

Freeing polyester from oligomers

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Introduction

Customer expectations have risen in recent years to the point where a simple shade variation is no longer considered acceptable. Consumers are now more likely to analyse the look and feel of a garment before making a purchase.

Polyester fibre is in widespread use across the fashion and home textiles markets, but the fabric is sensitive to the issue of dye migration. The problem occurs when polyester oligomers move from the fabric core to its surface.

Oligomers are a low molecular weight byproduct of the polymerisation of diethylene glycol and terephthalic acid, which is a process for obtaining polyester. They have different structures and are classified according to the number of units they contain.

These oligomers exhibit high thermal sensitivity; hence they migrate from the core of the fibre to its surface during high temperature polyester dyeing. The depth of dye determines how many oligomers are displaced.

These oligomers are insoluble and agglomerate to form bigger crystals. The presence of oligomers can lead to nucleation and growth of dye crystals resulting in dye spots, unevenness, and poor fastness.

Oligomers pose the following problems:

- White deposit on yarn or package
- Deposition on machine wall
- Uneven dyeing
- Clogging of spindles
- Dusting during rewinding, knitting, and weaving
- Filtration effect (inside out variation) due to build-up of oligomers in package
- Improper pump pressure due to deposits on pump
- Variation in rate of rise of temperature due to deposits on heating elements
- Duller shades
- Higher energy requirements
- Increase friction value of yarn resulting in more yarn breakages in winding

Keeping in mind the above problems and remedies, textile chemical manufacturing company Sarex has developed a novel process using Eliminator-GLO to resolve the issue of oligomers in polyester dyeing.

Unique features

- An effective oligomer removing agent used during polyester dyeing
- Enables uniform and solid dyeing
- Reduces the machine cleaning cycles as it keeps the oligomers in suspended/dispersed forms and prevents their redeposition
- Use the product, along with caustic, for machine cleaning during polyester dyeing
- When used in the dye bath, the product will benefit from improved wash fastness

- Improves the combing quality of stock-dyed material
- No retardation of disperse dyes: no negative effect on colour yield or fastness

Mechanism of Eliminator-GLO

Polyethylene terephthalate polymers have a certain proportion of low molecular weight compounds referred to as oligomers, which are produced during the manufacture of polyester. At temperatures above the glass transition temperature of polyethylene terephthalate, oligomers migrate out of the fibre and onto the surface. These oligomers tend to deposit on the surface of the polyester and on the dyeing machine on cooling. Since oligomers cannot be dyed with the disperse dyestuffs, they appear as a white dusting powder on the dyed goods.

Eliminator-GLO can keep the oligomers in suspended, or dispersed, form. Eliminator-GLO will prevent the re-deposition of oligomers onto the fabric allowing more oligomer to go down the drain.

Materials and methods

Materials: 100% Polyester yarn

Chemicals: Eliminator-GLO

Experimental

Eliminator-GLO Dilution Method:

Take 01 parts of Eliminator-GLO and dilute it with 05 parts of warm water and stir. Continue stirring to get a homogeneous product. Avoid adding concentrated product directly into the machine.

Exhaust application process:

% Shade depth	Recommended dosages
up to 1%	1 g/l
2-3%	2.5 g/l
3-5%	3 g/l
very dark shade	4 g/l

A→	Regular machine cleaning	Machine cleaning on monthly maintenance
Caustic	5 g/l	5 g/l
Hydrose	5 g/l	5 g/l
Eliminator-GLO	2 g/l	5 g/l
Sarakol-NF	–	5 g/l
	90°C, 60 min	90°C, 60 min

Test methods

1. Degree of dispersion and oligomer filtration test
2. Surface morphological study by SEM (Scanning Electron Microscope)
3. Oligomer content determination

Technical briefing: dye migration

Results and discussions

Degree of dispersion and oligomer filtration test:

A definite amount of oligomer is taken in the test solution. Same parameters to be kept as that of polyester dyeing. The temperature was raised to 135°C and then it was lowered to 80°C. The solution is filtered with black filter paper.

