brentosyn B8, 6%       Developed azo       Blue       Strong (black>-blue)       R=1.2         PE541       11528       Dispersol Diazo Black R, 4% + Brentosyn B8, 6%       Developed azo       Blue       Strong (black>-blue)       R=1.2         PE543       11520       Dispersol Fast Orange B (0.2%) + Duranol Red X3B       Ternary dye mixture       Pale vellow       Strong (bla	PES31	11518	Brentamine Fast Red GG Base, 6% + Brentosyn BB, 6%	Developed azo		Bright red	No	R=1.2
PFS3311520Brentamine Fast Red Cl. Base, 6% + Brentosyn BB, 6% Developed azoDeveloped azoBright red FuchsiaNoR = 1.2 R = 1.2 	PES32	11519	Brentamine Fast Red 3GL Base, 6% + Brentosyn BB, 6%	Developed azo		Bright pink	No	R = 1.4
PE53411521Brentamine Fast Red B Base, 6% + Brentosyn BB, 6%Developed azoFuchsiaWeakR = 1.2PE53511523Bispersol Fast Orange G, 6% + Brentosyn BB, 6%Developed azoBlueStrong (deep red>fuchsia)R = 1.3, $\Delta\Lambda = + 20$ nmPE53611523Brentamine Fast Blue B Base, 3% + Brentosyn BB, 6%Developed azoBlueStrong (purple>blue)R = 1.5, $\Delta\Lambda = -20$ nmPE53711524Brentamine Fast Blue B Base, 3% + Brentosyn BB, 6%Developed azoBlueWeakR = 1.7, $\Delta\Lambda = -20$ nmPE53811525Dispersol Diazo Black B, 7.5% + Brentosyn BB, 6%Developed azoBlueWeakR = 1.7, $\Delta\Lambda = -10$ nmPE53911526Dispersol Diazo Black B, 7.5% + Brentosyn BB, 6%Developed azoBlueWeakR = 1.2PE54011527Dispersol Diazo Black B, 4% + Brenton DT, 2.5%Developed azoDark greyStrong (black-blue)R = 1.2PE54111528Dispersol Fast Orange B (0.2%) + Duranol Red X3BTernary dye mixturePale yellowStrongKrongPE54311530Dispersol Fast Orange B (1.3%) + Duranol Red X3BTernary dye mixturePale orangeStrongKrongPE54411531Dispersol Fast Orange B (1.5%) + Duranol Red X3BTernary dye mixturePale pale wellowStrongKrongPE54411531Dispersol Fast Orange B (1.5%) + Duranol Red X3BTernary dye mixturePale brownStrongKrongPE54411532Dispersol Fast Orange B (2.5%) + Duranol Red X3BTernary dye mixture	PES33	11520	Brentamine Fast Red GL Base, 6% + Brentosyn BB, 6%	Developed azo		Bright red	No	R = 1.2
PES3511522Dispersol Fast Orange G, 6% + Brensoyn B8, 6%Developed azoFuchsiaStrong (deep red>fuchsia)R = 1.3, Δλ = + 20 nmPES3611523Brentamine Fast Blue B Base, 4% + Brentosyn B8, 6%Developed azoBlueStrong (purple>blue)R = 1.5, Δλ = -20 nmPES3711524Brentamine Fast Blue B Base, 4% + Brentosyn B8, 6%Developed azoBlueWeakR = 1.7, Δλ = -10 nmPES3811525Dispersol Diazo Black B, 2% + Brentosyn B8, 6%Developed azoBlueWeakR = 1.7, Δλ = -10 nmPES3911526Dispersol Diazo Black B, 2% + Brentosyn B8, 6%Developed azoDark greyStrong (black>-Due)e)R = 1.2PES4011527Dispersol Diazo Black B, 2% + Brentosyn B8, 6%Developed azoDark greyStrong (black>-Due)e)R = 1.2PES4111528Dispersol Fast Orange B (0.3%) + Duranol Red X38Ternary dye mixturePale yellowStrongStrongNe(0.1%) + Duranol Blue G (0.2%)Dispersol Fast Orange B (1.5%) + Duranol Red X38 (0.5%)Binary dye mixtureGreyNoStrongPES4411531Dispersol Fast Orange B (5.1%) + Duranol Red X38 (0.5%)Binary dye mixtureOrangeStrongStrongStrongPES4411532Dispersol Fast Orange B (1.6%) + Duranol Red X38Ternary dye mixtureOrangeStrongStrongPES4411532Dispersol Fast Orange B (1.6%) + Duranol Red X38Ternary dye mixturePale redStrong (red-brown>pink)StrongPES4511532Dispersol Fast Oran	PES34	11521	Brentamine Fast Red B Base, 6% + Brentosyn BB, 6%	Developed azo		Fuchsia	Weak	R=1.2
