Supported by:

Federal Ministry for Economic Affairs and Energy

on the basis of a decision by the German Bundestag

Coalescence Modelling for Design of Technical Equipment

David Leleu, Andreas Pfennig
dleleu@uliege.be
Products, Environment, and Processes (PEPs)
Department of Chemical Engineering
Université de Liège
www.chemeng.uliege.be/Pfennig

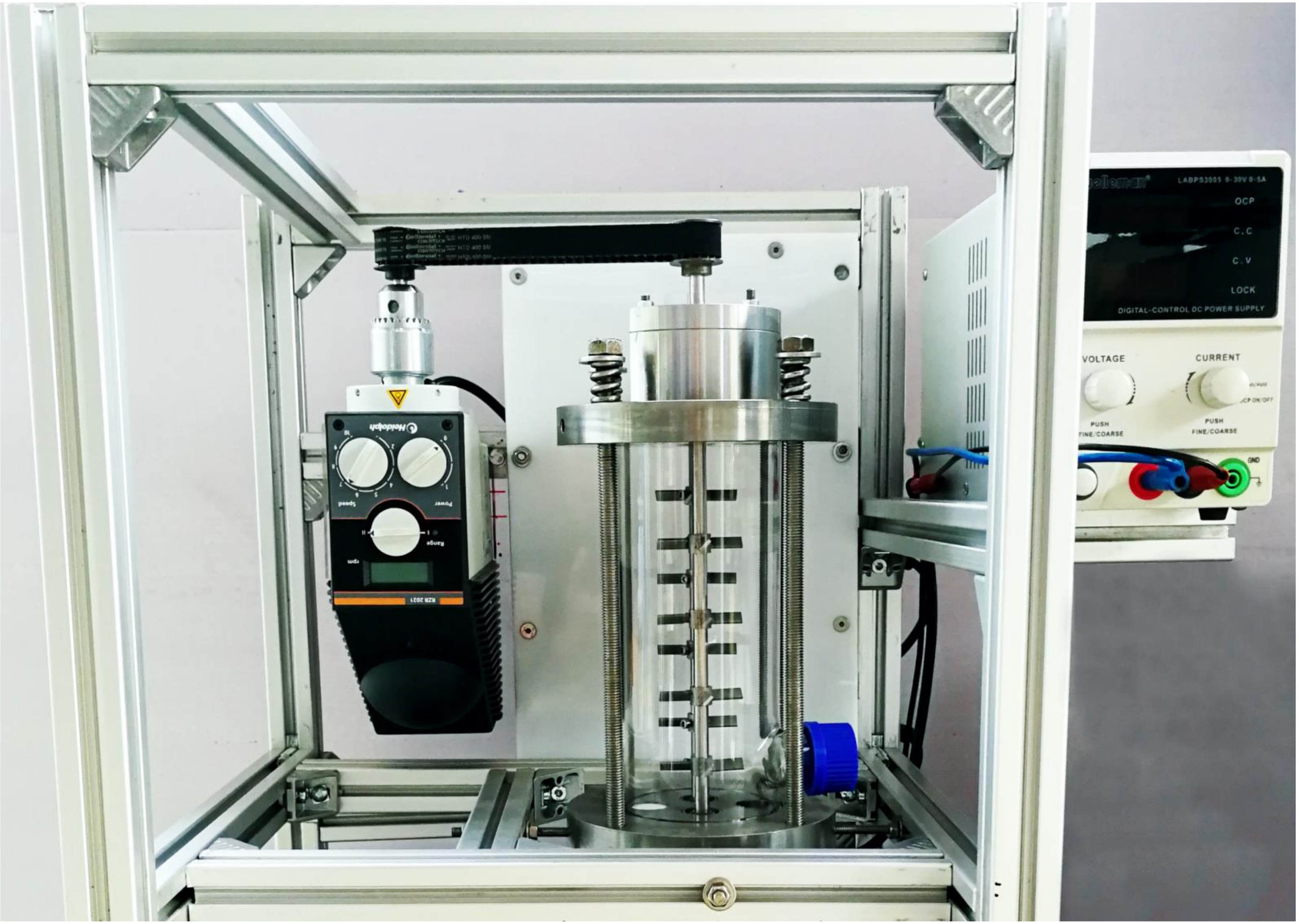
