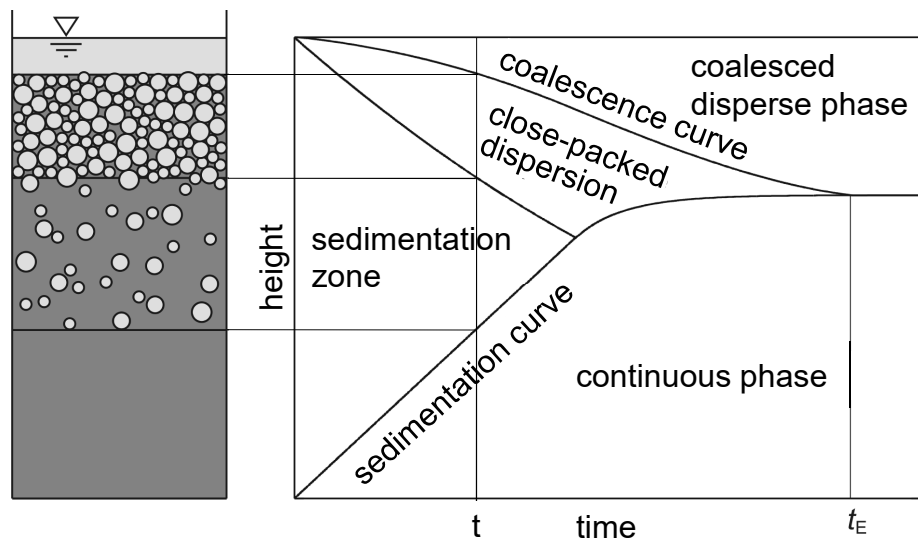


Drop-Based Settler-Design Tool Developed Based on Iso-Optical Systems

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general settler concept

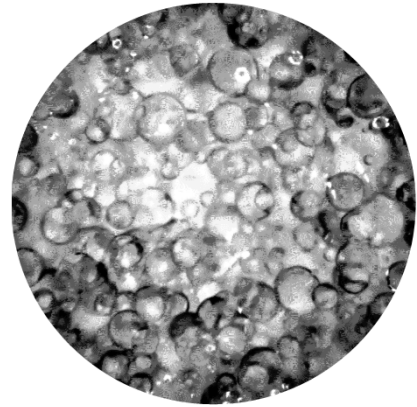


e.g.: Henschke, Schlieper, Pfennig, 2002: Determination of a coalescence parameter from batch-settling experiments. Chem. Eng. J. 85, 369-378.

3

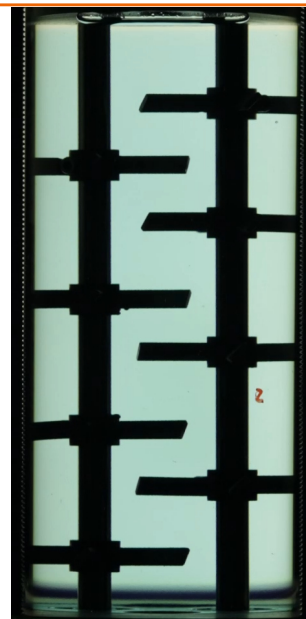


settling cell with SOPAT probe

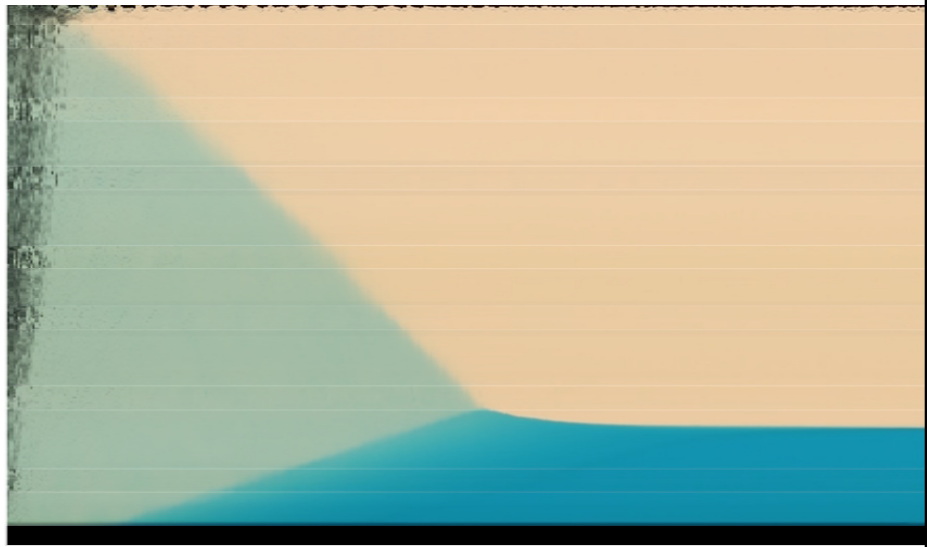


iso-optical system

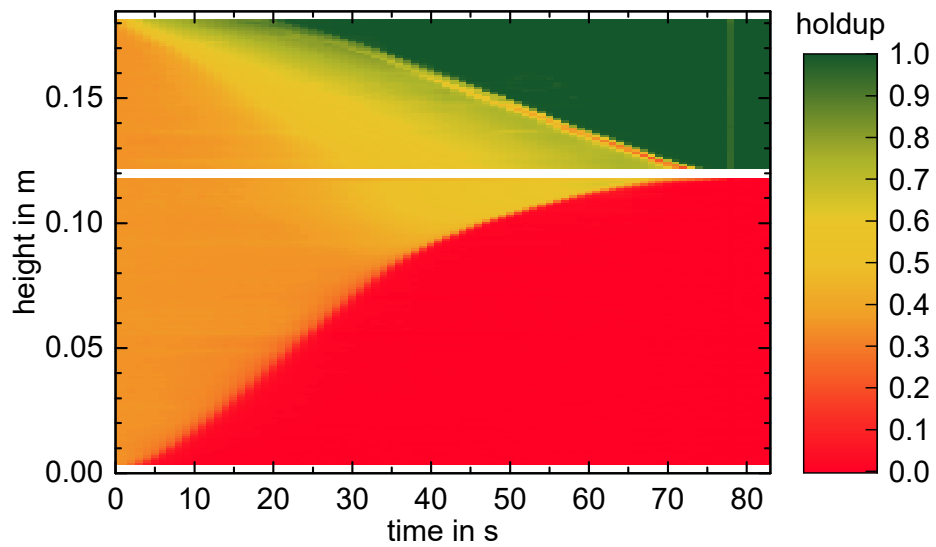
- water + ethylene glycol + hexane
- identical refractive index of phases
 - no refraction at interface
 - transparent dispersion