PES36       11523       Brentamine Fast Blue B Base, 4% + Brentosyn BB, 6%       Developed azo       Blue       Strong (purple>blue)       R=1.3, Δλ = -20 nm         PES37       11524       Brentamine Fast Blue B Base, 3% + Brentosyn BB, 6%       Developed azo       Blue       Weak       R=1.7, Δλ = -20 nm         PES38       11525       Dispersol Diazo Black 2B, 4% + Brentosyn BB, 6%       Developed azo       Blue       Weak       R=1.7, Δλ = -10 nm         PES34       11527       Dispersol Diazo Black B, 7.5% + Brentosyn BB, 6%       Developed azo       Dark grey       Strong (black>-blue)       R=1.2         PES41       11528       Dispersol Fast Orange B (0.5%) + Duranol Red X3B       Ternary dye mixture       Pale yellow       Strong       No         (0.1%) + Duranol Blue G (0.1%)       Ternary dye mixture       Grey       No	PES35	11522	Dispersol Fast Orange G, 6% + Brensosyn BB, 6%	Developed azo		Fuchsia	Strong (deep red>fuchsia)	$R = 1.3$ , $\Delta \lambda = +20$ nm
PES37       11524       Brentamine Fast Blue B Base, 3% + Brenchol FO, 3%       Developed azo       Blue       Strong (purple>blue)       R = 1.5, AN = -20 nm         PES38       11525       Dispersol Diazo Black 2B, 4% + Brentosyn BB, 6%       Developed azo       Blue       Weak       R = 1.7, AN = -20 nm         PES39       11526       Dispersol Diazo Black B, 75% + Brentosyn BB, 6%       Developed azo       Blue       Weak       R = 1.2         PES40       11527       Dispersol Fast Orange B (0.8%) + Duranol Red X38       Ternary dye mixture       Pale yellow       Strong (black> dark violet)       R = 1.2         PES41       11528       Dispersol Fast Orange B (0.8%) + Duranol Red X38       Ternary dye mixture       Grey       No	PES36	11523	Brentamine Fast Blue B Base, 4% + Brentosyn BB, 6%	Developed azo		Blue	Strong	$R = 1.3$ , $\Delta \lambda = -20$ nm
PES38       11525       Dispersol Diazo Black 28, 4% + Brentoosyn B8, 6%       Developed azo       Blue       Weak       R = 1.7, Δλ = −10 nm         PES39       11526       Dispersol Diazo Black 8, 7.5% + Brentosyn B8, 6%       Developed azo       Dark grey       Strong (black>blue)       R = 1.2         PES40       11527       Dispersol Tast Orange 8 (0.8%) + Duranol Red X3B       Ternary dye mixture       Pale yellow       Strong       Strong       R = 1.2         PES41       11528       Dispersol Fast Orange 8 (0.2%) + Duranol Red X3B       Ternary dye mixture       Pale yellow       Strong       No         PES42       11529       Dispersol Fast Orange 8 (0.2%) + Duranol Red X3B       Ternary dye mixture       Pale orange       Strong       Strong       Strong         PES43       11530       Dispersol Fast Orange 8 (1.5%) + Duranol Red X3B       Ternary dye mixture       Pale orange       Strong       Strong       Strong         PES44       11531       Dispersol Fast Orange 8 (5.1%) + Duranol Red X3B       Ternary dye mixture       Pale orange       Strong	PES37	11524	Brentamine Fast Blue B Base, 3% + Brenthol FO, 3%	Developed azo		Blue	Strong (purple>blue)	$R = 1.5$ , $\Delta \lambda = -20$ nm
