



Application Note AN N230

FT-NIR-Spectroscopy for Process Monitoring of Polymers

Modern product management philosophies like “Total Quality Management” or “Zero Defect Operation” share the same aim: To produce highest quality as quickly as possible for the least possible expense. This is why in recent years, the need of online monitoring of chemical reactions and production flows became more and more important. The polymer and plastics industry needs fast, reliable, non-invasive and cost effective analytical methods for process control.

FT-NIR spectroscopy has a distinct advantage compared to other technologies: It provides a real-time assessment of the process on a molecular basis. The recorded spectra relate directly to the composition of the material. With the use of fiber-coupled probe heads, the “eye” is brought straight into the area of interest without interference in the production process. The spectrometer itself can either be installed alongside the measurement point or further away in the analysis house.

Modern control software hands the data over to the process control system and if the product is running out of specification, it will be detected within seconds and corrective measures can be carried out. With the classical off-line analysis, several hours can pass before the sample

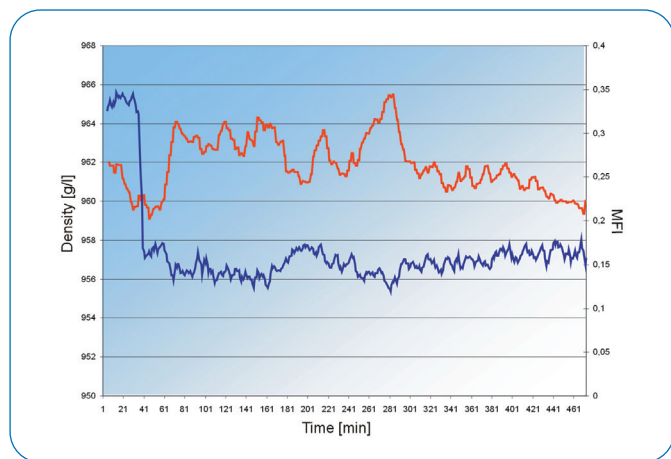


FT-NIR Process Spectrometer MATRIX-F with Probe an sensor head

is analysed. During that time the production of material with unknown quality continues; the longer the analysis time, the more waste could be produced.

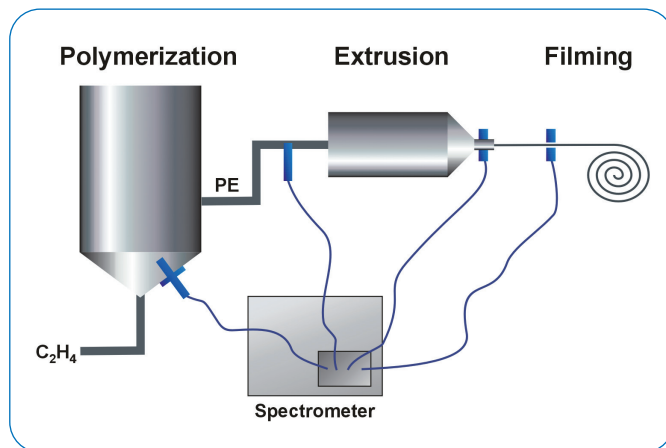
Recent advances in the development of new high temperature and high pressure probes allow the adaptation into various processes. The classical transmission probes of stainless steel or Hastalloy with sapphire windows are suitable for most translucent liquid systems. When the system is more scattering or opaque, like polymer melts,

powders or pellets, diffuse reflection probes are favored. With direct insight into the molecular structure of the material, parameters like OH-number, NCO-content, Acid-value, or the content of free monomers can be determined. But also the analysis of physical properties is possible. A typical application is the simultaneous monitoring of density and Melt Flow Index of Polyethylene. These parameters are crucial for the processing of the material, like extruding or moulding, making them the most frequently determined parameters in the quality control of polymers.



Real-time Monitoring of Density (red) and MFI (blue)

A good example for the complete monitoring of a polymer process is the production of a polyethylene film. The progression of the polymerization can be monitored with a diffuse reflection probe directly in the vessel. The material quality can also be analyzed in the pipe before entering the extruder. At the outlet of the extruder,



Monitoring a complete Process with FT-NIR

a transmission probe checks the polymer before it is processed. A quality control of the finished film before coiling up detects irregularities and defects effectively.

Instrumentation

Bruker Optics offers a wide variety of instrumentation to meet your specific needs. For process applications, the FT-NIR spectrometer MATRIX-F is recommended. Its multiplexing capability, ruggedness and easy serviceability make it the perfect process system.

Various process measurement accessories are available for contact and non-contact measurements of liquids, solids and slurries. Near-infrared sample spectra can be collected from driers using diffuse reflectance probes or non-contact sensor heads.

The use of fiber optics makes it possible to locate the instrument in either an enclosure in a hazardous location close to the measurement sites or in a control room. In a process environment the MATRIX-F can be used along with our process software CMET to perform the measurement and analysis of the sample and also output the results via a variety of I/O options (4-20mA, Modbus, Profibus DP, OPC DA etc).

Applications for Polymers:

- OH-Number
- Acid-value
- Amine-value
- NCO Content
- Dry Extract
- Residual Moisture
- Free Monomer Content
- Melt Flow Index
- Density
- Viscosity
- Melting Point
- Degree of Polymerization
- Cross Linking
- Tacticity
- End Group Determination

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