iso-optical system



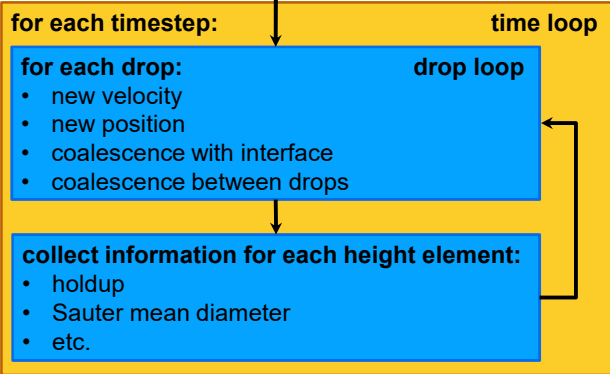
experimental holdup, initial holdup: 35 % organic



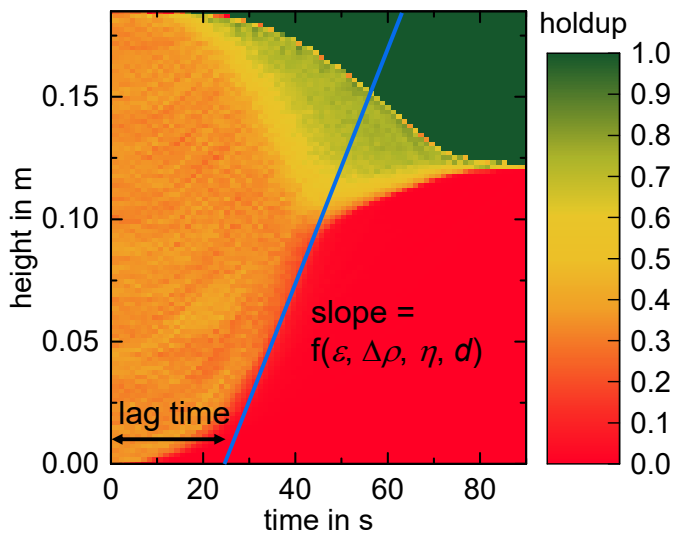
ReDrop: drop-based modeling

definition of system:

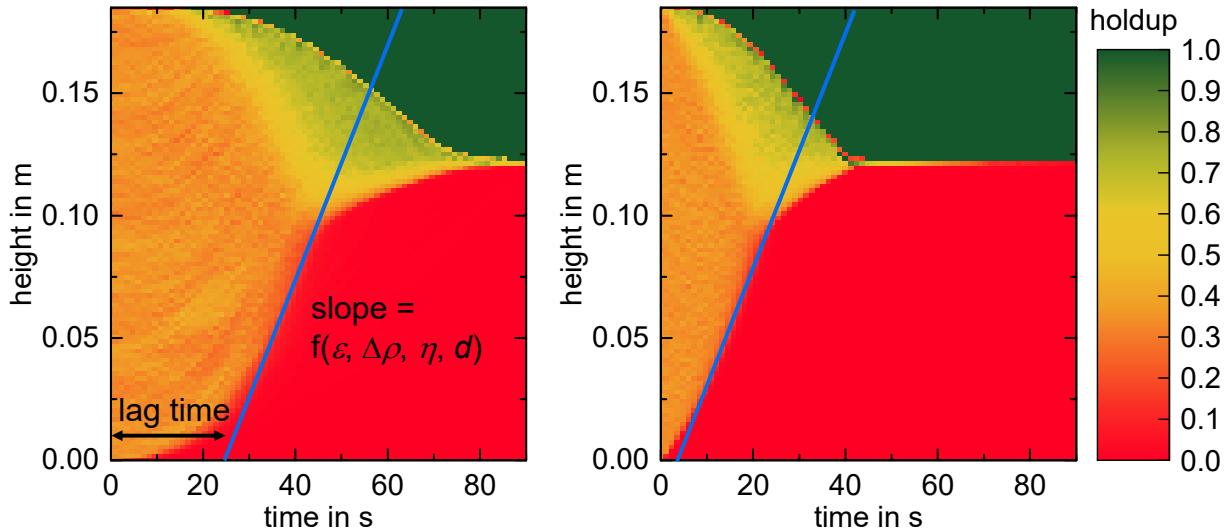
- material properties
- process variables
- simulation parameters
- set up arrays and system



