ODOUR AND SOLVENT RETENTION IN PACKAGING PRINTING
OVERVIEW

- Why and what we smell
- How to test
- What has that to do with packaging
  - Some examples for typical impact of components of packaging (incl. ink)
- What can we learn from that
- Human senses have been developed and sharpened during evolution to help us survive
- Our nose helps us to identify threats to our health, avoid poisoning or attract us to the right food
- Direct connections into the unconscious part of the brain
- Smell may be associated with personal experiences and moods
- Our senses can get used to a certain stimulus – „if you had it long enough you don’t smell it any more“

AND

- Analytical identification of smelling substances may be extremely difficult
Our industries produce packaging materials for food, beverages, sweets, pharmaceuticals aso

Close contact of packaging to foodstuff

For EU Countries: Regulation (EC) No 1935/2004

This Regulation requires that no food contact material (whether printed or not) should endanger human health, change the composition of the food or alter the organoleptic properties of the food

This Regulation repealed Framework Directive 89/109/EEC

Objective is for every printer to supply material which meets the legislation and specific requirements of the package in question
SMELL AND TASTE

Smell „happens“ in our nose and brain.

It is volatile substances that smell, at sometime very low concentration.

Our tongues can distinguish only 5 different categories of taste: sweet, sour, salty, bitter and umami.

What man perceives in every day life as „taste“ is about 90 % „smell“.
Odour threshold is the lowest detectable concentration of a certain substance (mg/m³)

- **Red Pepper**
  - 2 kg in 50 railway waggons

- **Grapefruit mercaptan**
  - 1g in a swimming pool

- **Trichloranisol (TCA)**
  - 33 g Lac Leman (CH)
    (Cork smell)
<table>
<thead>
<tr>
<th>SOLVENT</th>
<th>odour threshold mg/m³</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ethylacetate</td>
<td>141</td>
</tr>
<tr>
<td>Ethanol pure</td>
<td>988</td>
</tr>
<tr>
<td>MEK</td>
<td>126</td>
</tr>
<tr>
<td>Isopropanol</td>
<td>491</td>
</tr>
<tr>
<td>Solvent Naphtha 80/110</td>
<td>448</td>
</tr>
<tr>
<td>Isopropylacetate</td>
<td>68</td>
</tr>
<tr>
<td>n-Propanol</td>
<td>16</td>
</tr>
<tr>
<td>Ethoxypropanol</td>
<td>0,3</td>
</tr>
<tr>
<td>Hexanal</td>
<td>0,001</td>
</tr>
</tbody>
</table>
- Comparison with not printed substrate; accepted quality of printed material
- Odour panel – trained people
- Man is mediocre in his ability to detect smell
RESIDUAL SOLVENTS IN THE LAB
RESIDUAL SOLVENTS AT PRESS SIDE
Potential threat for genuine taste of foodstuff from all components of a packaging material

- INKS / LACQUERS
- SUBSTRATE(S)
- RETAINED SOLVENTS
- ADHESIVES COLDSEALS

Secondary reactions with something from „outside of the package“ or crossreaction
- Corona treatment of coex OPP („Maggi“ or condiment smell)
- Aging of Polyefines and film additives
- Residual monomers in plastic films like PS
- Hexanal smell of paper or board
- Cellophanes „sulfur smell“
- Chemistry of ink system
  All parts of the formulation have to be selected carefully for low smell  
  (standard procedure in Siegwerk)
  Binders, pigments, additives
- Mostly used solvents
  Alcohols, Esters, Ketones, Retarders (Glycolethers)
  Monitoring by GC state of the art
  Ink manufacturer and printer buy solvents (incoming inspection !)
- Ink layer thickness: the more ink the higher the tendency to retain solvents
- Machine drying capacities
Kind of solvent (mixture)

Quality of solvents
  Impurities from manufacturing process of solvents
  synthetical Ethanol vs agraric Ethanol

Process conditions (printing speed, drying conditions)

Thickness of layers (viscosity, solvent mixture, engravings, aniloxes)

Retained solvent level to be monitored by GC

further information on the following slides
Redissolving, swelling of substrates
Acrylic coated films; PVDC coated films, Cellophane
PVC, Polystyrene