PES39       11526       Dispersol Diazo Black B, 7.5% + Brentosyn BB, 6%       Developed azo       Dark grey       Strong (black>blue)       R = 1.2         PES40       11527       Dispersol Fast Orange B (0.8%) + Duranol Red X3B       Ternary dye mixture       Pale yellow       Strong       Strong       R = 1.2         PES41       11528       Dispersol Fast Orange B (0.8%) + Duranol Red X3B       Ternary dye mixture       Pale yellow       Strong       No         (0.1%) + Duranol Blue G (0.1%)       Ternary dye mixture       Orange       Strong       Strong       Strong         PES41       11530       Dispersol Fast Orange B (1%) + Duranol Red X3B       Ternary dye mixture       Pale orange       Strong       Strong         PES43       11530       Dispersol Fast Orange B (1%) + Duranol Red X3B       Ternary dye mixture       Orange       Strong       Strong         PES44       11531       Dispersol Fast Orange B (1.6%) + Duranol Red X3B       Ternary dye mixture       Orange       Strong       Strong         PES45       11532       Dispersol Fast Orange B (1.6%) + Duranol Red X3B       Ternary dye mixture       Pale brown       Strong       Strong         (0.6%) + Duranol Blue G (0.2%)       Ternary dye mixture       Pale red       Strong (red-brown>pink)       Strong       Strong       Strong	PES38	11525	Dispersol Diazo Black 2B, 4% + Brentosyn BB, 6%	Developed azo		Blue	Weak	$R = 1.7$ , $\Delta \lambda = -10$ nm
PES40       11527       Dispersol Diazo Black 8, 4% + Brenthol 07, 2.5%       Developed azo       Dark grey       Strong (black>-dark violet)       R=1.2         PES41       11528       Dispersol Fast Orange B (0.8%) + Duranol Red X3B       Ternary dye mixture       Pale yellow       Strong         PES42       11529       Dispersol Fast Orange B (0.2%) + Duranol Red X3B       Ternary dye mixture       Grey       No         PES43       11530       Dispersol Fast Orange B (0.2%)       Duranol Red X3B (0.5%)       Binary dye mixture       Pale orange       Strong         PES44       11531       Dispersol Fast Orange B (5.1%) + Duranol Red X3B       Ternary dye mixture       Orange       Strong         PES44       11531       Dispersol Fast Orange B (5.1%) + Duranol Red X3B       Ternary dye mixture       Orange       Strong         PES44       11531       Dispersol Fast Orange B (1.6%) + Duranol Red X3B       Ternary dye mixture       Orange       Strong       Strong         PES45       11532       Dispersol Fast Orange B (2.2%) + Duranol Red X3B       Ternary dye mixture       Pale brown       Strong       Strong         PES46       11533       Dispersol Fast Orange B (2.2%) + Duranol Red X3B       Ternary dye mixture       Pale red       Strong (red-brown>pink)       Strong         (4%) + Duranol Billie G (0.5%	PES39	11526	Dispersol Diazo Black B, 7.5% + Brentosyn BB, 6%	Developed azo		Blue-grey	Strong (black>blue)	R = 1.2
