Numerische Modellierung der Phasentrennung in Zentrifugalextraktoren

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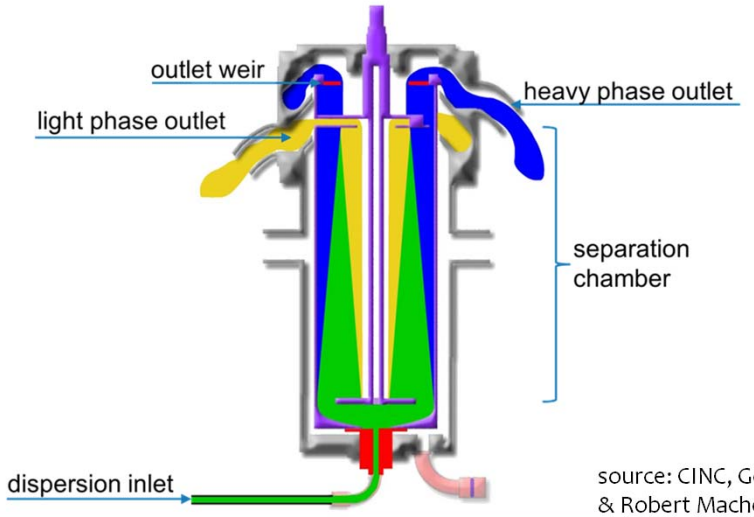
outline

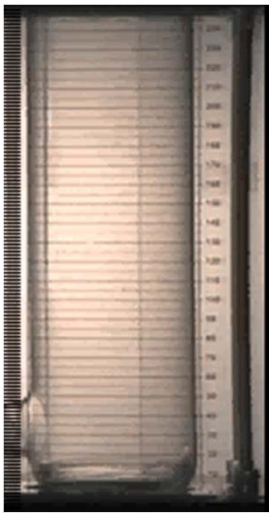
- motivation
- model basis
- model results
- summary

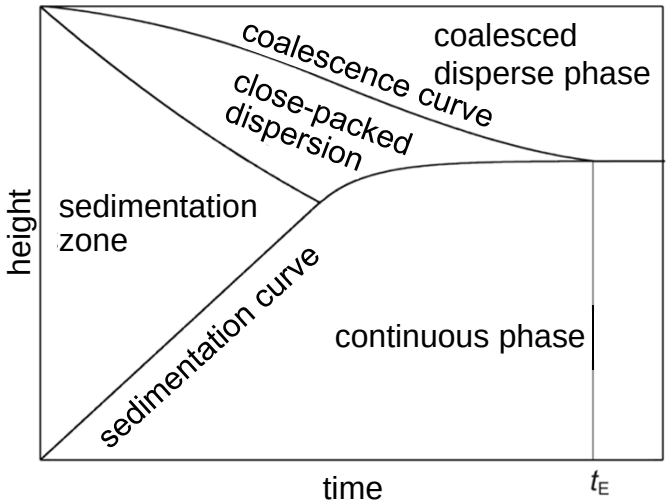
principle of centrifugal separation



source: CINC, Germany & Robert Macher

principles of settling



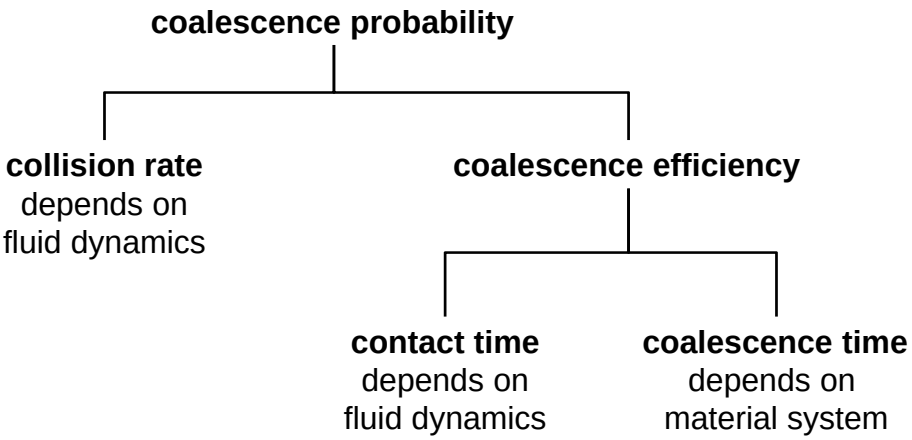


modelling

ReDrop: representative individual drops:

