Standardized Settling Cell Design

D. Leleu and A. Pfennig
University of Liège, Department of Chemical Engineering – PEPs, Belgium
http://chemeng.ulg.ac.be – dleleu@ulg.ac.be

Introduction

- to design properly continuous settlers used for separating liquid-liquid dispersion, an experimental characterization of dispersion is necessary in a standardized settling cell with respect to settling time [1,2]
- different settling cells with different characterization procedures were developed
- goal: design one single standardized settling cell with optimal properties in order to compare results between partners of a common project
- how: by comparing two different standardized equipments and their characterization tool. Their individual positive aspects are found in order to build an optimal settling cell

Shaken vs. Stirred

Two 'standard' settling cells

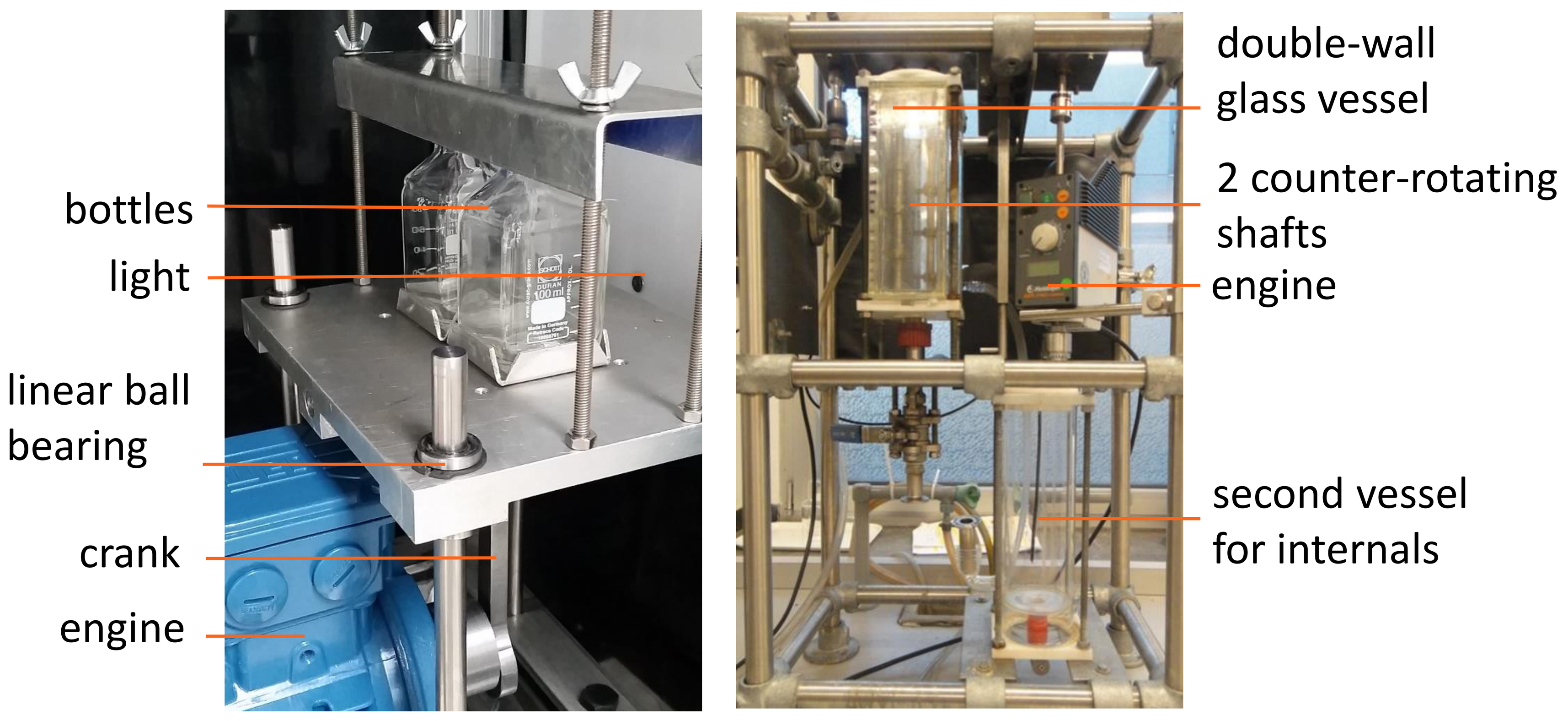

Figure 1. Shaking cell (left) Henschke cell (right)

	filling volume	air exchange	dispersion generation
shaking cell [1]	2 bottles of 100 ml	closed	shaken
Henschke cell [3]	1 vessel of 800 ml	open	stirred