agenda

- motivation
- basic understanding
- coalescence modelling
- settler simulation

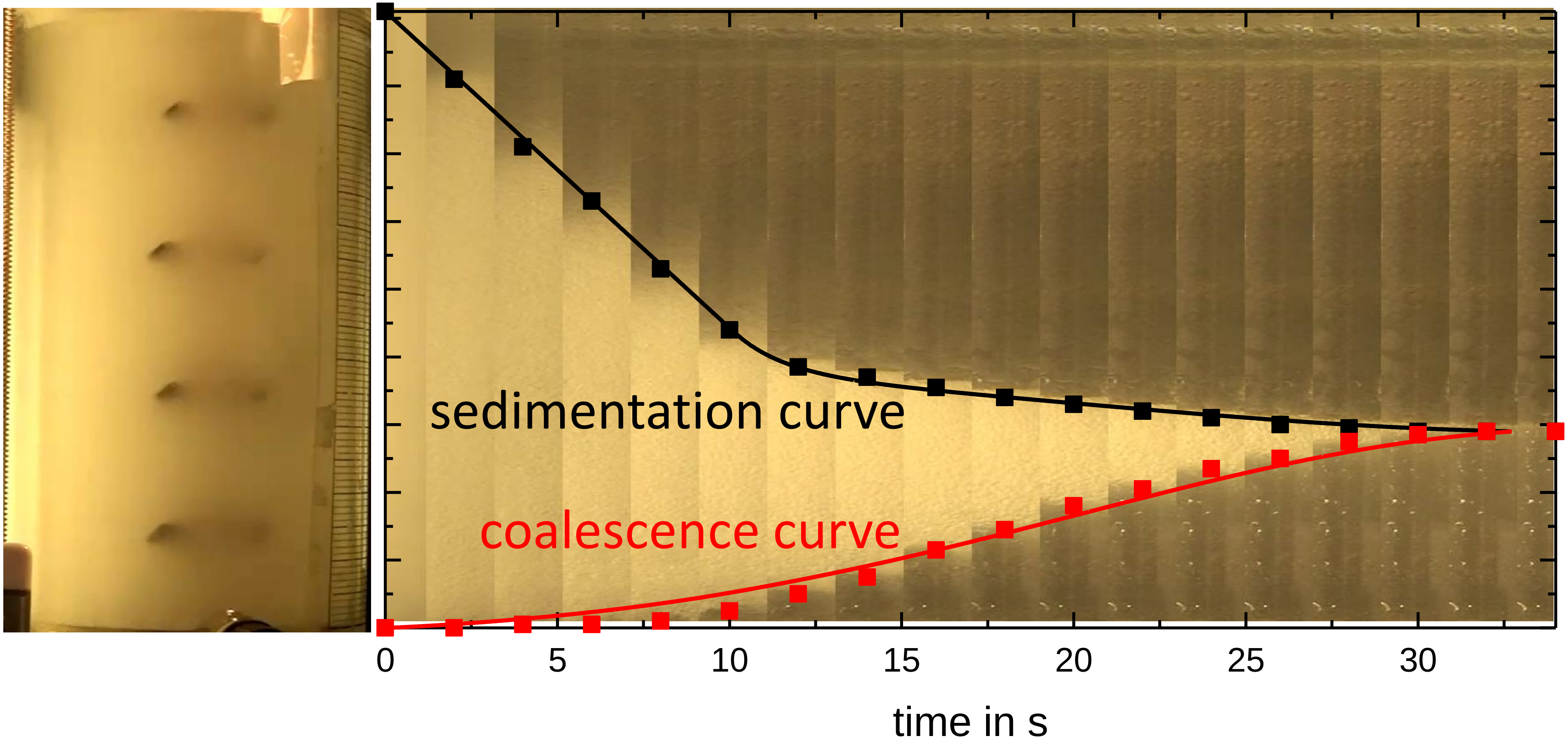
gravity settler

technical equipment's

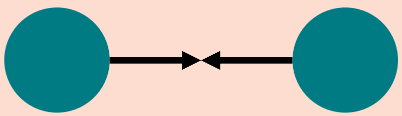
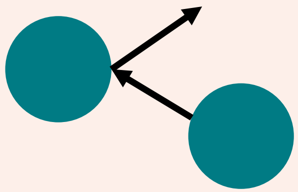
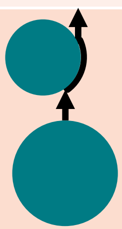
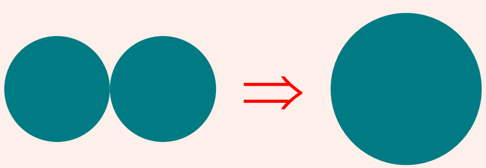
stirring cell



