QUALITY MONITORING - ON-LINE / OFF-LINE

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Chips & Snacks
Formed Products to End-of-Line
NDC Technologies

Owned by spectris

- NDC Technologies is part of the “In-line instrumentation business group”
- Malton, Essex, UK – NIR gauges for food and bulk materials measurement
- Irwindale, California, USA – scanning systems for packaging materials
- Dayton, Ohio, USA – laser based measurement systems for cables and tubing
- Loncin, Belgium – surface quality systems for metals

Definition of terms

- **On-line device** – an instrument that measures continuously in the process in real time, displaying outputs, and/or transmitting outputs to the process control system. It is calibrated to agree with the local reference method, so that lab and process have same data
- **Off-line Device** – an instrument typically used in the processing area in which samples brought to it from the process are tested by production personnel. It is calibrated to agree with the local reference method so that lab and process have the same data

Presentation overview

- Key drivers: quality, service, operational and financial perspectives
- Measurements available
- Technology choices and suppliers – pros and cons
- Differences in on- and off-line approaches
- Features of the different technologies available and their benefits
- Making the choice between on- and off-line
  - capital and consumable costs
  - maintenance and staff capabilities
  - quality improvement and product consistency
  - flexibility
- Current state-of-art – and what the future holds
- Practical aspects
  - installation and maintenance
  - calibration
  - closed-loop control
  - environmental issues
Available measurements

- "Direct" measurements on-line
  - Moisture (Water content)
  - Fat or oil content
  - Colour
  - Degree of baking or frying

- "Indirect" measurements on-line
  - Salt content
  - Flavouring levels

- Laboratory measurements
  - Moisture (water content)
  - Fat or oil content
  - Colour
  - Salt content
  - Flavouring levels
  - pH
  - Ash etc etc

Moisture content vs degree of browning

Key drivers

- Consistent desirable snacking experience
- Consistent and efficient production
- Best “asset optimisation”
- Reduction of waste
- Avoidance of acrylamide development
- “You can’t control what you can’t measure”
Quality, service, operational and financial perspectives

► “Fit and forget”
► Minimal calibration effort – preferred "pre-calibrated"
► Support contracts
► Non-skilled “ownership” in daily use
► Low cost of ownership, and good ROI

Technology choices and suppliers – pros and cons

► Filter based (<€20k):
  ▶ Fixed spectrum
  ▶ Multi-component
  ▶ Can incorporate visible spectrum for brownness
  ▶ Typically pre-calibrated
  ▶ Use of longer wavelengths
  ▶ Long term stability
  ▶ Long life Source 40k hours
  ▶ Easy to integrate
  ▶ Process orientated, not R&D
  ▶ Additional components not easy to add

► Diode array based (>€30k):
  ▶ Broader spectrum
  ▶ Multi-component
  ▶ Can incorporate visible spectrum for brownness
  ▶ Require “database” creation
  ▶ User shorter wavelengths
  ▶ Require hourly re-standardising
  ▶ Source life 10k hours
  ▶ Need a dedicated computer
  ▶ More suited to R&D
  ▶ Potential to use existing hardware for new measurements

Technology choices – how it works

► Near infrared spectroscopy:
  ▶ Based on the phenomenon that certain molecular bonds in water and other constituents are excited by and therefore cause absorption of certain wavelengths of infrared light (energy). If we can emit these wavelengths and measure how much energy is absorbed, since the absorption is proportional to the amount of constituent present, we can make effectively measure the constituent content.
Technology choices – how it works

Laboratory reference

Perfect calibration line $Y=X$ or Gauge = Reference

Slope, $M = \frac{Y}{X}$

Intercept = C

Calibration line $Y = MX + C$
Technology choices – the key objectives?

► Avoid the delays associated with laboratory tests
► Empower production personnel to make informed decisions
► Achieve process automation

Target

Moisture

Critical Moisture Limit

Process nears out-of-spec condition and corrected by control system

Grab #1
Grab #2
Grab #3

Actual out-of-spec product

Developed Product

Technology choices and suppliers – pros and cons
Technology choices and suppliers – pros and cons

Measurements available: moisture, fat, colour, flavour, salt, texture, etc

- **On-line measurements:**
  - Moisture
  - Fat/Oil
  - Colour/Brownness
  - Flavour/Spice
  - Salt
  - Sugar
  - Protein

- **Off-line measurements:**
  - Moisture
  - Fat/Oil
  - Colour/Brownness
  - Flavour/Spice
  - Salt
  - Sugar
  - Protein
  - Texture

Differences in on- and off-line approaches

- Continuous
- Real-time
- Process connected
- Large representative quantity
- Accurate measurement

- Requires sampling
- Historical data
- Disconnected
- Small sample
- Precise measurement
Making the choice between on- and off-line

- Capital and consumable costs
- Maintenance and staff capabilities
- Quality improvement and product consistency
- Flexibility

Practical aspects of on-line monitoring

- Installation and maintenance
- Calibration
- Closed-loop control
- Environmental issues
- Ability to withstand the conditions in the snacks process

Practical aspects of on-line monitoring: What questions to ask!

- Is it pre-calibrated and if not, what resource do I need to calibrate it?
- Is it designed for the process? Sealing to IP65/7? Ambient temperature? Product height changes? Seasonal/crop influences?
- Product flow – product presence/absence recognition
- Interface – for supervisor, for operators
- Connectivity – digital, analogue
- Long-term stability? Service intervals? Consumable parts change frequency?
- Local support? Competence level
- MTBF? Cost of support? Warranty period. Service contract delivery
- References – are they instrumentation suppliers or are they “snacks people”?