Film Inspection: The Gel Count Standard
What resolution and defect detection can be realised and make sense
- with practical examples

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  (Optical, Pharma, Technical, Diaper, Food & Surface Protection Films, Extrusion Coating Alu Boards)
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Web Inspection in Film Extrusion

100 % Optical Control of the Web

- Photo of every defect
- Position of every defect
- Database Interface
- Reports
- Alarms
Advantages of Web Inspection

- **Process Control**
  (cleaning, waste, reduction of downtime)

- **Raw Material**
  (control material + recipe)

- **Product**
  (better quality, less claims, more competitive products)

Considerable Cost Savings!!
Definition Gel
Inspection Standard of the Polymer Industry

Additives → Process
Raw material → Process

Feedback:

Determination of the process parameters

Production → Sampling

On-line Quality Assurance

Data (opt. measuring technique)

Process computer
Online Quality Control
Online Laboratory
Online Anticipation of Plant Shut Down
Online Control of Extruder Start Up

![Graph showing extruder startup after plant restart, start extruder cleaning, stop injection cleaning agent, and stop extruder rinsing.](image)
Benefits of Online Control

- **Process Control**  
  (Optimisation, capacity, cleaning, waste)

- **Raw Material**  
  (Optimisation material + recipe, control material)

- **Product**  
  (better quality, customer satisfaction/relation, less claims, more competitive products)
Defect Types

- Gels
- Black Specs
- Contaminations
- Die Lines
- Insects
- Calander Defects
- Oil Stains
- Air Bubbles
- etc.
Origin of Defects

- Extrusion Line 20%
  (screw geometry / dead zones)

- Resin 25%
  (contamination, recipe)

- Production Process 15%
  (extruder temperatures, screen change)

- Pellet Transport 40%
  (external/internal)
Practical Examples
- Optical Films & Sheets
- Pharma Films & Coatings
- Technical Films
- Diaper Films
- PET Food Films
- Surface Protection Films
- Extrusion Coating on Alu Boards
Optical Films & Sheets

- Product: Optical Film & Sheet & Coatings
- \( W = 1400 - 2500 \text{ mm} \)
  \( V = 3 - 80 \text{ m/min.} \)
- Defects:
  - gels, black specs, fish eyes
  - optical distortions, lenses, flow/die lines, scratches
- Resolution Range: 25 – 100 \( \mu \text{m} \)
- Defects Specs: various
Darkfield Inspection
Optical Distortion Inspection
Optical Distortion Inspection: Lens
Closed Frame Optical Films 50 µm res.
Closed Frame
Pharma Films & PVDC Coatings

- **Product:** PVC Pharma Films & PVDC Coatings
- **W =** 1400 - 2500 mm
  **V =** 100 - 200 m/min.
- **Defects:**
  gels, black specs, fish eyes, holes, insects
  inclusions, coating voids, coating structure defects
- **Resolution:** 200 µm
- **Defect Specs:**
  1 defect < 1 mm² per 10 m²
  0 defect > 1 mm² per 10 m²
Pharma Films & Coatings
Inclusion
Coating Structure
Technical Films

- **Product:** Technical Films

- \( W = 1400 - 2600 \text{ mm} \)
  \( V = 100 - 200 \text{ m/min.} \)

- **Defects:**
  - gels, black specs, fish eyes, holes, insects

- **Resolution:** 100 - 200 \( \mu \text{m} \)

- **Defect Specs:** various
Closed Frame Blown Film
Time History (Gel Level)
Rolling Map / Die Defect
Diaper Films

- **Product:** Diaper Films
- **Width:** $W = 1400 - 2600$ mm
  - **Velocity:** $V = 200 - 600$ m/min.
- **Defects:**
  - gels, black specs, fish eyes, holes, insects
- **Resolution:** 500 µm
- **Defect Specs:** 1 mm
Slit Alarm

F1 - Cde marche
F2 - Cde stop
F3 - Données de la cde
F4 - Configuration
F5 - Laize de la bande
F6 - Mosaique

Active Alarms -> 1

Tableau | Carte de défaits | Mosaic | Défilement horaire | Distribution de réseau local | Bruitage | Répartition de voie active
---------|-----------------|--------|-------------------|----------------------------|----------|------------------------
32736µm 841.668µm unknown
34856µm 554.211µm unknown
20379µm 328.178µm unknown
28883µm 691.939µm unknown
31024µm 755.936µm unknown
38136µm 1142.280µm unknown

Attention Quelques valeurs d’enregistrement ne peuvent

Station : 1 | Configuration OK!
Gap : 0 (0 -> 0)
Disk space : 10.3 GByte (C:\DATA)
Printjobs : 0
Def: 0 Mos: 0 (GB)
PET Food Films

- Product: PET Food Films
- Width: $W = 1400 - 2600$ mm
  - Velocity: $V = 200 - 250$ m/min.
- Defects:
  - gels, black specs, fish eyes, holes, insects
- Resolution: 200 - 500 $\mu$m
- Defect Specs: visible
PET Food Films
Alarms / Repeating Defect
Surface Protection Films

- Product: Surface Protection Films
- $W = 1400 - 2600 \text{ mm}$
  $V = 100 - 250 \text{ m/min.}$
- Defects:
  - gels, black specs, fish eyes, holes, insects
- Resolution: $60 - 160 \mu\text{m}$
- Defect Specs: $1 \text{ mm}$
- Defect Height: factor $1.1 - 1.5$ times film thickness
Surface Protection Films
Defect Results

Fish-eye in a 3-layer Coex Film
Defect Results

Aluminium/Film Laminate with Contamination
Extrusion Coating on Alu Boards

- **Product:** PE Coated Aluminium Board

- **W =** 1400 - 2800 mm  
  **V =** 500 - 600 m/min.

- **Defects:**  
  PE spots, black spots, coating spots,  
  aluminium splices, missing coating,  
  aluminium peel-off, paper board creases

- **Resolution:** 350 µm
High Power COB LED 3.000 mm Extrusion Coating Alu
Metal Splice
Oil Drop
Burst Bubble
Wrinkle
Conclusion:
General Specifications (Resolution)

- PET Food Films: Ø 200 - 500 µm
- Technical Films: Ø 100 - 200 µm
- Surface Protection Films: Ø 60 - 160 µm
- Optical sheets + films: Ø 25 - 100 µm
- Extrusion Coating: Ø 350 µm
- Diaper Films: Ø 500 µm
- Pharma Films: Ø 200 µm
Thank you

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