PES4111528Dispersol Fast Orange B (0.8%) + Duranol Red X3BTernary dye mixturePale yellowStrongPES4211529Dispersol Fast Orange B (0.2%) + Duranol Red X3BTernary dye mixtureGreyNoPES4311530Dispersol Fast Orange B (1%) + Duranol Red X3B (0.5%)Binary dye mixturePale orangeStrongPES4411531Dispersol Fast Orange B (1%) + Duranol Red X3BTernary dye mixtureOrangeStrongPES4411531Dispersol Fast Orange B (1.6%) + Duranol Red X3BTernary dye mixtureOrangeStrongPES4511532Dispersol Fast Orange B (1.6%) + Duranol Red X3BTernary dye mixturePale brownStrongPES4611533Dispersol Fast Orange B (2.2%) + Duranol Red X3BTernary dye mixturePale redStrong (red-brown>pink)PES4711534Dispersol Fast Orange B (2.2%) + Duranol Red X3BTernary dye mixturePale blueWeakPES4811535Dispersol Fast Orange B (0.2%) + Duranol Red X3BTernary dye mixturePale blueWeakPES4811535Dispersol Fast Orange B (2.2%) + Duranol Red X3BTernary dye mixturePale blueWeakPES4811535Dispersol Fast Orange B (0.2%) + Duranol Red X3BTernary dye mixtureBlueWeakPES4911536Dispersol Fast Orange B (0.2%) + Duranol Red X3BTernary dye mixtureBlueWeakPES4911536Dispersol Fast Orange B (0.2%) + Duranol Red X3BTernary dye mixtureStrongStrong (red-brown>pink)PES49 <td< td=""><td>PES40</td><td>11527</td><td>Dispersol Diazo Black B, <math>4\%</math> + Brenthol OT, 2.5%</td><td>Developed azo</td><td></td><td>Dark grey</td><td>Strong (black&gt;dark violet)</td><td>R = 1.2</td></td<>	PES40	11527	Dispersol Diazo Black B, $4\%$ + Brenthol OT, 2.5%	Developed azo		Dark grey	Strong (black>dark violet)	R = 1.2
PES42       11529       Dispersol Fast Orange B (0.2%) + Duranol Red X3B       Ternary dye mixture       Grey       No         PES43       11530       Dispersol Fast Orange B (1%) + Duranol Red X3B (0.5%)       Binary dye mixture       Pale orange       Strong         PES44       11531       Dispersol Fast Orange B (5.1%) + Duranol Red X3B       Ternary dye mixture       Orange       Strong         PES45       11532       Dispersol Fast Orange B (1.6%) + Duranol Red X3B       Ternary dye mixture       Pale brown       Strong         PES46       11533       Dispersol Fast Orange B (1.6%) + Duranol Red X3B       Ternary dye mixture       Pale red       Strong (red-brown>pink)         PES47       11532       Dispersol Fast Orange B (1.2%)       Ternary dye mixture       Pale blue       Weak         PES48       11535       Dispersol Fast Orange B (0.2%) + Duranol Red X3B       Ternary dye mixture       Pale blue       Weak         PES48       11535       Dispersol Fast Orange B (0.2%) + Duranol Red X3B       Ternary dye mixture       Pale blue       Weak         PES48       11535       Dispersol Fast Orange B (0.2%) + Duranol Red X3B       Ternary dye mixture       Pale blue       Weak         PES49       11536       Dispersol Fast Orange B (0.2%) + Duranol Red X3B       Ternary dye mixture       Blue       Weak </td <td>PES41</td> <td>11528</td> <td>Dispersol Fast Orange B <math>(0.8\%)</math> + Duranol Red X3B</td> <td>Ternary dye mixture</td> <td></td> <td>Pale yellow</td> <td>Strong</td> <td></td>	PES41	11528	Dispersol Fast Orange B $(0.8\%)$ + Duranol Red X3B	Ternary dye mixture		Pale yellow	Strong	
