TUT Paper Converting and Packaging Technology Laboratory

- Two environmental test chambers (23-38°C / 50-90%RH, volume 120l)
- Barrier measurements:
  - \( O_2 \) TR: MOCON Ox-Tran 2/21 MH and Ox-Tran 2/21 SS
  - WVTR: MOCON Aquatran 1G and Cup test (ASTM E96-10)
  - \( CO_2 \) TR: MOCON Permatran-C 4/41
  - Grease resistance (ASTM F119-82)
- Dual column material testing machine: Strength properties and adhesion measurements (90° and 180° peel)
- Contact angle and surface energy (KSV CAM200 and Pocket goniometer PG3)
- Heat sealability:
  - Hot bar sealing and hot tack (KOPP SGPE 20 laboratory sealer)
  - Hot air sealing
- Coefficient of friction (Qualitest FX7100-V)
- FTIR with ATR unit
- Optical microscope with polarisation contrast + microtome
- Extrusion rheometer
- K control sheet coater
- Brookfield viscometer
- Creasing – perforating machine (Cyklos GPM4 50)
- Package testing:
  - Hydrogen leak detector H2000
  - PBI Dansensor CheckPoint O2/CO2

18.11.2015
Water Vapour Transmission Rate (WVTR)

- Gravimetric Cup – Method, SCAN P22:68 (ASTM E96)
- i.e. The Desiccant Method (e.g. anhydrous calcium chloride or Silica gel)
- Sample stored in specific test conditions: for example 75% RH ja 25°C
- WVTR [g/m², 24h]

MOCON AQUATRAN MODEL 1G
HIGH SENSITIVITY COULOMETRIC WATER VAPOR TRANSMISSION RATE TEST SYSTEM

- Bases on coulometric phosphorous pentoxide sensor
- WVTR range: 0.0005 – 5 g/m²/d
- Test temperature range: 10 – 40 °C
- Relative humidity range: 35 – 90, 100 %
- DIN 53122:2
**TUT Paper Converting and Packaging Technology - Barrier Measurements**

**Oxygen Transmission Rate (O$_2$TR)**

**MOCON Ox-Tran 2/21 MH + SS**

**Standard Oxygen Transmission Rate Testing System**

- Bases on coulometric sensor
- O$_2$TR range:
  - Unmasked: 0.05 – 200 cm$^3$/m$^2$/d
  - Masked: 0.5 – 2000 cm$^3$/m$^2$/d
- Test temperature range: 10 – 40 °C
- Relative humidity range: 0 (SS), 35 – 90 % (MH)
- Edge leakage adaptors for coated papers/boards
- Package testing adaptors
- ASTM D3985 (films), ASTM F1927 (films), ASTM F1307 (packages)
Oxygen Transmission Rate (O$_2$TR)

- Oxygen is brought on the surface side of the sample and the carrier gas on the backside will collect the oxygen that has migrated through the sample.
- The volume of the migrated O$_2$ is measured.
- OTR [cm$^3$ / (m$^2$, d, bar)]

---

**Diagram:**
- Oxygen input (O$_2$ in)
- Nitrogen input (N$_2$ in)
- Oxygen exhaust (O$_2$ exhaust)
- Test barrier
- Sensor
- Load resistor
- Recorder
- Diffusion cell

---

18.11.2015
Carbon Dioxide Transmission Rate (CO₂TR)

**Mocon Permatran-C 4/41**

**Standard** carbon dioxide transmission rate testing system

- Bases on infrared sensor
- CO₂TR range:
  - Standard: 1 – 10 000 cm³/m²/d
  - Masked: 10 – 500 000 cm³/m²/d
- Test conditions: T = 15 – 50 °C, RH = 0%

*More info on the following slides →*
MOCON PERMATRAN C 4/41

- Determination of carbon dioxide transmission rate through papers, films, packages,…

- 1 - 10 modules, computer & printer

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Minimum testing temperature / °C</td>
<td>5 ± 0.5</td>
</tr>
<tr>
<td>Maximum testing temperature / °C</td>
<td>50 ± 0.5</td>
</tr>
<tr>
<td>Testing relative humidity / %</td>
<td>0 %</td>
</tr>
<tr>
<td>Operational environmental temperature/ °C</td>
<td>22 ± 2 (±1 per hour)</td>
</tr>
<tr>
<td>Operational environmental relative humidity / %</td>
<td>20 - 80</td>
</tr>
<tr>
<td>Minimum CO₂ transmission for 50 cm² film / cm³/(m² - day)</td>
<td>1 (repeatability ± 0.5 %)</td>
</tr>
<tr>
<td>Maximum CO₂ transmission for 50 cm² film / cm³/(m² - day)</td>
<td>8000 (repeatability ± 0.2 %)</td>
</tr>
</tbody>
</table>
Testing of flat films

- A module contains test cells (A and B) and a reference cell (R)

- Two samples can be tested at a time, reference film is tested for comparison

Special cases:
- Unsymmetrical layer structure: testing direction should be considered
- Very high or low transmission rates
- Foil masks reduce the sample area and thus lower the transmission rate

Sample divides the cell into chambers
- Outer chamber: CO2 (test gas)
- Inner chamber: N2 (carrier gas)
• CO2 permeates through the film and is lead with N2 through an IR sensor

• Voltage that is proportional to the CO2 concentration is produced and CO2 transmission is calculated

• ASTM standard F2476-05: Standard Test Method for the Determination of Carbon Dioxide Gas Transmission Rate (Co₂TR) Through Barrier Materials Using An Infrared Detector
  • Conditions, calibration, measuring, calculation, accuracy analysis

• Testing of packages
  • Rigid packages and flexible pouches, empty or filled
  • Testing in room air is possible but not recommended: special chambers exist
• **Grease barrier testing** according to ASTM F119-82
• Visual analysis of penetration of test grease, for example olive oil
• Analysis of time in which the grease has penetrated through the sample (minutes/hours/days..)
Dimensions of sealing bars: 5 x 100 mm
Sealing temperature up to 300 °C
Sealing and cooling times: 0,2 – 99,99 s
Sealing force: 0 – 1000 N
Seal strength and hot tack testing:
  - Sample dimension (approx.): Length: 90 mm
    Width: 45 mm
    Thickness (max.): 0,5 mm
  - Tractive speed: 2,5 – 25 m/min
  - Tensile strength measurement range: 0,5-200 N
TUT Paper Converting and Packaging Technology – Hot air sealing

- Hot air sealing machine to simulate e.g. side sealing of carton cups
TUT Paper Converting and Packaging Technology
- Friction properties & Surface Energy

KSV CAM 200
- Optical contact angle and surface tension meter
  - Automatic motorized 4 liquid dispenser
  - Motorized sample stage
  - Digital CCD fire-wire camera (60 fps)
  - 1 or more test liquids can be used

QUALITEST FX-7100-VS
Coefficient of Friction (COF) tester
- Measurement ranges: 0-250, 0-500 and 0-2000 gf
- Variable speed: 25 – 500 mm/min
- ASTM D1894