Modelling of Migration of Laminates into Simulant D at High Temperatures

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Introduction and Aims

The use of packaging for high temperature purposes necessitates high requirements of the material. At the processing of food in the packaging material (sterilisation, pasteurisation) or the preparation of the food directly in the packaging temperatures near the melting point of the used sealing layers are reached. The aim of this investigation was to predict the influence of temperature, time and layer thickness on the overall migration (OM) of sealing layers at high temperatures (> 70°C) in contact with fatty food. Therefore a design of experiments was used. With the help of the results and non-linear regression the migration behaviour should be modelled.

Influence of temperature, time and layer thickness

The determination of the overall migrate with sun flower oil was carried out with a method established in our group.[1,2] Using a Box-Behnken-design the dependency of the migration of temperature (70/90/110 °C), time (30/60/90 °C) and layer thickness (40/50/60 µm) was determined (**Fig. 1**). For that only 15 migration experiments had to be carried out. The temperature showed the highest influence on the migration. Furthermore interactions between temperature and layer thickness was shown.

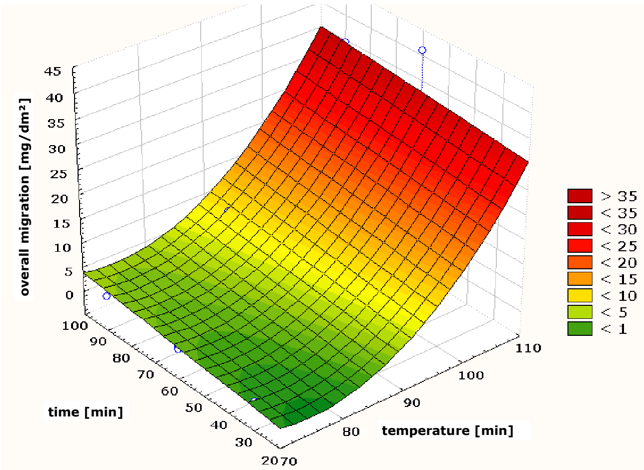

Fig. 1: 3D-Areaplot of the modelling of the overall migration for a layer thickness of 50 µm

For the modelling an equation was estimated with the help of non-linear regression. This equation allows to calculate the overall migrate at different temperatures, times and layer thicknesses (cf. box „application question").

Verification of the calculated model

In order to evaluate the estimated model extra experiments were carried out at 100 °C and different migration times and layer thicknesses. The values achieved by experiment have been compared to the calculated values of the model. The residuals (calculated values – experimental values) are shown in **Fig 2**. The divergence of the values is ±3 mg/dm². This is also the analytical tolerance given by DIN EN 1186-1 for fatty food simulant.[3]

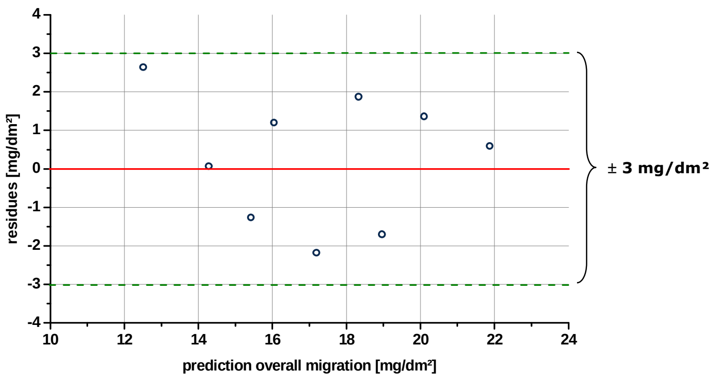

Fig. 2: Comparison of the experimental and calculated values at 100 °C

Comparison of the migration of sealing layer and composite film

The migration behaviour of a composite film and its corresponding sealing layer was investigated. **Fig. 3** shows the overall migration at different temperature-time combinations for a 75 µm PE sealing layer and the composite film build of it. The migration results showed no significant difference (α = 0.95).

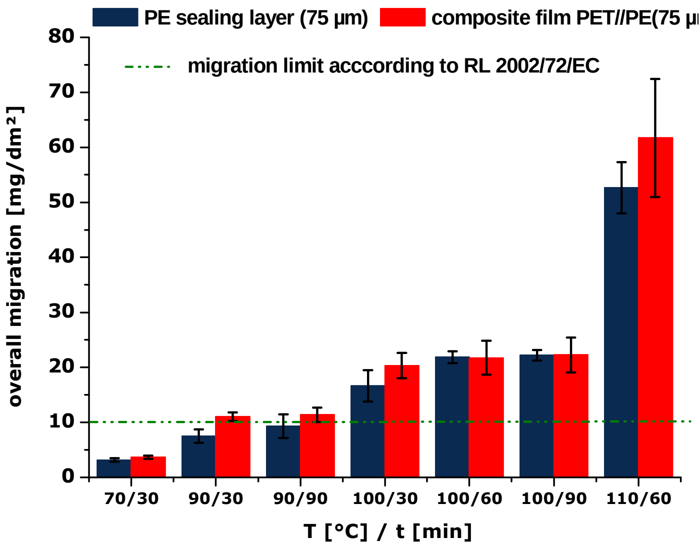

Fig. 3: Comparison of the overall migrate of a laminate and ist corresponding PE sealing layer

Hence it is possible to determine the overall migration behaviour of a sealing layer and to use this results for different composite films produced using the sealing layer.

Application question:

Will the OM comply with the 10 mg/dm² limit for

sealing layer thickness: 60 µm
time: 45 min
temperature: 85 °C ?

Calculation of the prediction value:

GM = -47,82663723 + 1,13555179 · **85°C** - 0,00666418 · (**85°C**)² + 0,05895837 · **45min** + 3,83254564 · **60µm** - 0,10084962 · **85°C** · **60µm** + 0,00065437 · (**85°C**)² · **60µm**

prediction value = **2,49 mg/dm²**

⇨ Complies to RL 2002/72/EC

Literature

[1] DIN EN 1186-11 (2002) [2] N. Paul et al.: Poster pesented on 35. Dt. Lebensmittelchemikertag in Dresden, september 2006 [3] DIN EN 1186-1 (2002)

Acknowledgement

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WIPAK