Advances in reactive dyes

“Earth tones made easy“

NOVACRON® NC reactive dyes

Convention on Colors
Mumbai, February 2009
Textile fiber consumption / dyes for cellulosic fibers

<table>
<thead>
<tr>
<th>Dye Type</th>
<th>Market Share</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reactive</td>
<td>45%</td>
</tr>
<tr>
<td>Sulfur</td>
<td>12%</td>
</tr>
<tr>
<td>Vat</td>
<td>8%</td>
</tr>
<tr>
<td>Pigments</td>
<td>12%</td>
</tr>
<tr>
<td>Direct</td>
<td>12%</td>
</tr>
<tr>
<td>Indigo</td>
<td>8%</td>
</tr>
<tr>
<td>Naphtol</td>
<td>3%</td>
</tr>
<tr>
<td>Cel man-made</td>
<td>5%</td>
</tr>
<tr>
<td>Cotton</td>
<td>(36%)</td>
</tr>
<tr>
<td>WO</td>
<td>3%</td>
</tr>
<tr>
<td>PES</td>
<td>37%</td>
</tr>
<tr>
<td>PA</td>
<td>8%</td>
</tr>
<tr>
<td>PAN</td>
<td>5%</td>
</tr>
<tr>
<td>Others</td>
<td>6%</td>
</tr>
</tbody>
</table>

The world wide consumption of textile fiber is dominated by CEL and PES. Reactive dyes have gained the highest market share of all CEL dyes classes.
Major causes for market share increase of reactive dyes

- Substantial increase in cotton consumption in recent years
- Concern about some technical/ environmental drawbacks of alternative dyeing methods and dyestuffs classes
- Strong demand for bright and deep shades
- Convenient, simple economical dyeing methods
Characteristics of reactive dyes
(1965-1975)

Strengths:
• Wide shade spectrum
• Excellent brightness
• Acceptable wet fastness level
• Suitability for all application methods

Weaknesses
• high amounts of salt and long dyeing cycles (exhaust)
• low degree of fixation
• need for long washing-off cycles
• moderate light, wet-light, gas fading, photochromy issues and poor chlorine fastness in some shades
• Lack of reproducibility in critical shades
Introduction of hetero-bireactivity end of 1980

Monoreactive dye

- FT
- Hydrolysis
  - 25%
  - OH
- Fixation
  - 75%
  - OCell

CIBACRON C

- FT
- VS
- Hydrolysis
  - 25%
  - VS
  - OH
  - OH
- Fixation
  - 75%
  - CellO
  - OCell

Washing 60°C

Fixation
- Fixation
  - 75%
  - 93%

Research & Technology /JMS

C.O.C Mumbai, February 2009
Advantage of FT/VS molecular engineering

Vinylsulphone dye
Fluorotriazine dye

Fluorotriazine group
Vinylsulphone group

Alkali
Time
temperature

Chr.

Loss of yield

2 3 4 5 6 7 8 9 10 11
pH

0 20 40 60 80 100

Vinylsulphone dye
Fluorotriazine dye
Reduction of salt amount in dyeing bath

- The addition of salt is time-consuming and requires manpower.
- This is the amount of salt used for conventional reactive dyes.
- Time and cost saving, easier handling - The great benefits of NOVACRON LS.

Textile Effects
Research & Technology /JMS
C.O.C Mumbai, February 2009
A dyeing produced with a conventional golden yellow reactive dye, covered and then exposed to the light for 4 h.

Another dyeing produced with CIBACRON Yellow NP reactive dye, covered and then exposed to the light for 4 h.
Earth tones........

Sand, brown, olive, beige, gris, khaki,

Always critical issues for the dyers!
Earth tones.....

For Apparel
Trousers, shirting, uniform, yarn, polo shirts, garment dyeing

For Home textile
Terry toweling, bed sheeting, textile for furnishing

Dyeing processes
- Pad-batch
- Exhaust
- Continuous

Source: Huntsman's internal data
Reactive dyes or vat dyes?