Settling time evaluation methods

visual method:
- settling time is reached when the half of the interface is filled by a monolayer of droplets

numerical method:
- settling time is reached when the average grey level inside a area of interest (AOI) is lower than a certain threshold
- it depends on three parameters: the area of interest, the lower and the upper phase thresholds

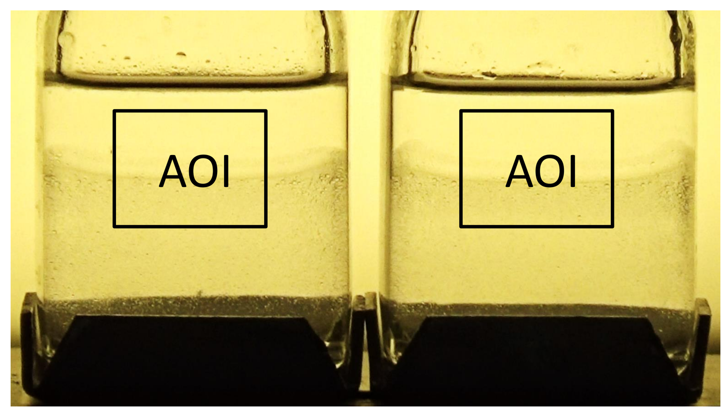

Figure 2. Definition of the area of interest for the shaking device [3]

Comparing the Cells based on:

- dispersion generation
  variation of the stirrer speed and the mixing time to define the experimental parameters ensuring a well-dispersed system
- settling-time evaluation
  comparison of settling-time evaluation methods for both equipments
- filling volume
  test different filling height for both equipments
- air exchange
  open one bottle during two hours and keep the other one closed for the shaking cell

Results and Discussion

Settling time evaluation

	settling time (s)	
	shaking cell	Henschke cell
different areas of interest	196-200	63-64
different thresholds	196-207	64-71
visual method	120	70-77

- wall effect with shaking cell
- methods give comparable results for the Henschke cell
- visual method allows direct measurement