- Stokes with centrifugal acceleration
- Richardson & Zaki (1954) for swarm behaviour
- coalescence with Kopriwa (2014)

coalescence in extraction columns



coalescence model in detail

coalescence rate

$$\omega = h_{\text{collision}} \lambda$$

collision rate

$$h_{\text{collision}} = C_{\text{coll,turb}} (d_1 + d_2)^2 \Psi^{1/3} \left(d_1^{2/3} + d_2^{2/3} \right)^{1/2} \frac{2-\varepsilon}{2(1-\varepsilon)^3} + C_{\text{coll,sed}} A_{\text{coll}} \left(v_{\text{sed},1} - v_{\text{sed},2} \right)$$

coalescence efficiency

dependent on material system

$$\lambda(d_1, d_2) = \exp\left(-\frac{t_{\text{drainage}}}{t_{\text{contact}}} \right) = \exp\left(-\frac{C_{\text{lambda}} \eta_c \Psi^{1/3}}{H_{\text{cd}}^{1/6} r_s^{*1/3} \sigma^{1/3} (\Delta\rho g)^{1/2} (d_1 + d_2)^{2/3}} \left(\frac{d_1 d_2}{d_1 + d_2} \right)^{1/3} \right)$$

$C_{\text{coll,turb}}$, $C_{\text{coll,sed}}$, C_{lambda} independent of material system

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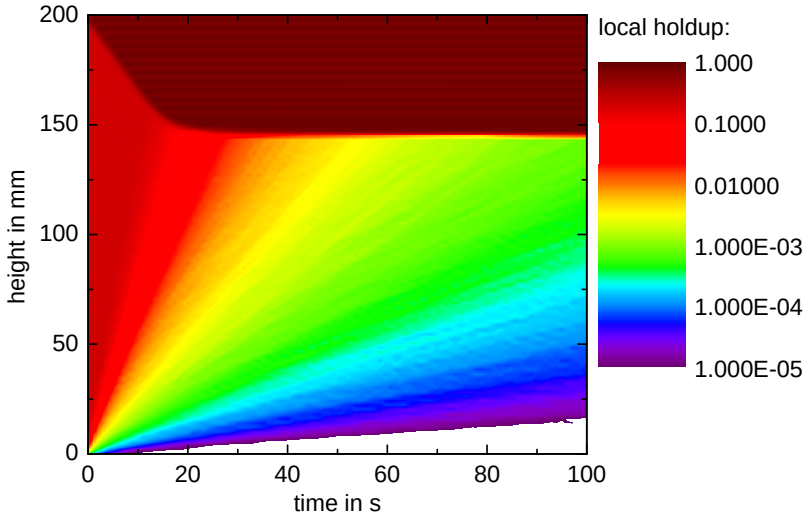
reference: gravity settling



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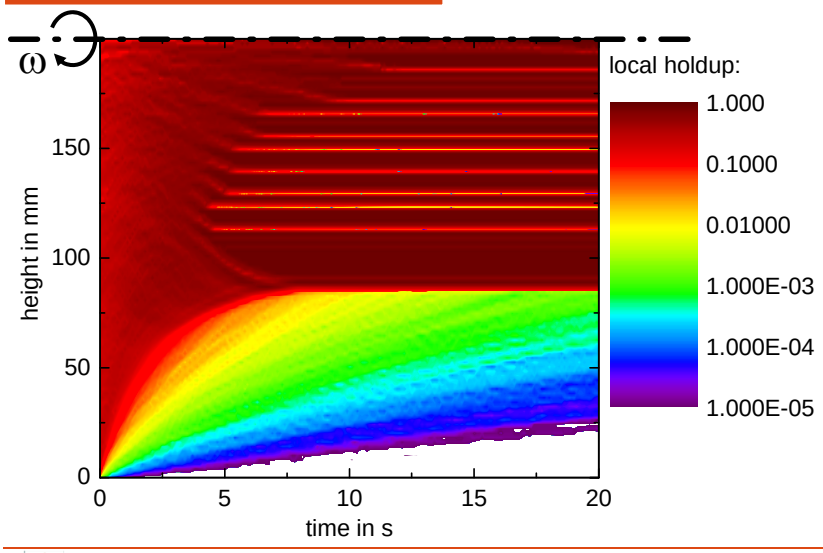
centrifuge at 1000 s^{-1}