Why do dyers use/prefer reactive dyes instead of vat dyes

- Higher versatility of application processes (pad-batch, exhaust, continuous)
- Bright, fashion, deep shades achievable
- Meets most modern fastness requirements in Apparel and Home Textile
- Cheaper recipe cost particularly for medium/deep shades
- More simple dyeing/application procedures, better penetration
  - no reduction step
  - no oxidizing
- No specks by dyeing pale shades
- Higher productivity due to easier shade planning (reactive/vat product mix not easy to manage in bulk)
- Easier stripping and shade correction
Use of vat dyes

Apparel and Home textiles

For what shades do the dyers prefer using vat dyes?

Especially for dyeing pale and medium shades, and when the brightness is not an issue

Reasons ........

The reproducibility of vat dyes is much better but care must be taken to application conditions (dispersing, steaming, rinsing, oxidizing, soaping)

The fastness requirement are fulfilled
NOVACRON NC Dyes
Earth tones

The Solution !!
A selection of new reactive dyes having the shade of vat dyes, combining the reproducibility of vat dyes and that can be applied as reactive dyes

NOVACRON NC (Non Contrasting)
The new Concept for pad-batch, exhaust and continuous Applications
NOVACRON NC Dyes

- FT chemistry, with 2-3 reactive groups
- Homogeneous NC self shades
- Non photochromic yellow component
- High compatibility within the range
- Designed for pad and exhaust application
- Non contrasting approach

Reproducibility of shades
Operational excellence
End-use flexibility
Fastness

Benefits for
- mills
- brands and retailers
- machine suppliers
Conventional dyes

Contrasting approach

Conventional and current dye selection

Blue

Moderate / poor reproducibility, reprocess cost

Yellow

Red

Textile Effects

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NOVACRON NC dyes
Non Contrasting approach

Improvement of dyeing performances
Principle of Non Contrasting effect

Conventional reactive dyes
Yellow Red Blue

Non Contrasting NOVACRON NC reactive dyes
Brown NC Olive NC Grey NC

Conventional vat dyes
Yellow 3R Brown BR Olive S/T

Variation of dye concentration in the recipe

<table>
<thead>
<tr>
<th>Recipe</th>
<th>Variation</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>-7.5</td>
</tr>
<tr>
<td>2</td>
<td>-5</td>
</tr>
<tr>
<td>3</td>
<td>-3</td>
</tr>
<tr>
<td>4</td>
<td>-1</td>
</tr>
<tr>
<td>5</td>
<td>0</td>
</tr>
<tr>
<td>6</td>
<td>2</td>
</tr>
</tbody>
</table>

Variation of dye concentration in the recipe:
- Reactive Yellow: 4.20 g/l
- Reactive Red: 1.90 g/l
- Reactive Blue: 4.00 g/l
- Novacron Brown NC: 1.40 g/l
- Novacron Olive NC: 6.80 g/l
- Novacron Grey NC: 1.20 g/l
- Novasol Yellow 3R md: 0.60 g/l
- Novasol Brown BR md: 1.60 g/l
- Novasol Olive S md: 12.00 g/l

Textile Effects
Research & Technology / JMS
C.O.C Mumbai, February 2009
Principle of Non Contrasting effect

Any fluctuation of the behavior of conventional yellow/red/blue reactive dyes (i.e. sensitivity to dyeing parameters as time-temperature, lack of compatibility) leads to shade changes that impair the results of the dyehouse.