Kind of substrate: absorbing, Yes / No; coated, lacquered

Further information on the following slides
<table>
<thead>
<tr>
<th>SUBSTRATE</th>
<th>EtOH</th>
<th>EtOH/EAc</th>
<th>EAc</th>
</tr>
</thead>
<tbody>
<tr>
<td>Paper</td>
<td>35</td>
<td>35</td>
<td>20</td>
</tr>
<tr>
<td>Coex. BOPP</td>
<td>6</td>
<td>8</td>
<td>6</td>
</tr>
<tr>
<td>CN primed Alu</td>
<td>28</td>
<td>35</td>
<td>45</td>
</tr>
<tr>
<td>Polyamid</td>
<td>85</td>
<td>78</td>
<td>22</td>
</tr>
<tr>
<td>Cellophane (PVdC)</td>
<td>15</td>
<td>47</td>
<td>52</td>
</tr>
</tbody>
</table>

EtOH = Ethanol  
EAc = Ethylacetate  
Model printing ink under lab conditions; results in mg/m²
<table>
<thead>
<tr>
<th>ADHESIVES</th>
<th>COLDSEALS</th>
</tr>
</thead>
<tbody>
<tr>
<td>§ Smell of the binder system</td>
<td>§ typical genuine smell, Ammonia which is removed by thorough drying</td>
</tr>
<tr>
<td>§ Solvent based adhesives can also lead to retained solvents Redissolving into reverse printed inks.</td>
<td></td>
</tr>
<tr>
<td>§ It can make a difference in retained solvents if the adhesive is applied to printed substrate or not printed substrate</td>
<td></td>
</tr>
<tr>
<td>§ No such danger from solventfree adhesives</td>
<td>§ Smell of the binder system</td>
</tr>
<tr>
<td></td>
<td>§ Catalytical decomposition through copper ions; microorganisms</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>SECONDARY REACTIONS</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>„Cat piss“</strong></td>
</tr>
<tr>
<td><strong>TCA</strong></td>
</tr>
</tbody>
</table>
IMPACT OF RETAINED SOLVENTS ON FOODSTUFF

- Consistency of foodstuff
  - Coarse, fine, powdered, pasty, liquid

- Absorbancy of foodstuff
  - Fatty, dry

- Ratio of packaging material surface to filling weight
  - Chips, piece of meat

- Genuine smell of foodstuff
## A COFFEE BREAK

<table>
<thead>
<tr>
<th></th>
<th>WATER</th>
<th>GRINDED COFFEE</th>
<th>PIECE OF CHOCOLATE</th>
<th>SUGAR</th>
</tr>
</thead>
<tbody>
<tr>
<td>Consistency</td>
<td>liquid</td>
<td>dry brown powder</td>
<td>solid</td>
<td>cristals white</td>
</tr>
<tr>
<td>Chemical structure</td>
<td>polar</td>
<td>complex</td>
<td>fatty</td>
<td>water soluble</td>
</tr>
<tr>
<td>Genuine smell</td>
<td>none</td>
<td>strong, typical</td>
<td>typical, sweet to bitter</td>
<td>none</td>
</tr>
<tr>
<td>Known chemical composition</td>
<td>$H_2O$</td>
<td>complex mixture, identified Some 600</td>
<td>fat and butter type, complex aromas identified some 500</td>
<td>yes, Disaccharide</td>
</tr>
</tbody>
</table>
RESIDUAL SOLVENTS AS HEALTH RISK?

Coming back to Regulation (EC) No 1935/2004
Estimation health risk for typical packages with specific or global migration limits

5 mg/m² Ethylacetate (EAc) in chocolate bar (50 g) packaging

Under worst case conditions (100% transfer) → 0.1 mg EAc per chocolate bar

One apple contains 3-4 mg EAc (natural content)

You need to eat 30 to 40 chocolate bars to take in the amount of EAc which naturally occurs in one apple

No danger for human health from retained solvents in professionally produced packaging material

Some food brings more solvent with it than retained solvents from packaging (dry fruit, raisins contain often esters like Ethylacetate)

→ no sensorical impact
Smelling substances like perfume oils can be encapsulated and printed (gravure and offset)
SCRATCH AND SNIFF

Typical application advertisements free samples of perfume
CONCLUSION

- Smell is complex
- Possible threats for the respective foodstuff have to be excluded for combination of packaging materials, inks and adhesives / coldseals
- Food manufacturers do qualify packaging material together with converter
- Measures to safeguard sensorically flawless quality
  - Raw materials to be specified
  - Incoming inspection of solvents (sensorical test and GC)
  - Monitor machine parameters
  - GC for QC
  - and evtl sensorical tests (random sampling or even permanent)
  - All tests in comparison to accepted quality
THANK YOU FOR YOUR KIND ATTENTION!