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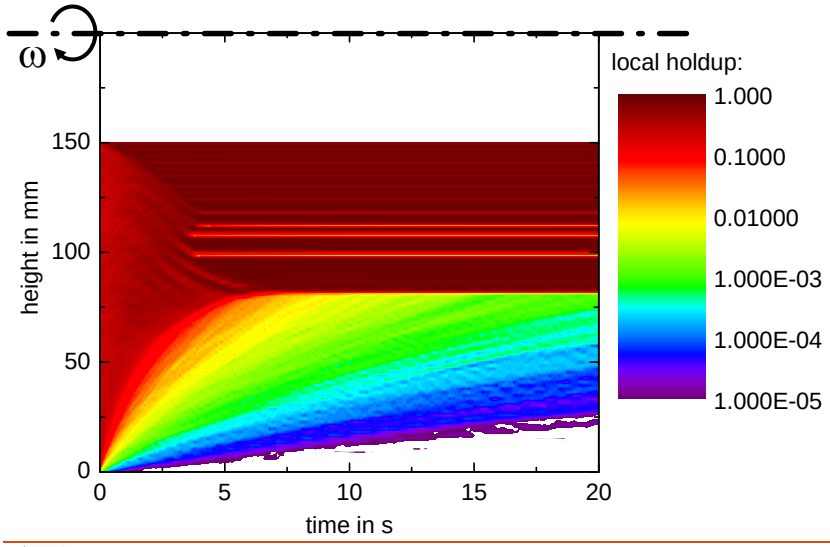
centrifuge at 1000 s^{-1}



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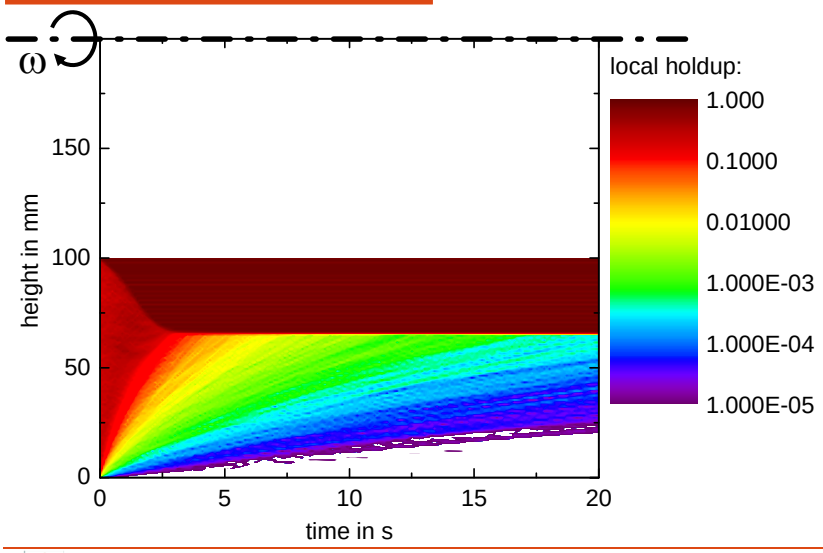
centrifuge at 1000 s^{-1}