The newly developed HUNTSMAN NOVACRON NC reactive dyes allow for a tremendous improvement of dyehouse performances: Higher reproducibility, less seconds, cost saving and better competitiveness.
Advantages of NOVACRON NC reactive dyes by pad-batch & continuous dyeing

Influence of bath stability on shade variation
Pad-batch process

Influence of steaming time variation
Pad-dry-pad-steam process

Yellow NC / Brown NC / Olive NC Non Contrasting reactive dyes
Conventional Yellow / Red / Blue reactive dyes
Advantages of NOVACRON NC reactive dyes by exhaust dyeing

Influence of dyeing parameters fluctuations on shade reproducibility

Standard conditions
0.036 % Novacron Yellow NC
0.020 % Novacron Brown NC
0.123 % Novacron Olive NC
30 g/l common saltsal
10 g/l soda ash
LR: 1/10
300 kg single jersey
Isotherm process, 60°
Advantages of NOVACRON NC by exhaust dyeing. Comparison with conventional reactive dyes

NOVACRON NC recipe:
- 0.153 % NOVACRON Yellow NC
- 0.031 % NOVACRON Brown NC
- 0.122 % NOVACRON Olive NC

Conventional recipe:
- 0.187 % Reactive Yellow
- 0.070 % Reactive Red
- 0.092 % Reactive Blue

Strength difference
- NOVACRON NC reactive dyes

Shade variation
- Conventional reactive dyes

Standard application conditions
- Dyeing temperature: 60°C
- Fixation time: 45 min
- Liquor ratio: 1/10

A: Salt + 20%
B: temperature – 5°C
C: temperature + 5°C
D: Alkali +20%
E: Fix. time: +15 min
F: LR 1:6
G: LR 1/12
Advantages of NOVACRON NC reactive dyes by exhaust and continuous application

Any variation of the application conditions by pad-batch, exhaust or continuous application has practically no influence on the shade of NOVACRON NC dyes

Consistency, Reproducibility, Competitiveness will consequently be tremendously improved
NOVACRON NC Dyes

Benefits for the mill

• Four dimensional consistency and outstanding reproducibility
  1. **No tailing** in the length
  2. No center-side shade variation in the width
  3. No two-sidedness in the thickness
  4. The same shade today, tomorrow and the day after
• Increase of productivity by reducing complex processes

• Outstanding fastness level satisfying the most stringent customers requirements

• Suitable for subsequent enzyme/stone wash, moist cross linking/FR/NH3 post-treatment and post-mercerizing with minimal shade change allowing for easier shade management

• Cost saving due to much lower effluent load (no need for sodium silicate, salt, hydrosulfite) and more efficient maintenance
Shade variation along the run

Tailing free dyeing pale shades with NOVACRON NC reactive dyes has become a reality

<table>
<thead>
<tr>
<th>Concentration</th>
<th>Dye</th>
<th>Fabric: Cotton Gabardine merc. 1650 m batch</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.36 g/l</td>
<td>Novacron Yellow NC</td>
<td>Pad-batch dyeing method, silicate free</td>
</tr>
<tr>
<td>0.20 g/l</td>
<td>Novacron Brown NC</td>
<td>Standard: beginning of the run, 20 m</td>
</tr>
<tr>
<td>1.23 g/l</td>
<td>Novacron Olive NC</td>
<td></td>
</tr>
</tbody>
</table>

Shade variation along the run
NOVACRON NC reactive dyes
Advantages over vat dyes

Influence of steaming and development conditions

Steaming with fully saturated steam

Steaming with not completely saturated steam (3-4% air)

NOVACRON NC recipe
1.4 g/l Brown NC
1.2 g/l Grey NC
6.8 g/l Olive NC

Vat dyes recipe
0.6 g/l Yellow 3R
1.6 g/l Brown BR
12.0 g/l Olive S/T

Shade variation
Lack of reproducibility
Need for reprocessing
**Finishing**

**NOVACRON® NC dyes enhance finishing**

Finishes such as easy care, moist-cross-linking, stain release and stain repellent, moisture management and anti-pilling add significant value to treated fabrics. The shade of conventional yellow/red/blue reactive dyes very often changes after finishing, leading to a complicated selection of dyes and/or application processes. Shades dyed with NOVACRON NC are particularly robust even under severe aftertreatment conditions. They show minimal variation after finishing and allow easier shade management and improved right-first-time performance.

