FIBER REACTIVE DYES AND OPTIONS
TO REDUCE ELECTROLYTE CONSUMPTION

by

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Technology Development and Training

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FIBER REACTIVE DYES
AND
OPTIONS TO REDUCE
ELECTROLYTE CONSUMPTION

COTTECH Conference
1993
Ciba
USE OF ELECTROLYTE IN TEXTILES

- Standardization diluent in dye manufacturing
- Exhaustion of FWA on Cellulosic fibers
- Exhaustion of fiber reactive dyes
- Exhaustion and post-treatment/antimigrant of direct dyes
- Leveling of some wool dyes
- Leveling of cationic dyes
- High temperature protection of modified polyester fibers
- Exhaustion for some vat/sulfur dye applications
- Exhaustion of naphthol dyes

*Electrolyte - sodium chloride and sodium sulfate*
ELECTROLYTE CONSUMPTION
(Million Pounds)

Sodium Chloride  512*
Sodium Sulfate  230

* 1991 U.S. Department of Interior
FRESHWATER ORGANISMS USED FOR EFFLUENT TOXICITY

- ceriodaphnia dubia (daphnid)
- daphnia pulex and daphnia Magna (daphnids)
- pimephales promelas (fathead minnow)
- oncorhynchus mykiss (rainbow trout) and salvelinus fontinalis (brook trout)
### ACUTE TOXICITY LEVELS WITH DAPHNIA PULEX

#### LC50 Concentrations

<table>
<thead>
<tr>
<th>ELECTROLYTE</th>
<th>PPM</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sodium Chloride</td>
<td>2,376</td>
</tr>
<tr>
<td>Sodium Sulfate</td>
<td>2,766</td>
</tr>
</tbody>
</table>

*Source: Burlington Research*
TYPICAL EXAMPLE OF ELECTROLYTE USE

Plant Conditions

- 75,000 pounds/day with 6 days/week schedule
- cotton knit
- 30% bleach white and 70% dyed shades
- 10:1 Liquor-to-Goods Ratio
- 20 gallons/pound water consumption

Electrolyte Discharge

- 2530 ppm with 60 g/L electrolyte
- 1687 ppm with 40 g/L electrolyte
ELECTROLYTE REDUCTION OPPORTUNITIES

- Options with fiber reactive dyes
- Alternate dyeclasses
- Cationic Cotton
- Electrolyte Substitutes
ELECTROLYTE REDUCTION

Options With Fiber Reactive Dyes

- Dyes with increased reactivity
- Low liquor ratio exhaust dyeing
- Pad batch dyeing
- Single pad-steam versus wet-on-wet
- Procedure/product optimization
- Higher affinity dyes
**ELECTROLYTE REDUCTION**

Influence of Low Liquor Ratio Dyeing
CIBACRON F REACTIVE DYES

**Grams/Liter Electrolyte Requirement**

<table>
<thead>
<tr>
<th>Percent Dye*</th>
<th>12:1</th>
<th>8:1</th>
<th>6:1</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.5</td>
<td>25</td>
<td>20</td>
<td>15</td>
</tr>
<tr>
<td>1.0</td>
<td>40</td>
<td>30</td>
<td>20</td>
</tr>
<tr>
<td>2.0</td>
<td>60</td>
<td>35</td>
<td>25</td>
</tr>
<tr>
<td>3.0</td>
<td>70</td>
<td>45</td>
<td>35</td>
</tr>
</tbody>
</table>

*100% Cotton Dyed at 60°C
# ELECTROLYTE REDUCTION

Reactive Dyes with Increased Reactivity

## Grams/Liter Electrolyte Requirement

<table>
<thead>
<tr>
<th>Percent Dye*</th>
<th>High Reactivity Monofluorotriazine 60°C</th>
<th>Low Reactivity Monochlorotriazine 80-93°C</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.5</td>
<td>25</td>
<td>40</td>
</tr>
<tr>
<td>1.0</td>
<td>40</td>
<td>60</td>
</tr>
<tr>
<td>2.0</td>
<td>60</td>
<td>80</td>
</tr>
<tr>
<td>3.0</td>
<td>70</td>
<td>100</td>
</tr>
</tbody>
</table>