PES42       I1529       Dispersol Fast Orange B (0.2%) + Duranol Red X3B       Ternary dye mixture       Crey       No         PES43       11530       Dispersol Fast Orange B (1.0%) + Duranol Red X3B       Binary dye mixture       Pale orange       Strong         PES44       11531       Dispersol Fast Orange B (1.5%) + Duranol Red X3B       Ternary dye mixture       Orange       Strong         PES45       11532       Dispersol Fast Orange B (1.6%) + Duranol Red X3B       Ternary dye mixture       Pale brown       Strong         (2.7%) + Duranol Blue G (0.2%)       Puranol Red X3B       Ternary dye mixture       Pale brown       Strong         PES46       11532       Dispersol Fast Orange B (1.6%) + Duranol Red X3B       Ternary dye mixture       Pale brown       Strong         PES46       11533       Dispersol Fast Orange B (2%) + Duranol Red X3B       Ternary dye mixture       Pale red       Strong (red-brown>pink)         (4%) + Duranol Brilliant Violet BR (1%)       Ternary dye mixture       Pale blue       Weak         PES47       11534       Dispersol Fast Orange B (0.2%) + Duranol Red X3B       Ternary dye mixture       Pale blue       Weak         PES48       11535       Dispersol Fast Orange B (0.2%) + Duranol Red X3B       Ternary dye mixture       Blue       Weak         PES49       11536 <td>DEC 10</td> <td>11500</td> <td>(0.1%) + Duranol Blue G <math>(0.1%)</math></td> <td>m 1 .</td> <td></td> <td><u> </u></td> <td>N.</td> <td></td>	DEC 10	11500	(0.1%) + Duranol Blue G $(0.1%)$	m 1 .		<u> </u>	N.	
<ul> <li>PES43 11530 Dispersol Fast Orange B (1%) + Duranol Red X3B (0.5%) Binary dye mixture</li> <li>PES44 11531 Dispersol Fast Orange B (5.1%) + Duranol Red X3B Ternary dye mixture</li> <li>PES45 11532 Dispersol Fast Orange B (1.6%) + Duranol Red X3B Ternary dye mixture</li> <li>PES45 11532 Dispersol Fast Orange B (1.6%) + Duranol Red X3B Ternary dye mixture</li> <li>PES46 11533 Dispersol Fast Orange B (2%) + Duranol Red X3B Ternary dye mixture</li> <li>PES47 11534 Dispersol Fast Vellow A (0.1%) + Duranol Red X3B Ternary dye mixture</li> <li>PES48 11535 Dispersol Fast Vellow A (0.1%) + Duranol Red X3B Ternary dye mixture</li> <li>PES49 11536 Dispersol Fast Yellow A (0.8%) + Duranol Red X3B Ternary dye mixture</li> <li>PES49 11536 Dispersol Fast Yellow A (0.8%) + Duranol Blue G (0.3%)</li> </ul>	PES42	11529	Dispersol Fast Orange B $(0.2\%)$ + Duranol Red X3B	Ternary dye mixture		Grey	No	
PES43       11530       Dispersol Fast Orange B (1%) + Duranol Red X3B (0.5%)       Binary dye mixture       Paie orange       Strong         PES44       11531       Dispersol Fast Orange B (5.1%) + Duranol Red X3B       Ternary dye mixture       Orange       Strong         PES45       11532       Dispersol Fast Orange B (1.6%) + Duranol Red X3B       Ternary dye mixture       Pale brown       Strong         PES45       11532       Dispersol Fast Orange B (1.6%) + Duranol Red X3B       Ternary dye mixture       Pale brown       Strong         PES46       11533       Dispersol Fast Orange B (2%) + Duranol Red X3B       Ternary dye mixture       Pale red       Strong (red-brown>pink)         PES47       11534       Dispersol Fast Yellow A (0.1%) + Duranol Red X3B       Ternary dye mixture       Pale blue       Weak         (0.05%) + Duranol Blue G (0.5%)       Ternary dye mixture       Pale blue       