stirring-cell experiment



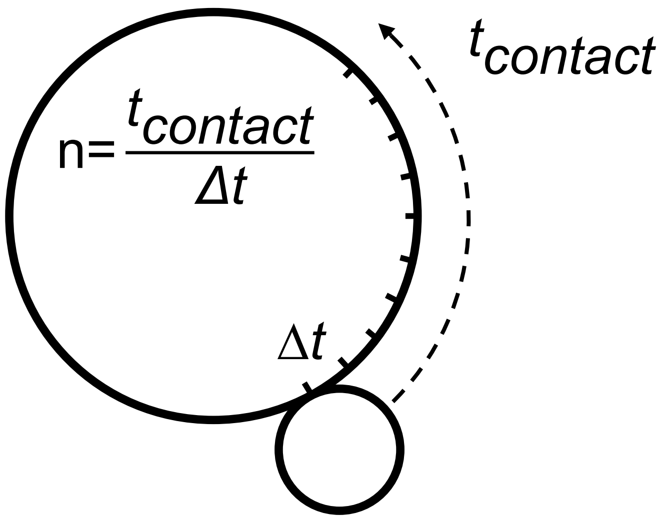
modelling coalescence of drops

effect	description	influenced by
	frequency at which drops meet	equipment type, fluid dynamics, holdup
	drops bounce at high relative velocity	equipment type, fluid dynamics, operating conditions
	time drops stay in contact, $t_{contact}$	equipment type, fluid dynamics, operating conditions
	characteristic time drops need to coalesce, $t_{coalescence}$	material system, drop size

coalescence probability: fundamental

$$p_{\text{coalescence,Coulaloglou\&Tavlarides}} = \exp\left(-\frac{t_{\text{coalescence}}}{t_{\text{contact}}}\right)$$

coalescence probability: fundamental



$$p_{\text{non-coal},n\Delta t} = p_{\text{non-coal},\Delta t}{}^{n}$$

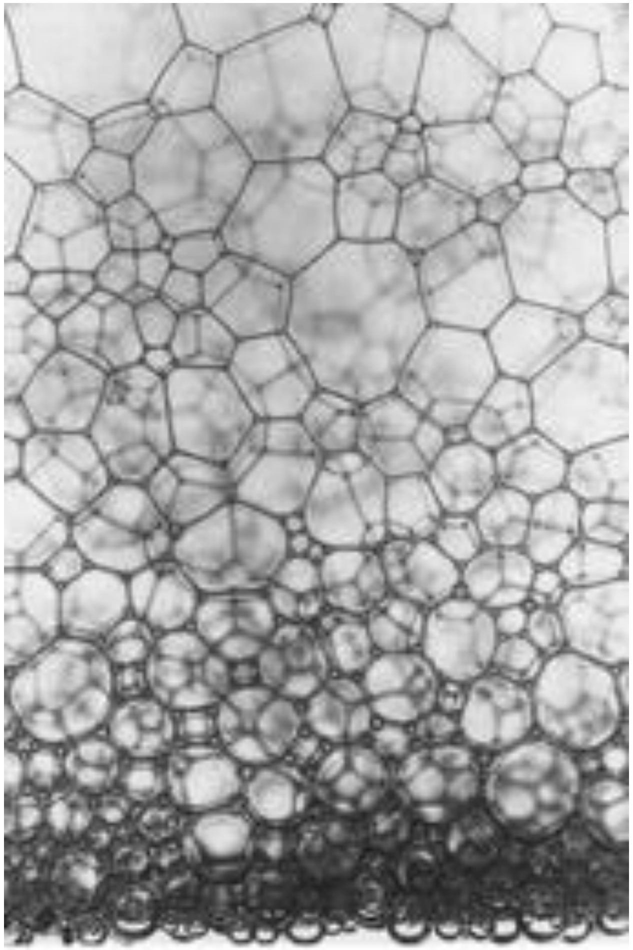
$$p_{\text{non-coal},\Delta t} = \exp\left(-\frac{\Delta t}{t_{\text{coal}}}\right)$$

$$p_{\text{non-coal},n\Delta t} = \exp\left(-\frac{n\Delta t}{t_{\text{coal}}}\right)$$