<table>
<thead>
<tr>
<th>Pad-dry-pad-steam, bottom weight</th>
<th>Pad-steam, shirting</th>
<th>Pad-batch, trousers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Without finishing</td>
<td>Without finishing</td>
<td>Without finishing</td>
</tr>
<tr>
<td>1.90 g/l NOVACRON Yellow NC</td>
<td>0.22 g/l NOVACRON Yellow NC</td>
<td></td>
</tr>
<tr>
<td>1.15 g/l NOVACRON Brown NC</td>
<td>0.25 g/l NOVACRON Brown NC</td>
<td></td>
</tr>
<tr>
<td>2.25 g/l NOVACRON Olive NC</td>
<td>0.55 g/l NOVACRON Olive NC</td>
<td></td>
</tr>
<tr>
<td>With Easy care finishing</td>
<td>With MXL finishing</td>
<td>After enzyme washing</td>
</tr>
<tr>
<td>0.06 g/l NOVACRON Yellow NC</td>
<td>0.49 g/l NOVACRON Brown NC</td>
<td></td>
</tr>
<tr>
<td>1.75 g/l NOVACRON Olive NC</td>
<td>1.75 g/l NOVACRON Olive NC</td>
<td></td>
</tr>
</tbody>
</table>
Cost saving and ease of use with NOVACRON NC dyes

Silicate-free pad-batch process—cost saving

The silicate-free alkali systems for pad-batch used for NOVACRON® NC dyes offer advantages such as:

- prevention of incrustations/deposits on the padding mangle and feeding pipes which lead to deterioration
- no risk of precipitation/spots due to water hardness or by neutralization at washing step
- easier and faster range cleaning leading to increased productivity
- softer handle of dyed fabric
- easier and more efficient washing-off; no need for neutralizing
- much cheaper recipe cost, especially by dyeing pale shades

![Bar chart showing cost comparison between silicate and silicate-free processes.](chart.png)
Cost saving and environment protection with NOVACRON NC dyes

**Pad-dry-steam instead of pad-dry-pad-steam**—cost saving and easy handling

**Bulk production**

- Fabric: 2300 m batch, 2/1 gabardine bleached, mercerized, 330 g/running meter
- Running speed: 50 m/min
- Padding:
  - 1.2 g/l NOVACRON Yellow NC
  - 2.3 g/l NOVACRON Brown NC
  - 4.5 g/l NOVACRON Olive NC
  - 1.0 g/l ALBAFLOW PAD
  - 10.0 g/l THERMACOL MP
  - 10.0 g/l sodium bicarbonate
- Drying: IR predrying + hotflue drying at 100-120°C
- Steaming: 1 min with saturated steam
- Washing-off: open width, water consumption: 6 liters/kg fabric

**NOVACRON NC** dyes can be applied by the continuous pad-dry-steam process without chemical pad. This method offers several advantages over the conventional pad-dry-pad-steam process:

- no need for salt
- shorter process and time saving (no need to prepare highly concentrated salt solution or brine)
- no tailing due to absence of dye desorption in the chemical trough
- no corrosion of the steamer, less maintenance and longer life cycle of equipment
- no more effluent load and saving of water cost treatment

A pad-dry-pad-steam production of 1 million meters/month will require about 700 tons of common salt per year (about 14,000 salt bags, 20-30 trucks) and an additional water consumption of 250,000 liters/month salty water.
NOVACRON NC Dyes
Fastness properties

A new state-of-the-art in reactive dyeing

- Fast to light (ISO, AATCC 16 E, 60AFU)
- Fast to wet light and perspiration light (Nike/Adidas)
- Fast to nitrogen oxide (gas fading) and ozone
- Fast to chlorine (20 mg/l, home laundering)
- Fast to peroxide (M&S C10A)
- Fast to repeated washing (30x at 60°C) tested according European and US conditions
- Fast to post mercerizing
NOVACRON NC Dyes

Earth tones made easy

Let’s do it together
Promotion material