Weak         (0.05%) + Duranol Blue G (0.2%) + Duranol Red X3B       Ternary dye mixture       Pale blue       Weak         (0.05%) + Duranol Blue G (0.2%) + Duranol Red X3B       Ternary dye mixture       Pale blue       Weak         (0.05%) + Duranol Blue G (0.2%) + Duranol Red X3B       Ternary dye mixture       Blue       Weak         (0.05%) + Duranol Blue G (0.2%) + Duranol Blue G (0.3%)       Binary dye mixture       Grey <t< td=""><td>DEC 42</td><td>11520</td><td>(0.1%) + Duranol Blue G <math>(0.2%)</math></td><td>D'anna dan aintean</td><td></td><td>D.1</td><td>Character</td><td></td></t<>	DEC 42	11520	(0.1%) + Duranol Blue G $(0.2%)$	D'anna dan aintean		D.1	Character	
PES44       ITS31       Dispersol Fast Orange B (5.1%) + Duranol Red X3B       Ternary dye mixture       Orange       Strong         PES45       11532       Dispersol Fast Orange B (1.6%) + Duranol Red X3B       Ternary dye mixture       Pale brown       Strong         PES45       11532       Dispersol Fast Orange B (2.8) + Duranol Red X3B       Ternary dye mixture       Pale brown       Strong         PES46       11533       Dispersol Fast Orange B (2.8) + Duranol Red X3B       Ternary dye mixture       Pale red       Strong (red-brown>pink)         (4%) + Duranol Billiant Violet BR (1%)       Ternary dye mixture       Pale blue       Weak         (0.05%) + Duranol Bilue G (0.5%)       Ternary dye mixture       Pale blue       Weak         (0.05%) + Duranol Bilue G (0.2%)       Ternary dye mixture       Blue       Weak         (0.6%) + Duranol Bilue G (0.3%)       Ternary dye mixture       Blue       Weak         (0.6%) + Duranol Bilue G (0.3%)       Binary dye mixture       Grey       Weak	PES43	11530	Dispersol Fast Orange B $(1\%)$ + Duranol Red X3B $(0.5\%)$	Binary dye mixture		Pale orange	Strong	
PES45       11532       Dispersol Fast Orange B (1.6%) + Duranol Red X3B (2.7%) + Duranol Blue G (0.2%)       Ternary dye mixture       Pale brown       Strong         PES46       11533       Dispersol Fast Orange B (2%) + Duranol Red X3B (1%)       Ternary dye mixture       Pale red       Strong (red-brown>pink)         PES47       11534       Dispersol Fast Yellow A (0.1%) + Duranol Red X3B (1%)       Ternary dye mixture       Pale blue       Weak         PES48       11535       Dispersol Fast Yellow A (0.1%) + Duranol Red X3B (0.2%) + Duranol Red X3B (0.2%) + Duranol Blue G (0.3%)       Ternary dye mixture       Blue       Weak         PES49       11536       Dispersol Fast Yellow A (0.8%) + Duranol Blue G (0.3%)       Binary dye mixture       Grey       Weak	PES44	11531	Dispersol Fast Orange B $(5.1\%)$ + Duranol Red X3B	Ternary dye mixture		Orange	Strong	
PES43     F1532     Dispersol Fast Orange B (1.5%) + Duranol Blue G (1.2%)     Ternary dye mixture     Pale blown     Strong (red-brown>pink)       PES46     11533     Dispersol Fast Orange B (2%) + Duranol Red X3B     Ternary dye mixture     Pale red     Strong (red-brown>pink)       PES47     11534     Dispersol Fast Vellow A (0.1%) + Duranol Red X3B     Ternary dye mixture     Pale blue     Weak       PES48     11535     Dispersol Fast Orange B (0.2%) + Duranol Red X3B     Ternary dye mixture     Blue     Weak       PES49     11536     Dispersol Fast Vellow A (0.8%) + Duranol Blue G (0.3%)     Binary dye mixture     Grey     Weak	DECAE	11522	(0.6%) + Duranoi Blue G $(0.3%)Dispersel Fact Orange P (1.6\%) + Duranoi Pad X2P$	Tornary due minture		Dala brown	Strong	