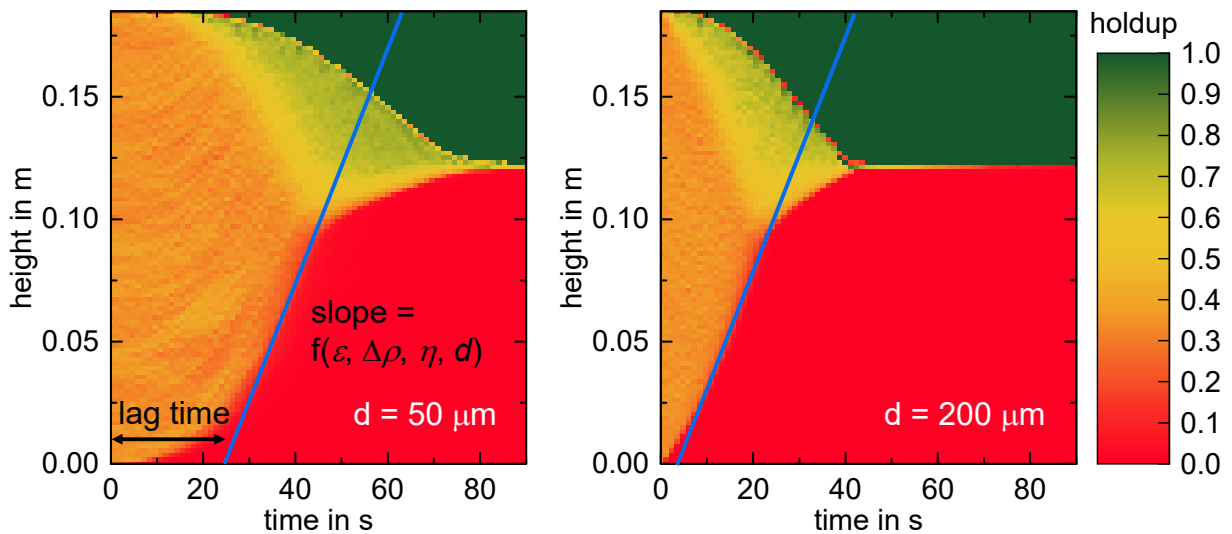
lag time & characteristic drop diameter



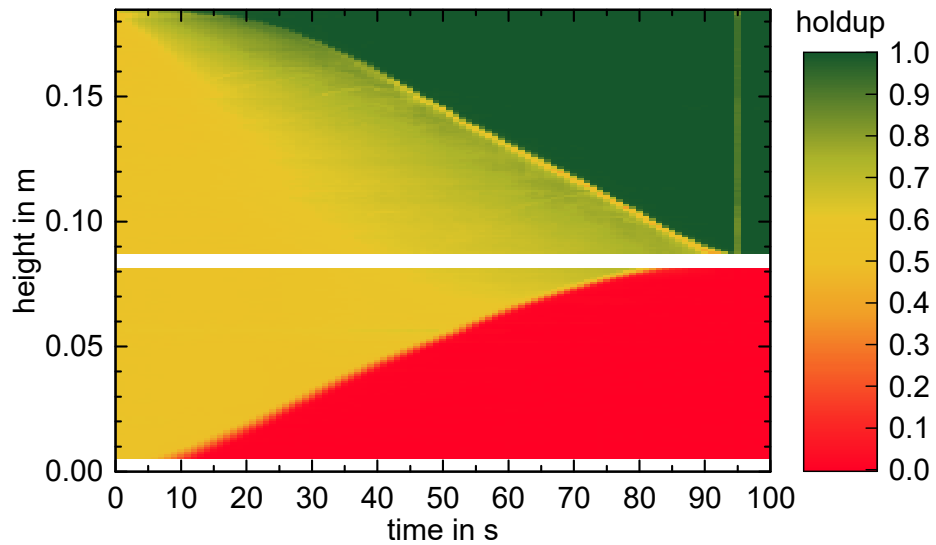
lag time & characteristic drop diameter



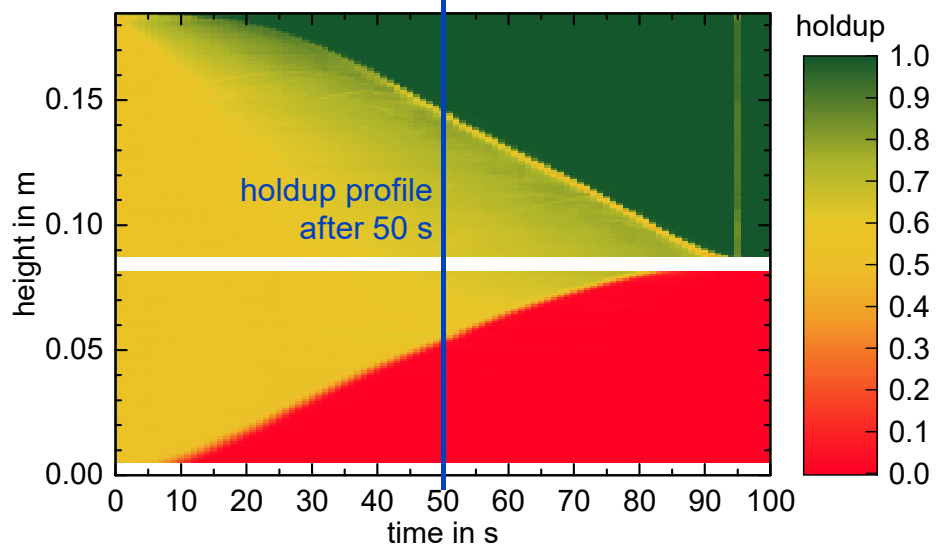
lag time & characteristic drop diameter



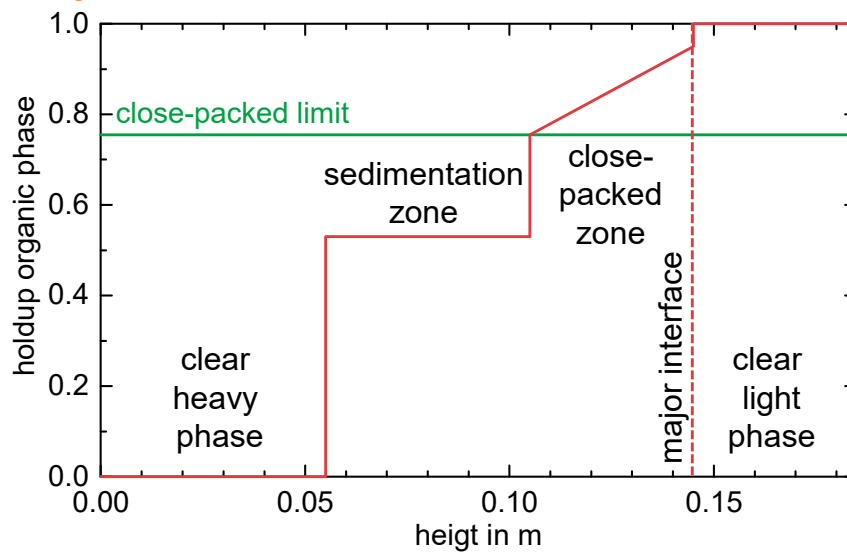
experimental holdup, initial holdup: 53 % organic



