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IN-LINE YELLOWNESS MEASUREMENT

CHEMICALS & PLASTICS

INTRODUCTION

When exposed to UV light, chemicals and processing conditions (i.e. high temperatures), raw materials and finished products will stain, soil, scorch, burn and degrade. This affects their visual characteristics and can produce a yellow tint. The yellowness observed is a condition where the light is absorbed in the blue part of the spectrum.

PHOTO1. POLYETHYLENE TEREPHTHLATE (PET)

YELLOWNESS IN PLASTICS

Chemical and physical mechanisms are responsible for changing the properties of polymer chains. When these changes take place, yellowness may be observed in several chemicals and plastics. Some of them are:

Polypropylene (PP)

PP is very prone to thermal oxidative degradation due to the presence of an alternative tertiary C atom in the main backbone. It leads to chain scission and unsaturation in PP that is responsible for yellowing. The appearance of yellow may be an indication of high extrusion temperatures and/or low antioxidant doses.

Polyvinyl Chloride (PVC)

PVC is known for both its low thermal and low light stability during processing and handling. Exposure to either one or both can cause degradation issues as a result of a dehydrochlorination reaction. The introduction of chemical groups into degraded PVC chains can result in the appearance of yellowness.

Polycarbonate (PC)

In PC, the energy absorbed from UV radiation promotes the scission of the carbonate linkage, forming two primary free radicals according to the photo-Fries mechanism. The free radicals then rearrange to form other molecules. Oxidation of these molecules results in substances such as ortho-dihydroxybenzophenone or diphenoquinone which absorb in the blue range and are responsible for the yellowing observed in photo-degraded samples.

Purified Terephthalic Acid (PTA)

Polymer grade terephthalic acid (TA) is one of the basic building blocks in the production of linear polyester resins used in the manufacture of polyester fibers, polyester film, packaging materials and bottles. PTA used in the manufacture of polyester resins must meet certain minimum purity requirements. The purified condition of terephthalic acid refers primarily to the absence of significant concentrations of 4-carboxybenzaldehyde (4-CBA), p-toluic acid and other aromatic compounds such as benzyls, fluorenones and/or anthraquinone that impart a characteristic yellow hue to the crude material

Polyethylene Terephthalate (PET)

Gray and/or yellow discoloration may occur during repeated heating of poly (ethylene terephthalate) (PET). The antimony content present in catalyst residues used in PET synthesis has high influence on the gray discoloration obtained during the reprocessing of PET. The yellow discoloration is partially generated by polyamide contaminants which are used as barrier layers in PET packaging materials such as soft drink bottles.

Yellowness Measurement

The yellowness index (YI) is a spectrometric calculation that is used to describe any change in color of a test sample clear (white) toward yellow. In industries, yellowness is measured in terms of “delta YI” which is denoted as ΔYI. This test is mainly based on determining the difference in color of a product at any given point in the product’s life cycle versus the original product.

Yellowness indices are used to quantify liquids and solids in transmission and opaque solids in reflectance.

With in-line yellowness measurements taking place directly in the manufactured product, not only is complete documentation possible, but when degradation occurs, immediate intervention can take place. The IPS eliminates many steps off the offline method and the measured results are available in real time.

PHOTO 2. IN-LINE PROCESS SPECTROPHOTOMETER (IPS)

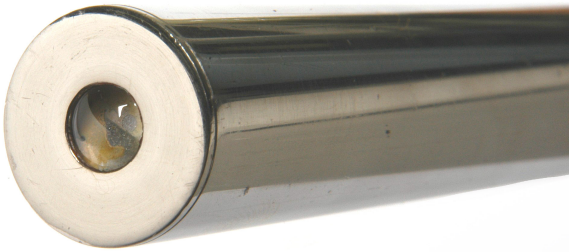

PHOTO 3. COLOR PROBE

Innovation

The Equispec In-Line Process Spectrophotometer (IPS) is a high-performance instrument designed for use in an industrial process. Its excellent sensitivity and flexibility make it useful process applications involving process lines or mixing tanks. The analyzer and process probes are designed to be used in high-temperature, high-pressure and corrosive environments. It can analyze powders (solids), liquids, gases, or slurries depending upon the process probe that is employed. This system is perfect for monitoring yellowness index or b* of polymers or powders including purified terephthalic acid (PTA) during or after the drying of material.

USER BENEFITS

- Real-time monitoring yellowness and b* of liquids & powders
- Real-time monitoring product purity and clarity
- Accountability tracking for sensitive materials
- Waste reduction
- Reaction optimization

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