Degree of dispersion

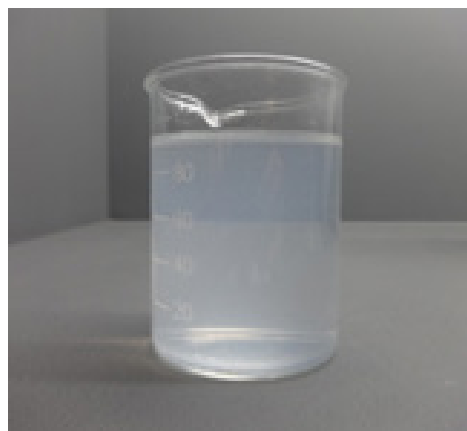
Without Eliminator-GLO

Oligomer aggregates observed in dioxane extraction

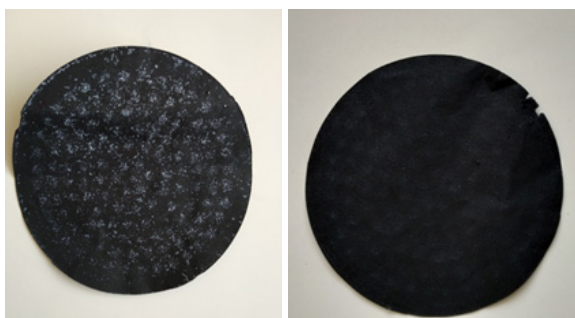


With Eliminator-GLO

Oligomers are uniformly dispersed in presence of Eliminator-GLO



Oligomer filtration test



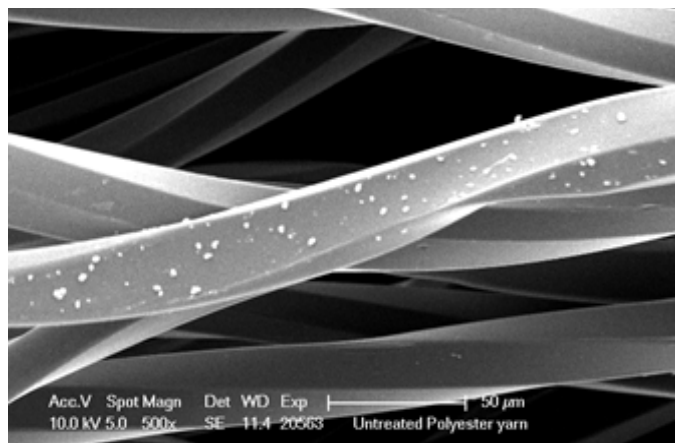
Without Eliminator-GLO

Presence of oligomer in the dyeing bath

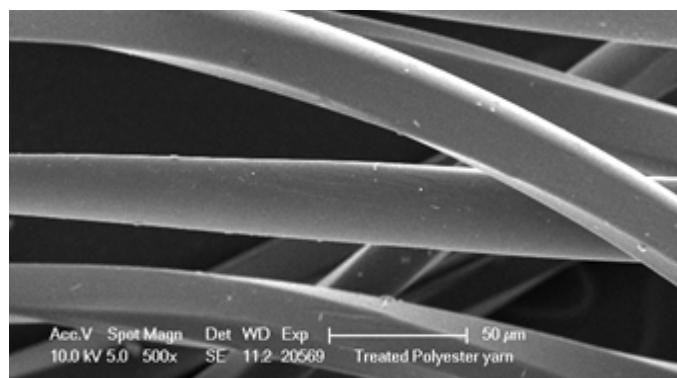
With Eliminator-GLO

Oligomer content found to be reduced with Eliminator-GLO

Surface morphological study by SEM



SEM image of polyester yarn containing oligomer. Oligomer deposits observed on PES yarn



SEM image of polyester yarn treated with Eliminator-GLO. PES yarn appears much cleaner

Oligomer content determination

Place 10 grams of polyester yarn/fabric in a Soxhlet extractor. Take an adequate quantity of solvent (one and half cycle) and extract the sample for four hours. Recover bulk of solvent by distillation and evaporate the extract to dryness. Further dry the residue in the flask in a drying oven at 105°C for four hours, or until a constant weight is obtained. Then weigh the flask.

Calculation

% oligomer content = (weight of residue X 100)/weight of specimen.
Where, weight of residue = (weight of flask + residue) - initial weight of flask.

Recipe	Oligomer content %
Untreated	2.78
2% Eliminator GLO	0.81

Therefore, with Eliminator-GLO treatment, 70-80% oligomer removal is obtained in a single treatment.

Conclusion

From the above test results, it could be concluded that Eliminator-GLO is an effective product for the removal of oligomeric impurities from polyester yarns and fabrics.