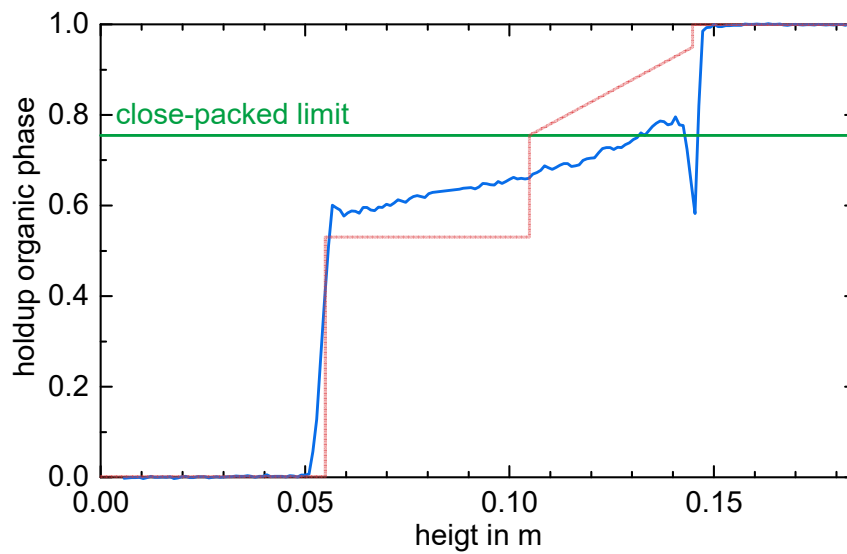
experimental holdup, initial holdup: 53 % organic