*100% Cotton Dyed at 10:1 Liquor-To-Goods Ratio*

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ELECTROLYTE REDUCTION

Pad Batch Dyeing For Cotton And Cotton Blends

- No sodium chloride or sodium sulfate required

- Alkali systems based on sodium hydroxide, soda ash, sodium silicate, or combinations

- Added benefit of energy and water savings, and low capital investment
ELECTROLYTE REDUCTION

Higher Affinity Reactive Dyes
Next Generation

0 to 20 Grams/Liter Electrolyte
ELECTROLYTE REDUCTION

Product And Process Optimization

○ Control liquor ratio

○ Control temperature

○ Eliminate adds/redyes

○ Follow supplier's recommendations
## ELECTROLYTE REDUCTION

### ALTERNATE DYE CLASSES

### Direct Versus Reactive Dyes

<table>
<thead>
<tr>
<th>Percent Dye</th>
<th>Low Reactivity Reactive Dyes</th>
<th>High Reactivity Reactive Dyes</th>
<th>Direct Dyes</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.5</td>
<td>40</td>
<td>25</td>
<td>7.5</td>
</tr>
<tr>
<td>1.0</td>
<td>60</td>
<td>40</td>
<td>15.0</td>
</tr>
<tr>
<td>2.0</td>
<td>80</td>
<td>60</td>
<td>22.5</td>
</tr>
<tr>
<td>3.0</td>
<td>100</td>
<td>70</td>
<td>25.0</td>
</tr>
</tbody>
</table>

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ELECTROLYTE REDUCTION OPPORTUNITIES

Alternate Dyeclasses

- Direct Dyes
- Sulfur Dyes
- Vat Dyes
ELECTROLYTE REDUCTION
ALTERNATE DYECATEGORIES

Direct, Vat, And Sulfur Dyes
Application Consideration

- Shade range capability
- Fastness performance
- Machine applicability
- Cost
ELECTROLYTE REDUCTION
ALTERNATE DYE CLASSES

Sulfur And Vat Dyes

No Electrolyte Requirement
ELECTROLYTE REDUCTION

Electrolyte Substitutes

- Magnesium salts (Burlington Chemical)
- Suitable for low sulfonation direct dyes
- LC 50 acute toxicity level increased by 50%
- Application pH <7.0
- Cost
ELECTROLYTE REDUCTION

Cationic Cotton

- Numerous investigations
- Commercial products introduced
- Application difficulties
  - unlevel pretreatment
  - reduced lightfastness
  - reduced wetfastness
ELECTROLYTE REDUCTION OPPORTUNITIES SUMMARY

- Cationic Cotton - Commercial Development Required
- Fiber Reactive Dyes - A New Generation Of Higher Affinity
## ELECTROLYTE REDUCTION OPPORTUNITIES SUMMARY

<table>
<thead>
<tr>
<th>Process</th>
<th>Dye Type</th>
<th>Reduction</th>
</tr>
</thead>
<tbody>
<tr>
<td>Exhaust Dyeing</td>
<td>Reactive Dyes with Increased Reactivity</td>
<td>30%</td>
</tr>
<tr>
<td></td>
<td>Low liquor ratio dyeing</td>
<td>50%</td>
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<tr>
<td></td>
<td>Direct Dyeing</td>
<td>75%</td>
</tr>
<tr>
<td></td>
<td>Vat and Sulfur Dyes</td>
<td>Elimination</td>
</tr>
<tr>
<td>Pad Dyeing</td>
<td>Pad Batch</td>
<td>Elimination</td>
</tr>
<tr>
<td></td>
<td>Continuous Single Pad Steam</td>
<td>75%</td>
</tr>
<tr>
<td></td>
<td>Vat and Sulfur Dyes</td>
<td>Elimination</td>
</tr>
</tbody>
</table>