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POLYESTER – REMOVAL OF OLIGOMERS

Oligomers are complexes of different by-products of low molecular weight formed during polymerisation of diethylene glycol with terephthalic acid to obtain polyester.

They have many different structures and are classified according to the number of units they contain. They can be monomers, dimers, linear trimer, cyclic trimers and so on, up to 7-8 units. They are mainly trimers and cyclic in structure. Their average quantity can be estimated as 1.5-2.5 per cent.

Surface oligomers cause dyeing faults. These low polymers have high thermal sensitivity, causing them to migrate from the heart of the fibre toward the surface, in particular hot state treatments or also during relatively brief treatment under pressure at very high temperature.

The oligomers are partially filtered on the fabric surface and form molecular groups (deposits) that retain, to an anomalous degree, the different substances dispersed in the bath. These groups are very difficult to remove with traditional washing treatments.

The main parameters influencing the migration speed of oligomers are:

- Formation and structure of the polymer
- Molecular weight and melting point
- Temperature, duration and turbulence of different industrial treatments
- pH of treatment baths
- Concentration and distribution of low polymer in fibre

A key factor that prevents surface deposits from forming is the temperature at which the bath is drained, after any treatment carried out at high temperature. Performing this operation at the highest possible temperature to prevent rapid crystallization of low polymers, leading to precipitation on the fibrous surfaces is recommended. It is best to drain the bath at 120-130°C.

Problems caused by oligomer deposits leading to unleveled dyeing include:

- Filtration effect due to build up of oligomers in package
- Improper pump pressure due to deposits on pump
- Variation in temperature rise rate due to deposits on heating elements
- Duller shades

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- Dusting during coning
- Higher energy costs

Factors to minimise oligomer problem in HT dyeing of PET

There are several ways to minimise oligomers, and no single method is effective enough. Using a combination of methods is recommended. These methods include:

- **Controlling dyeing parameter**: General dyeing parameters such as increasing dyeing temperature or dyeing time at high temperature during hold and strike rate of dyeing have influence on oligomer separation and removal (i.e. heating speed of dyeing results in oligomer separation).
- **Addition of oligomer dispersant and leveling agent during dyeing**: Oligomer dispersant liquids keep oligomers finely dispersed during dyeing and reduce their agglomeration and deposition on the textile substrate or machine parts. It can be easily drained off at high temperature without much redeposition. Due to fibre swelling along with strong diffusion acceleration or migrating property, liquid promotes oligomer exit more effectively compared to conventional leveling agents. Also, additional use of dye dispersing agent ensures good dispersion stability in presence of oligomers and thus avoids aggregation and agglomeration of disperse dyestuffs in the bath; preserving migration properties of oligomers dispersants.
- **Application of special solvents in HT dyeing**: Certain solvents, in high temperature dyeing, ensure good diffusion acceleration or migration effect; improving dispersion stability and minimising the oligomer problem. First, they remove oligomers from the fibre, then dissolve them in the liquor; ensuring their removal by draining off the liquor without affecting the final shade. However, this method is no longer practicable in some countries for ecological reasons.
- **Draining off liquor under HT conditions**: Draining off the liquor under high temperature conditions (110-130°C) alleviates the problem considerably.
- **Dyeing in alkaline conditions**: Polyester dyeing in soda alkaline medium (pH 9-9.5) for one bath one step disperse/ reactive dyeing of PET/ Cellulose blend reduces the oligomer problem considerably. There are select disperse dyes which are stable in alkaline pH range.
- **Applications of surfactants during reduction clearing**: Special quaternary compounds are used as alkaline accelerators for the removal of PET oligomers from the machine under HT conditions. The products in conventional alkaline reductive clearing at 80°C, saponify surface oligomers on the goods.
- **Machine clearing**: Cleaning of dyeing machine remains a major problem in the rationalization of dyeing plants. This is especially true recently with cases of oligomer production resulting from high speed spinning becoming more frequent as well as with increasing hardness of water used.

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- In addition, the increase in dyeing of union knits and weaves, which often requires more than one dyestuff, has raised the likelihood of trouble shooting occurring. It is recommended to carry out machine cleaning regularly to achieve best dyeing results. Resil, and also BASF (Germany), Clariant, and Croda have very good machine cleaning chemicals that will eliminate oligomer build up. They have got excellent inbuilt dispersing action on polyester oligomers and can be used as an efficient cleaning agent for oligomer deposits that may be accumulated in the dyeing machine.

Summing up (OLIGOMER)

_ Clean machine periodically
_ Use of high liquor ratio
_ Avoid prolonged treatments at 1300C and frequent/sudden temperature changes
_ Use oligomer dispersants during dyeing
_ Drain the bath at highest possible temperature

The complete removal of the oligomers is not possible. However, they can be partly eliminated
using specialty chemicals in dyeing, reduction clearing of dark/heavy dark polyester fiber in acidic
medium, proper finish having less affinity for the oligomers, and regular machine cleaning.

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