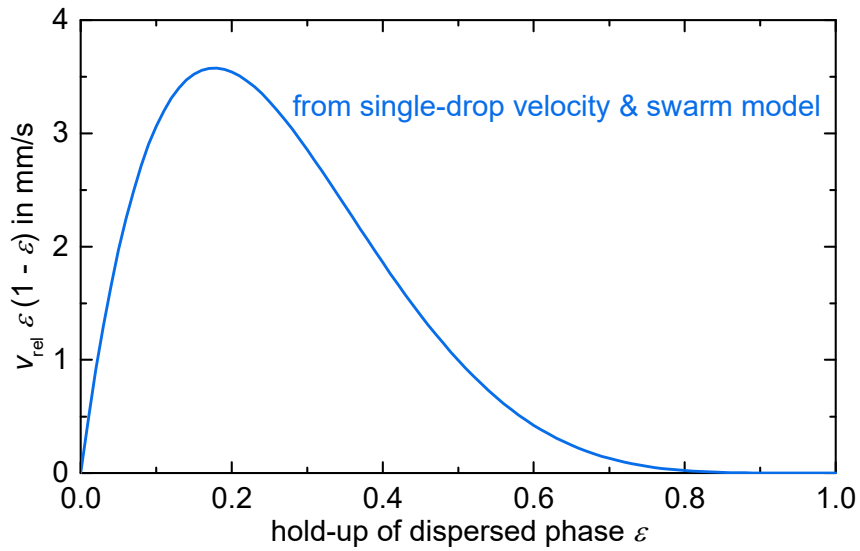
what we expect



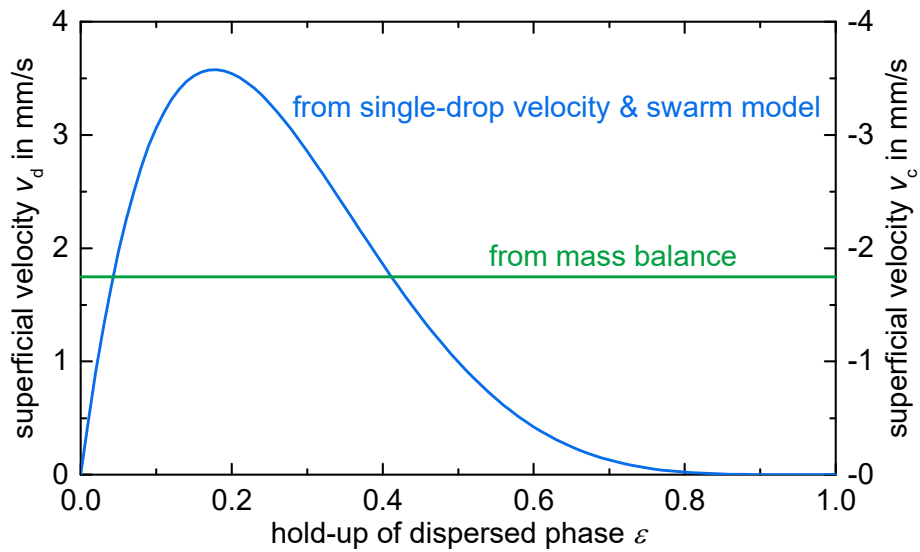
what we find



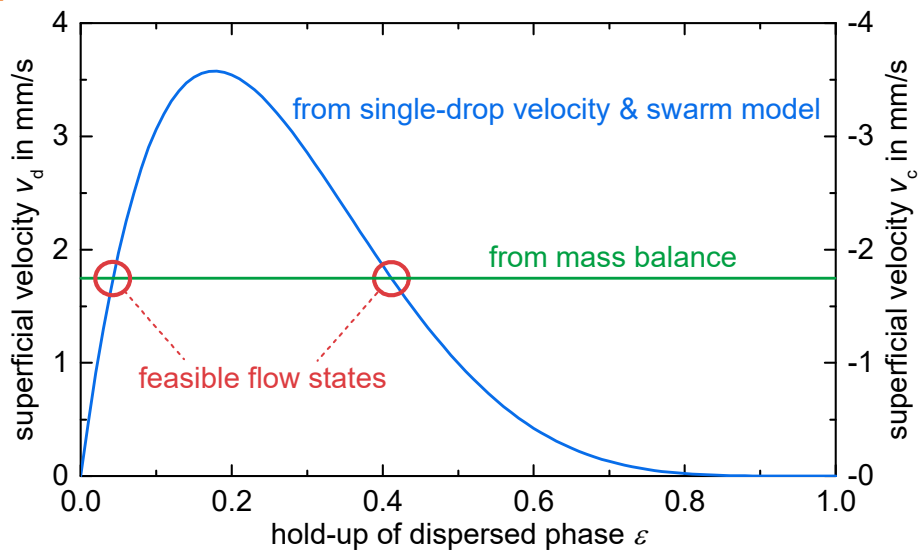
Wallis plot



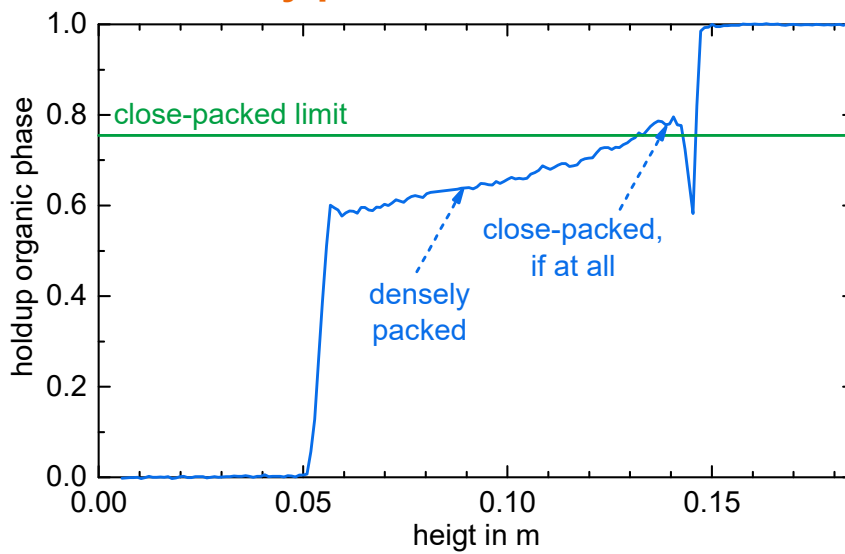
Wallis plot



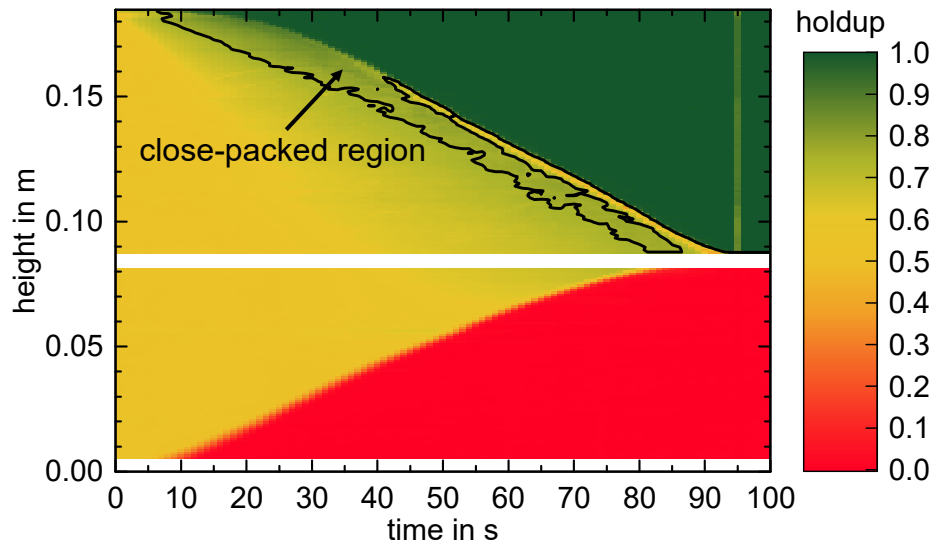
Wallis plot



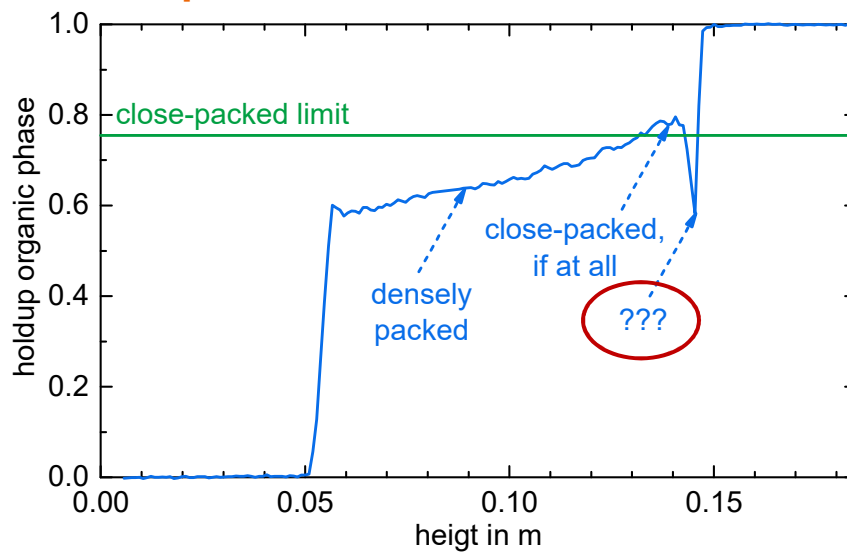
we find a wide densely packed zone



experimental holdup, initial holdup: 53 % organic

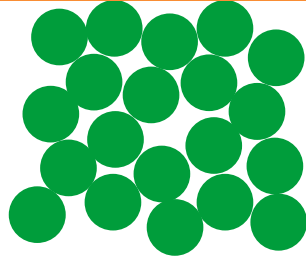


what is this bump?



