3D IMAGING OF THE TEXTURE EVOLUTION DURING CONVECTIVE DRYING OF SOFT SHRINKABLE MATERIALS

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DRYING of SOFT MATERIALS

SHRINKAGE

CRACKS

PRODUCT QUALITY?

FINAL TEXTURE?

Experimental set-up

Convective microdryer

X-Ray microtomograph

Skyscan-1074 X-ray scanner

• Source: 40 kV-1 mA
• Detector: 768 x 576 pixels
• 8-bit camera
• Spatial resolution: 41 µm

Approx. 3 min.

Material

SOFT MATERIAL = wastewater sludge
• Collected after secondary settling and thickening
• Mechanically dewatered in a laboratory filtration-expression-cell
• Extruded into small extrudate
• Diameter = 12 mm
• Height = 15 mm

Material preparation

Experimental set-up

3D reconstruction

2D Cross-sections

Binarised image

Corresponding filled binarised image

⇒ Equivalent diameter

⇒ Equivalent diameter + height

⇓ Shrinkage curve

Product quality?

Final texture?

Conclusions

X-ray microtomography is a very efficient non intrusive experimental technique to follow changes of size, shape and texture that soft material undergo during a drying treatment. The analysis of the internal texture of the dried samples reveals crack formation at the end of the drying process. The onset of crack formation is clearly related to the appearance of internal transfer limitations which bring about mechanical stresses causing the development of cracks. Further works are under development to characterize the internal moisture gradients by X-ray microtomography.

2D Image ⇒ 3D image

Relation between cracks formation and drying kinetics

1. External transfer limitations
   - Constant mass flux
   - No crack

2. Mixed external and internal transfer limitations
   - Mass flux decrease
   - Beginning of cracks development

3. Internal transfer limitation
   - Sharp mass flux decrease
   - Strong increase of cracks ratio

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