Dispersion generation

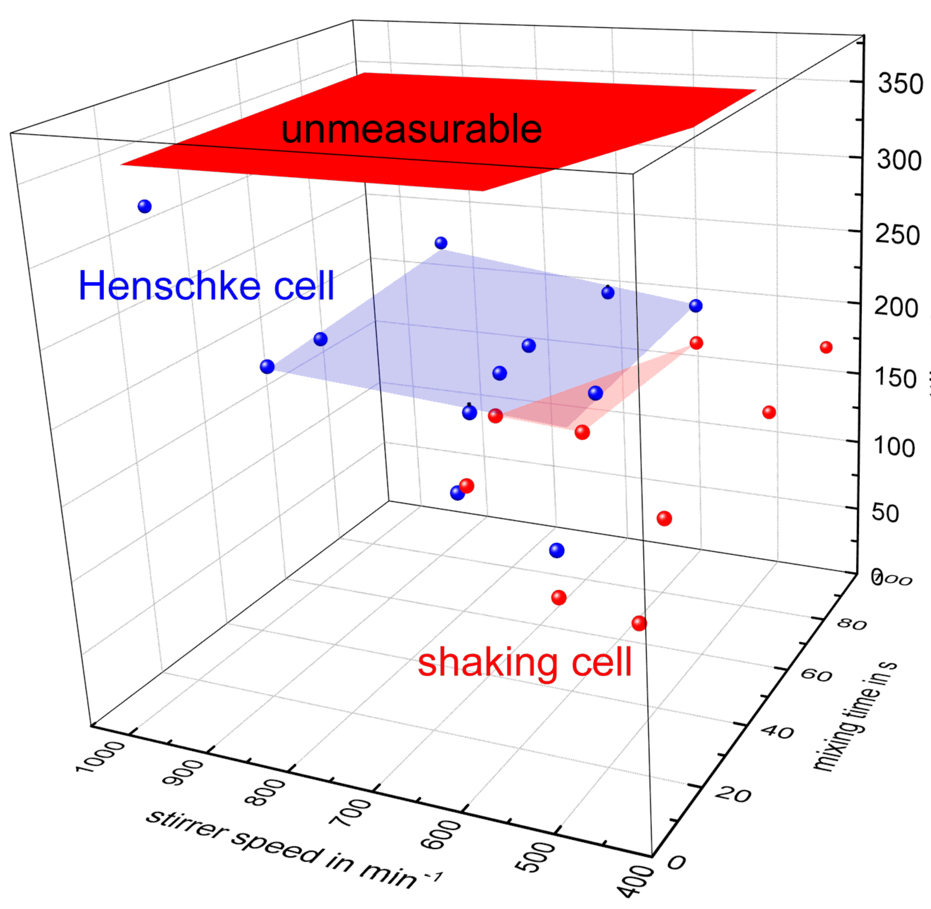

Figure 3. Variation of the settling time with mixing time and stirrer speed

- the settling time increases for low mixing parameter because the system is not well-dispersed
- plateau where settling time is stable for both equipments
- unmeasurable settling time region for the shaking cell due to an excess of very fine droplets which impedes settling time evaluation

Filling volume

comparison of different filling height:
- 1st experiment: the parameters of the sedimentation curve and the coalescence curve are fitted to the experimental data for its settling time evaluation [1]
- 2nd experiment: its own settling time is predicted with the parameters of the 1st experiment

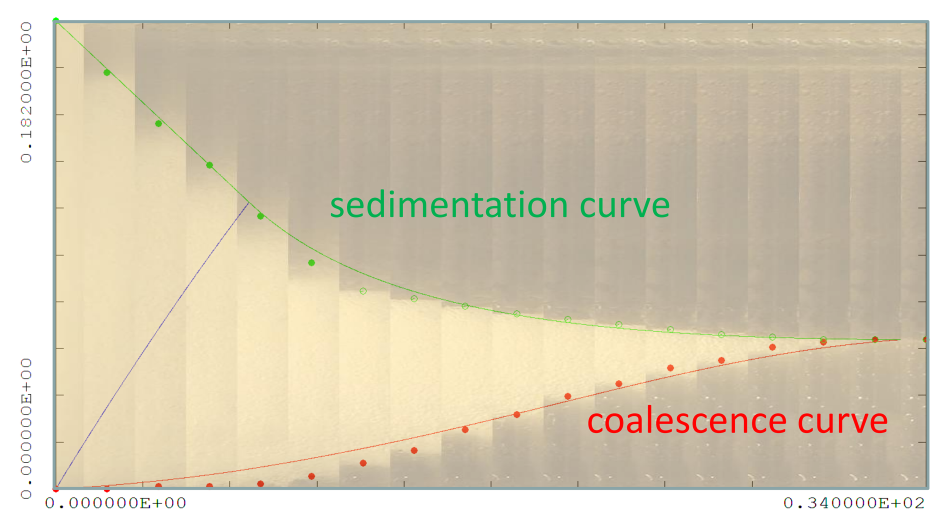

Figure 4. settling fitted curves based on experimental data [1]

	settling time (s)			
	Henschke cell (ml)		shaking cell (ml)	
	800	600	75	60
visual method	245	238	180	160
based on fitted settling curves	232	225	190	168
Prediction based on the first experiment analysis		213		164

- visual method in the same range than the evaluation of settling time based on the fitted settling curves
- prediction in good agreement with reality
- filling volume does not influence the settling behavior

Air exchange

	settling time (s)	
	shaking cell	Henschke cell
1st experiment	170	242
after opened for 2h	320	240

- Henschke cell is more stable than the shaking cell regarding the air exchange

Conclusions

- visual settling time evaluation method is quicker than the numerical method
- Henschke cell is more stable than the shaking device regarding the air exchange
- a significant wall effect was observed for the shaking cell
- both cells are independent of the filling volume
- settling behavior does not change with the mixing time and the stirrer speed for the Henschke cell

→ **Henschke cell (stirred cell) is more independent than the shaking device regarding the operational conditions**

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References

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[2] L. Schlieper, M. Chatterjee, M. Henschke, A. Pfennig, AIChE J., 50(4), 802-811, (2004).
[3] J. Villwock, F. Gebauer, J. Kamp, H.-J. Bart, M. Kraume, Chem. Ing. Tech. 37(7), 1-10 (2014).