at the interface

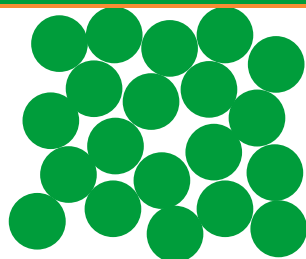
interface



before coalescence

at the interface

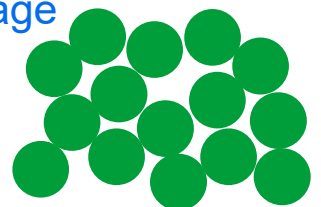
interface



before coalescence

interface

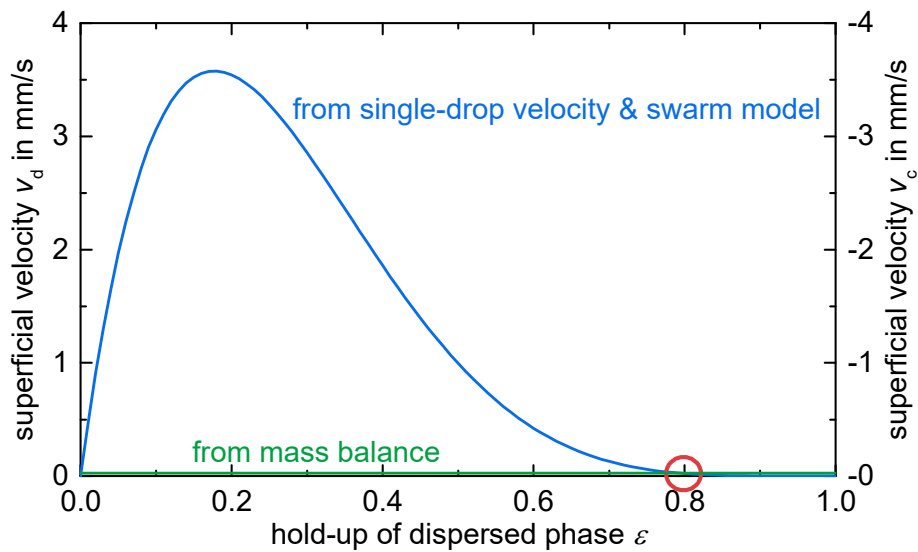
voidage



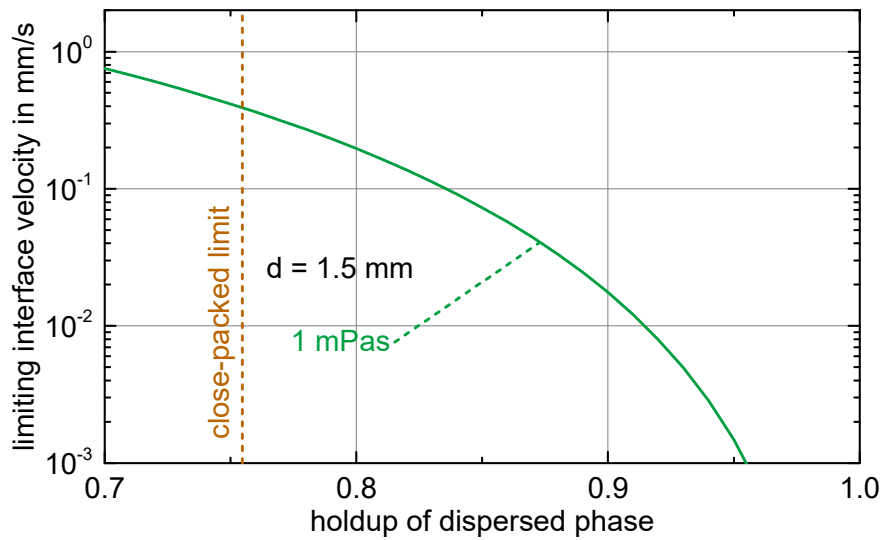
after coalescence

↑ dispersed phase
↓ continuous phase

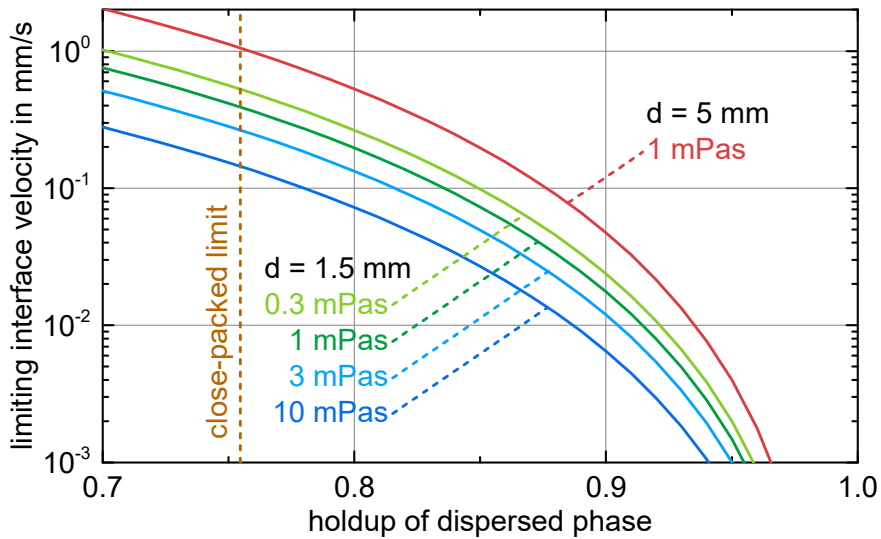
flowrate close to interface



is this a general effect?



is this a general effect?