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

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

close-packed zone

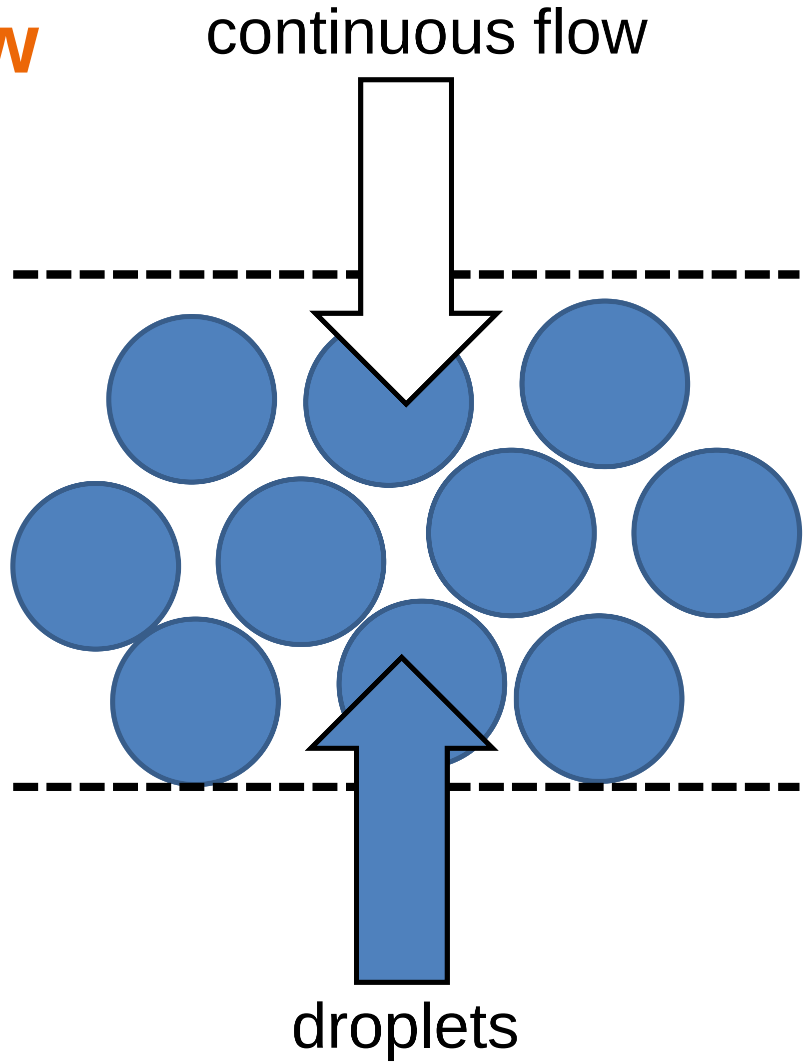


Arnaud Saint-Jalmes, 2006

- drops deformation
- film drainage

counterflow

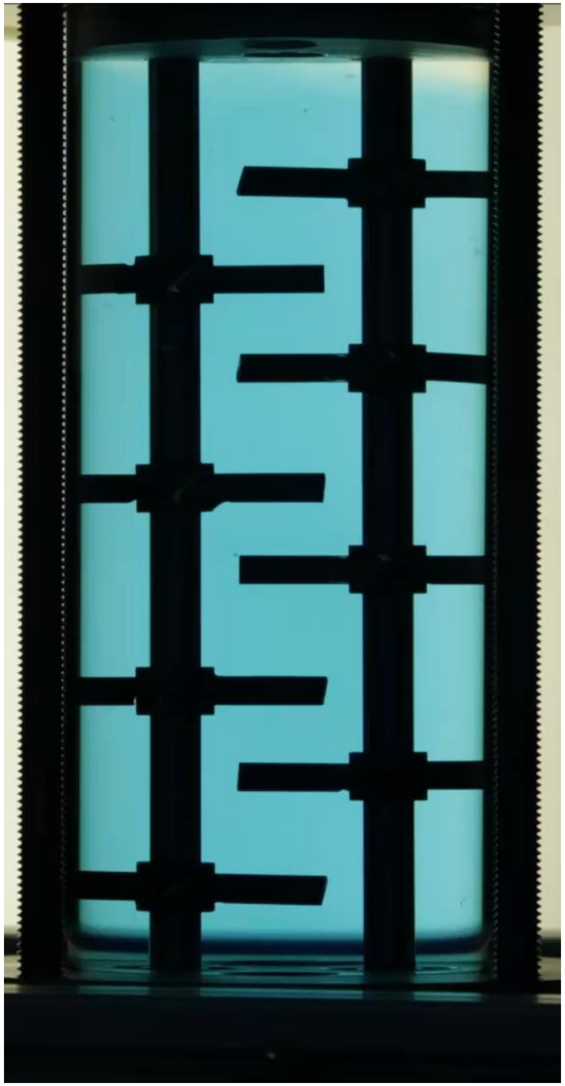
$\Delta P_{counterflow} \leftarrow v$



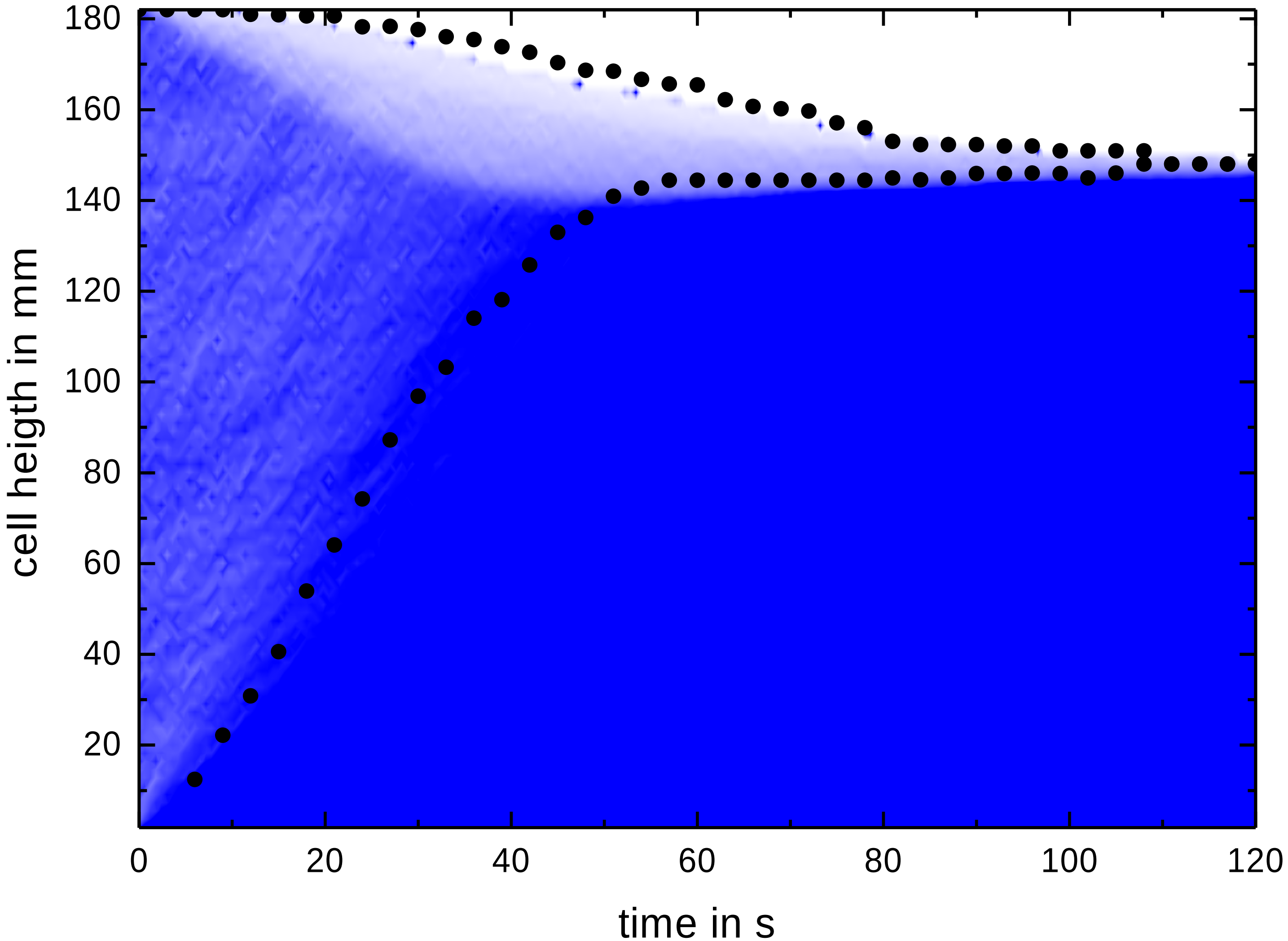
$\varepsilon \Delta h \rightarrow \Delta P_{hydrostatic}$

$$\Delta P_{total} = \Delta p_{hydrostatic} - \Delta P_{counterflow}$$

iso-optical settling experiment



settling simulation



summary

- consistent coalescence model
- calibrated setup for model validation purposes
- model able to characterize settling behavior for any system

Supported by:

Federal Ministry for Economic Affairs and Energy

on the basis of a decision by the German Bundestag

Coalescence Modelling for Design of Technical Equipment

David Leleu, Andreas Pfennig
dleleu@uliege.be
Products, Environment, and Processes (PEPs)
Department of Chemical Engineering
Université de Liège
www.chemeng.uliege.be/Pfennig