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Absorption of surfactants on porous media: Method development and Numerical prediction of surfactant distribution

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Media composition and structure play a fundamental role in the absorption of liquids into its porous media. Enhancing the absorption behaviour of such substrates is crucial for the printing industry to develop faster processes, better print quality and improving print durability. Absorption can among other be improved by tailoring the printing liquid. A common way to achieve this is by lowering the surface energy of interfaces by using surfactants in the ink composition. In this work we tackle the study of the influence of surfactants into porous media by developing a measurement method to extract surfactant concentration along the thickness of the paper and the developing of a numerical model that computes transport equations of surfactant during liquid uptake into capillaries

Microtomes are commonly used method to extract thin slices from porous media that can further be analysed. However, the usage of such method demands an extremely skilled operator and the accuracy of a microtome can often become a limiting factor. As an improvement on method development of the microtome method, a milling device is developed that can extract slices from several types of media very precisely. Subsequently, the composition of a water-surfactant mixture along the paper thickness was measured, using Karl Fischer titration to determine water content, and quantifying surfactants concentration using a Liquid Chromatography - Mass Spectrometry setup.

For modelling liquid update into porous media Darcy's law together with the continuum equation for incompressible flow was used to model the absorption process, and an advection-diffusion-adsorption equation was used to compute the surfactant concentrations. The influence of surfactants on the absorption rate was modelled using the Sheludko approximation as an equation of state which correlates the concentration at the interface to a change in solid-liquid surface energy. This model clearly shows that pore diameter, adsorption/desorption rate of surfactants into the solid interfaces and maximum surfactant concentration at solid interfaces are the predominant parameters that control absorption phenomena.

Combining both developments we can to show that there are fundamental differences between the absorption depth of surfactants on different porous media. This indicates that there is fundamental interaction between surfactants and the media which that can be further investigated using the developed model. This work clearly shows that depending on the surfactant interaction with the porous structure and the physical properties of both the porous medium and the surfactants we can have a situation where surfactants are transported along the wetting front or we can have a situation where the wetting front is depleted of all surfactants.

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References

Time Block Preference

Time Block A (09:00-12:00 CET)

Participation

Unsure

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