PES46       11533       Dispersol Fast Orange B (2%) + Duranol Red X3B       Ternary dye mixture       Pale red       Strong (red-brown>pink)         PES47       11534       Dispersol Fast Yellow A (0.1%) + Duranol Red X3B       Ternary dye mixture       Pale blue       Weak         PES48       11535       Dispersol Fast Orange B (0.2%) + Duranol Red X3B       Ternary dye mixture       Blue       Weak         PES49       11536       Dispersol Fast Yellow A (0.8%) + Duranol Blue G (0.3%)       Binary dye mixture       Grey       Weak	FE34J	11552	(2.7%) + Duranol Plus C $(1.0%)$ + Duranoi Red ASB	Ternary uye mixture		rale DIOWII	Strong	
PES47       11535       Dispersol Fast Vellow A (0.1%) + Duranol Red X3B (1%)       Ternary dye mixture       Pale blue       Weak         PES48       11535       Dispersol Fast Orange B (0.2%) + Duranol Red X3B (0.5%)       Ternary dye mixture       Blue       Weak         PES49       11536       Dispersol Fast Yellow A (0.8%) + Duranol Blue G (0.3%)       Binary dye mixture       Grey       Weak	DES/16	11533	(2.7%) + Duration Blue G (1.2%) Dispersol East Orange B (2%) + Duranol Red X3B	Ternary dye miyture		Dale red	Strong (red_brown>pink)	
PES47       11534       Dispersol Fast Yellow A (0.1%) + Duranol Red X3B (0.05%) + Duranol Blue G (0.5%)       Ternary dye mixture       Pale blue       Weak         PES48       11535       Dispersol Fast Orange B (0.2%) + Duranol Red X3B (0.6%) + Duranol Blue G (8%)       Ternary dye mixture       Blue       Weak         PES49       11536       Dispersol Fast Yellow A (0.8%) + Duranol Blue G (0.3%)       Binary dye mixture       Grey       Weak	FL340	11333	(4%) + Duranol Brilliant Violet BR (1%)	i ci nary uye mixture		i die ieu	Strong (red-brown>pink)	
PES48     11536     Dispersol Fast Orange B (0.2%) + Duranol Blue G (0.5%)     Ternary dye mixture     Blue     Weak       PES49     11536     Dispersol Fast Yellow A (0.8%) + Duranol Blue G (0.3%)     Binary dye mixture     Grey     Weak	PFS47	11534	Dispersol Fast Yellow A $(0.1\%)$ + Duranol Red X3R	Ternary dye mixture		Pale blue	Weak	
PES49 11536 Dispersol Fast Vranol Blue G (0.3%) + Duranol Red X3B Ternary dye mixture Blue Weak (0.6%) + Duranol Blue G (0.8%) PES49 11536 Dispersol Fast Yellow A (0.8%) + Duranol Blue G (0.3%) Binary dye mixture Grey Weak	1 2347	11334	(0.05%) + Duranol Blue G (0.5%)	i cinary aye mixtule		i aic bluc	cux	
(0.6%) + Duranol Blue G (8%)     Binary dye mixture     Grey     Weak	PES48	11535	Dispersol Fast Orange B $(0.2\%)$ + Duranol Red X3B	Ternary dve mixture		Blue	Weak	
PES49 11536 Dispersol Fast Yellow A (0.8%) + Duranol Blue G (0.3%) Binary dye mixture Grey Weak	. 25 10		(0.6%) + Duranol Blue G (8%)	- ernary aye minedic		Diac		
	PES49	11536	Dispersol Fast Yellow A (0.8%) + Duranol Blue G (0.3%)	Binary dye mixture		Grey	Weak	

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