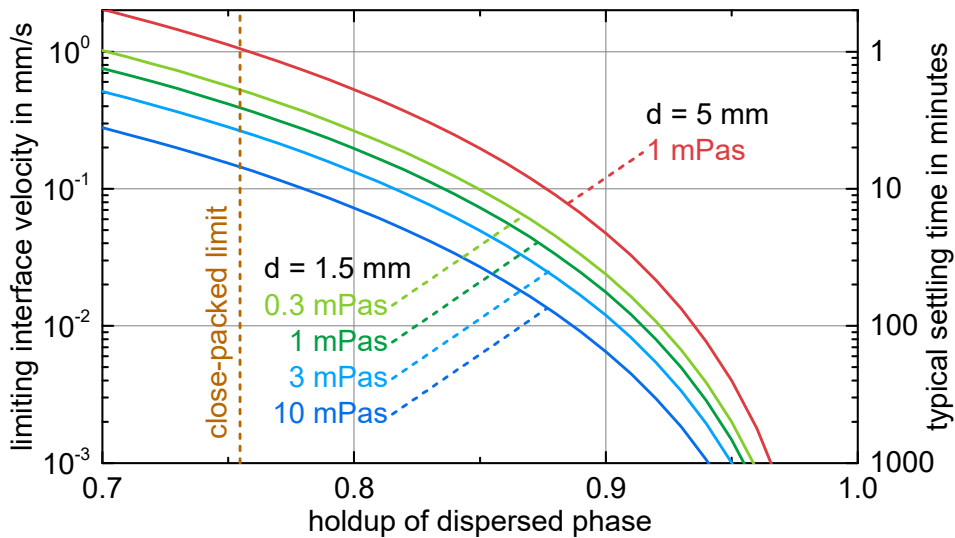
$\Delta\rho = 400 \text{ kg/m}^3$

model: Henschke, Waheed, Pfennig, 2000 & Richardson, Zaki, 1954

29



is this a general effect?



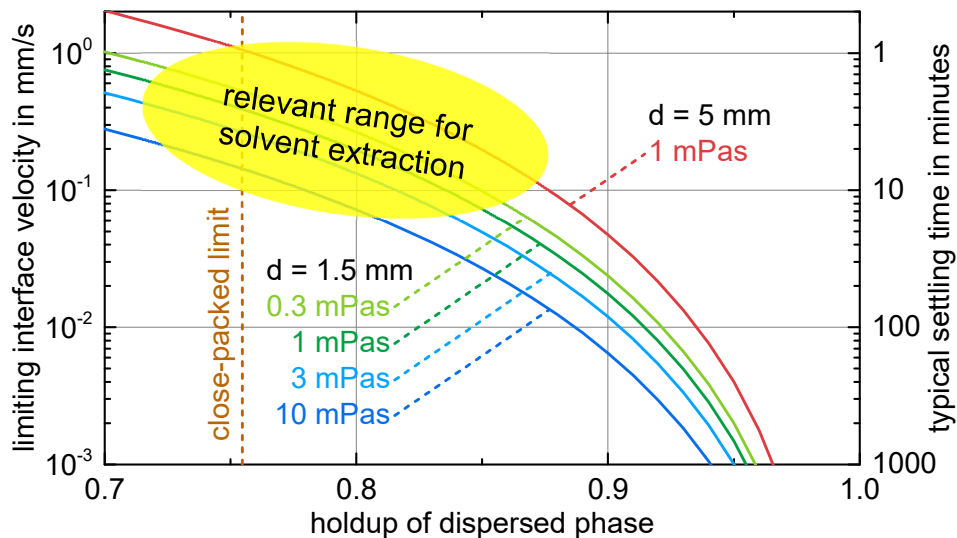
$\Delta\rho = 400 \text{ kg/m}^3$

model: Henschke, Waheed, Pfennig, 2000 & Richardson, Zaki, 1954

30



is this a general effect?



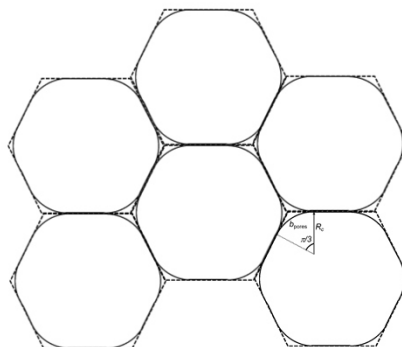
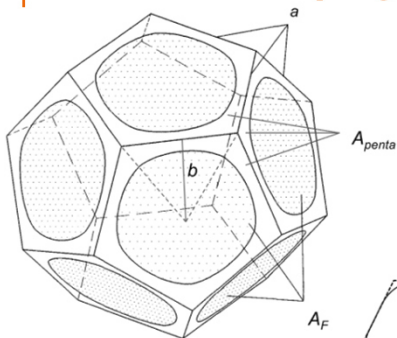
PEPs $\Delta\rho = 400 \text{ kg/m}^3$

model: Henschke, Waheed, Pfennig, 2000 & Richardson, Zaki, 1954

31



coalescence: polyhedron model of Henschke



$$p_{\text{coalescence}} = 1 - \exp\left(-\frac{t_{\text{contact}}}{t_{\text{coalescence}}}\right)$$

$$t_{\text{coalescence}} \sim \frac{6\pi^2 \mu R_F R_a^{3/2}}{F_{\text{driving}} r_s^* \sqrt{h_{\text{critical}}}}$$

$$F_{\text{driving}} = F_{\text{Young-Laplace}} = \frac{2\pi R_F^2 \sigma}{R}$$

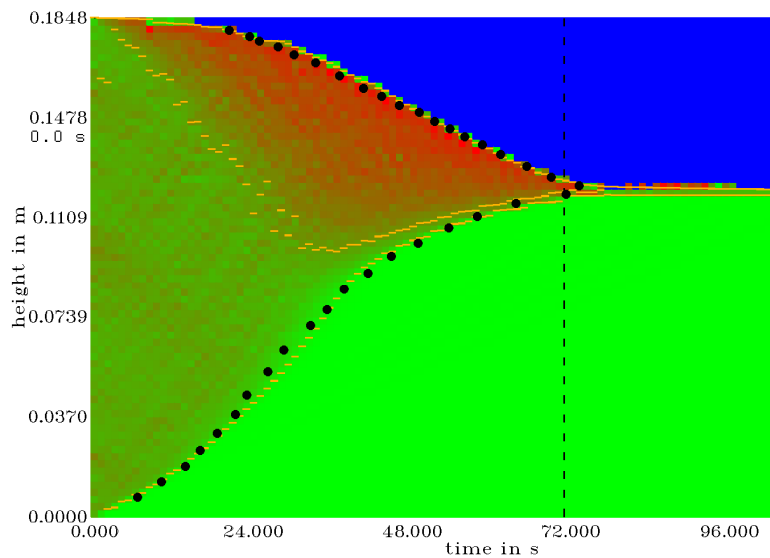


Henschke, 1995: Dimensionierung liegender Flüssig-flüssig-Abscheider anhand diskontinuierlicher Absetzversuche

