Dyeing Reactive Dyes Using Less Salt

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Introduction

An adage in the past when exhaust dyeing fiber reactive dyes, has been that "Salt is cheaper than Dye." Since fiber reactive dyes generally require higher quantities of salt than other cellulosic dyes, it has been a general practice to utilize high quantities of salt in exhaust dyeing. Some plants have increased general recommendations from dye manufacturers as much as 20-30%; some plants have used as much as 100-150 g/l.

Environmental concerns are requiring plants to reduce salt in their effluents. Machinery manufacturers promote lower liquor-to-goods ratio dyeing equipment. The industry in many instances has moved from 15:1 - 20:1 ratios to 8:1 - 5:1 ratios. This reduction in liquor-to-goods ratio improves the substantivity of fiber reactive dyes; therefore, salt quantities may be reduced.

Table I illustrates an example of the effect of reduced liquor-to-goods ratio with respect to quantities of salt required for 1,000 Ibs. of fabric. As noted in the example, salt required per pound of fabric may be reduced to 83.4%, thereby reducing salt in effluent and saving on the cost of salt.

Research and development for fiber reactives has been directed towards products with high fixation and lower salt requirements. Today, there are products available that require only 30-50 g/l at 10:1 ratios for optimum yield (Levafix Olive E-GLA/Levafix Royal Blue E-FR/Levafix Navy Blue E-BNA).

The dyer faces two critical questions:

- What is the minimal salt concentration that results in minimal total

Table I: Salt reduction due to lower liquor ratio.

75 Grams/Liter @ 10:1 = 750 lbs./l,000 lbs. Fabric
75 Grams/Liter @ 5:l = 375 lbs./1,000 lbs. Fabric
25 Grams/Liter @ 5:l = 125 lbs./1,000 lbs. Fabric

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When utilizing reduced salt for reduced liquor ratio reduction as illustrated is 5/6 or 83.4%.

For plant processing 500,000 lbs. fabric per week, this represents a savings of: 62,500 lbs. salt

$6,250	If Sodium Sulfate	(10 Cents/lb.)
$3,125	If Sodium Chloride	(5 Cents/lb.)

Table II: Formula correction--Levafix

Batch:
Formula: adr

Batch weight : 705.0 lbs.
Salt cost : 0.05 $/lb.
Water cost : 1.70 $/1000 gal

Original Formula

20	LX.G.YELL..EG 150	0.3830 %
59	LX.BR.RED E4BA	0.7120 %
95	LX.BR.BLUE EBRA	0.6510 %

Liquor ratio	20.0:1	
Salt		50 g/l
Dyestuff cost	$ 50.93 per 100 lbs.	
Salt cost	$ 5.00	
Water cost	$ 0.41	
Sum	$ 56.34	

cost for dye and salt?
- How does the reactive dye concentration need to be changed if the liquor-to-goods ratio is changed?

Computer program

A computer program has been developed to enable the dyer to adjust lye and/or salt formula using Levafix E/EA/EN dyes to varying dyeing condiions and to calculate the quantity of alkali for the Levametering alkali metering process.

There are two versions:
- "LEV 1" for occasional use. Most data has to be entered via the keyboard.
- "Lev 2" for frequent use. Most data is stored in data files.

The program consists of two parts:
1. Correction of dyestuff formulas for cellulosic fibers and cellulosic fiber blends, i.e.:
   - Adjustment of formulas to any liquor-to-goods ratio (between 4:1 and 40:1 for cellulosic fibers) and salt concentration (between 5 and 100 g/l either of common salt or sodium sulfate calc.).
   - Calculation of a standard salt concentration.
   - Calculation of the salt concentration which minimizes the total cost for dyes and salt.
2. Levametering for cotton and cotton blends, i.e.:
   - Calculation of the quantities of Caustic Soda (Flakes, 50%, 45% or 38 Be') and Sodium Bicarbonate when dyeing at constant temperatures between 45°C and 60°C (110°F and 140°F).

The program includes (when cost factors are installed):
- Calculation of the concentrations of Levafix dyes and chemicals in % o.w.f. or g/l ("laboratory formula") as well as the absolute quantities in lbs. for the respective batch weight and liquor volume ("production formula").
- Calculation of costs (in currency) units/l00 tbs. of goods for dyes, chemicals and water.

The main menus are:
- Correction of formula
- Levametering
- Editing of data set

For correction of formula, input of a standard formula is made. This may be a laboratory or a production formula which consists of:
- A. Dye formulation
- B. Liquid-to-goods ratio

Corrected Formula

Fraction of cell. fiber in blends: 100 %
Fiber- proc.-correct. factor :1.00
Dyestuff spec. correct. factor :0

Liquor volume : 4500 l

20	LX.G.YELL.EG 150	0.3722 % (-2.8 %)	2.624 lbs.
59	LX.BR.RED E4BA	0.6970 % (-2.1 %)	4.914 lbs.
35	LX.BR.BLUE EBRA	0.6294 % (-3.3 %)	4.437 lbs.

Liquor ratio 14.1:1
Salt standard 45 g/l 447 lbs.

Dyestuff cost	$ 49.47 per 100 lbs
Salt cost	$ 3.17
Water cost	$ 0.29
Sum	$ 52.93

Liquor volume : 3000 l

20	LX.G.YELL.EG 150	0.3686 % (-3.8 %)	2.599 lbs.
59	LX.BR.RED E4BA	0.6862 % (-3.8 %)	4.837 lbs.
95	LX.BR.BLUE EBRA	0.6254 % (-3.9 %)	4.409 lbs.

Liquor ratio 9.4:1
Salt standard 35 g/l 232 lbs.

Dyestuff cost	$ 48.99 per 100 lbs.
Salt cost	$ 1.64
Water cost	$ 0.19
Sum	$ 50.83

Liquor volume : 1700 l

20	LX.G.YELL.EG 150	0.3652 % (-4.6 %)	2.575 lbs.
59	LX.BR.RED E4BA	0.6688 % (-6.1 %)	4.715 lbs.
95	LX.BR.BLUE EBRA	0.6203 % (-4.7 %)	4.373 lbs.

Liquor ratio 5.3:1
Salt standard 25 g/l 94 lbs.

Dyestuff cost	$ 48.34 per 100 lbs.
Salt cost	$ 0.66
Water cost	$ 0.11
Sum	$ 49.11

C. Salt consentration

In the example (Table II) a standard formula at liquor ratio 20:1 has been entered.

In corrected formula 1 - change of liquor-to-goods ratio & salt concentration.
In corrected formula 2 - change of liquor to goods ratio & salt concentration
In corrected formula 3 - change of liquor-to-goods ratio & salt concentration

With stored data, the computer will provide a formulation for the salt and liquor-to-goods ratio (Table I) selected. The new formula also provides percentage change of each dye between the old and new formula. An example of standard formula and subsequent corrected formulas for various liquor volumes and salt changes (Table II) is also provided.

The “LEV” computer program has been proven to correlate well both in laboratory controlled dyeings as well as in production. Utilizing this program has resulted in reduced salt quantities, while obtaining optimum yield of Levafix dyes for various liquor-to-goods ratios. This results in less salt in the effluent while reducing the unit cost. □ □ □