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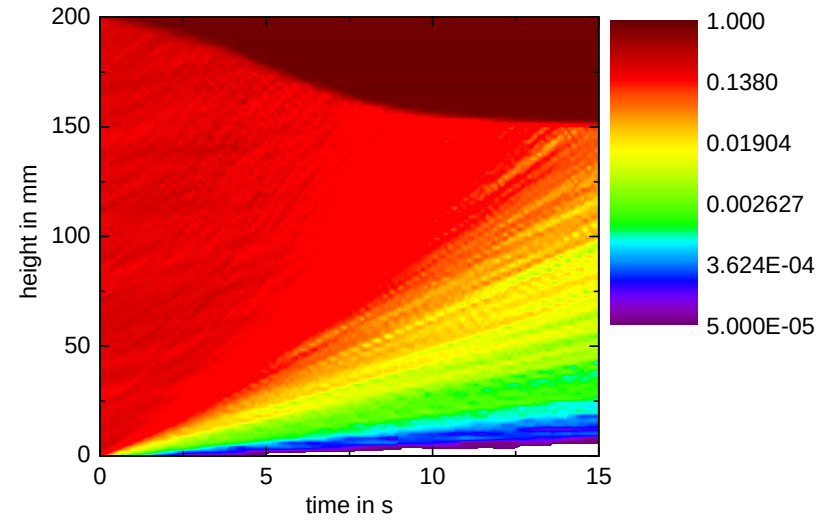
gravity settling with coalescence



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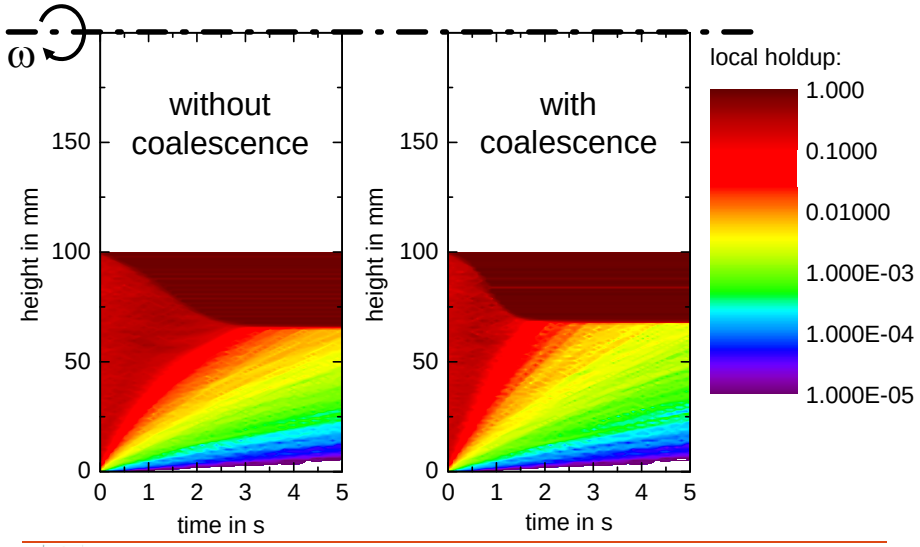
centrifuge without and with coalescence



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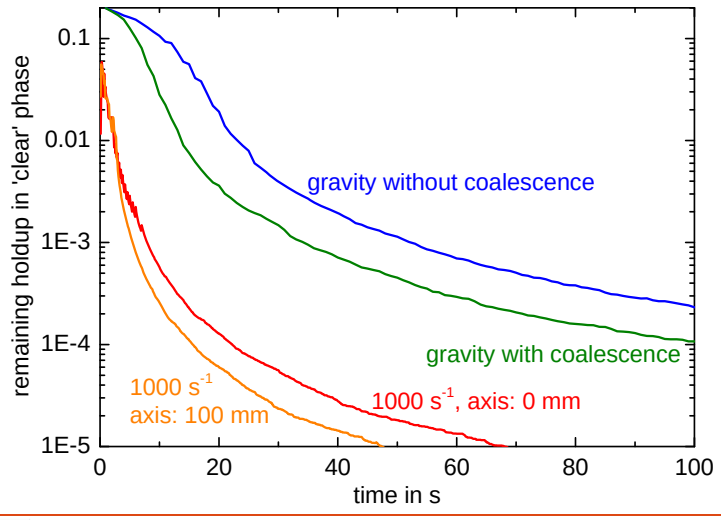
remaining holdup in clear liquid



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summary

- modelling:
  polydisperse droplets sedimentation with coalescence
- geometry of centrifuge is to be optimized
- less volume without influence on remaining fine dispersion
- coalescence improves separation, has little influence on optimization

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