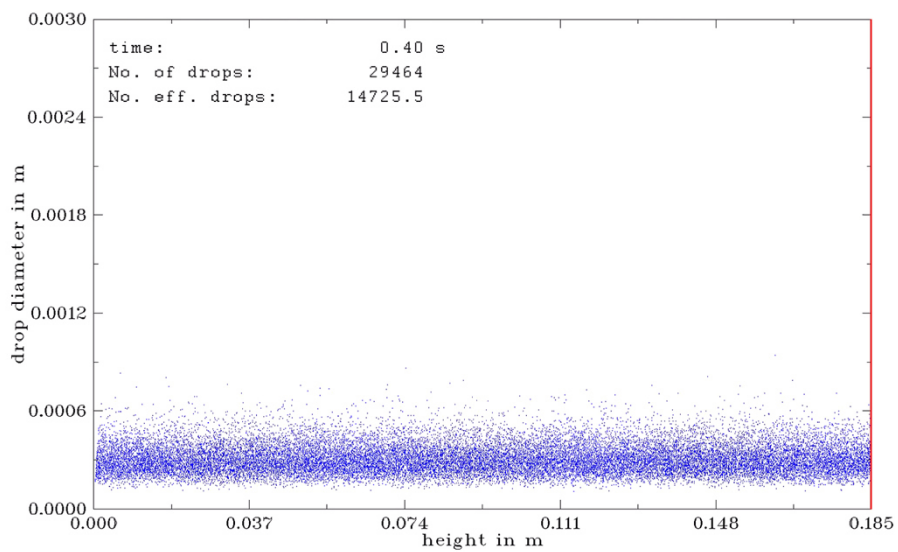
32



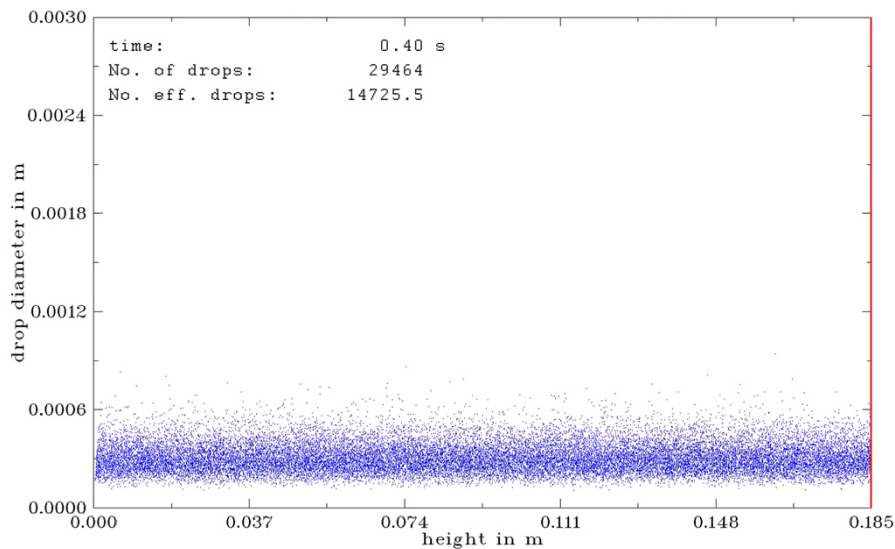
drop-based simulation results



drop-based simulation results



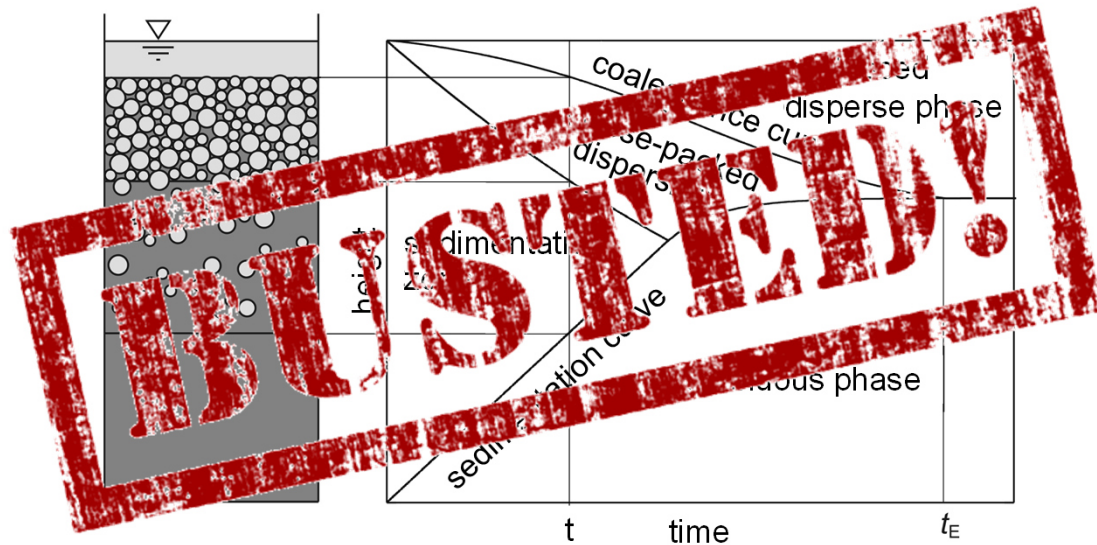
drop-based simulation results



conclusions

- **lag time**: small drops, hardly sediment but coalesce \Rightarrow **polydispersity**
- **densely packed zone** \Rightarrow **velocity** of drop swarm **up to high holdup**
- close-packed zone: hardly occurs, drops don't press on interface
- low holdup close to interface
- modeling, simulation: ReDrop (representative drops)
 - drop sedimentation: polydisperse swarm up to high holdup
 - coalescence: Henschke polyhedron model

general settler concept



ProcessNet & DECHEMA-BioTechNet Jahrestagungen 2022 & 13th ESBS Symposium
Aachen, September 12 to 15, 2022

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