Infrastructure Factsheet

Description of the infrastructure		
***Name(s) of the infrastructure(s)*:**	**C1.3 KINETIC STUDIES (NTNU ABSKIN)**	
Location (town, country):	NORWAY	
Website:	www.ntnu.no	
Legal name of organisation operating the infrastructure:		Norwegian University of Science and Technology
Location of organisation (town, country):		Trondheim, Norway
Infrastructure Contact *(i.e. name, email of primary contact)*	Hanna Knuutila hanna.knuutila@chemeng.ntnu.no	
RICC Contact *(i.e. name, email of secondary contact)*	Morten Grønli morten.g.gronli@ntnu.no	

****Infrastructure (s)**: means a facility, a resource (or a coherent set of them) together with the related services that are used by the scientific community to conduct research.*
*****Installation:** is a part of an infrastructure that could be used independently from the rest.*

Description of the facilities

Brief general description of the infrastructure to which access is offered highlighting its state-of-the-art equipment and services offered to users that make it rare or unique in Europe. Outline the areas of research normally supported by the infrastructure, as well as any possible new areas opening to users. If the infrastructure is composed of several installations**, are these described here including their specific features. If parts of the infrastructure are still under construction, the description includes the starting date of construction and indicative date when access can realistically be made available.

TA1.3 KINETIC STUDIES (NTNU ABSKIN)

Absorption kinetics are crucial when estimating the height of the absorber and during process simulations. Additionally to absorption rate data, data for physical properties are needed to model the kinetics. Therefore, this facility offers

- Three setups for measurement of kinetics
- Viscosity and density measurements
- The possibility to measure the physical solubility of CO_2 using N_2O analogy.

Measurement of absorption kinetics can be performed with three different setups, string of discs, wetted wall column and stirred cell. We choose the setup to be used based on existing data on similar chemical structures. Both unloaded and loaded solutions can be measured. The amount of solvent needed is large for the string of discs and wetted wall column.

All the kinetic apparatuses are suitable for loaded and unloaded solutions. The wetted wall column and string of discs can be used up to 80°C using atmospheric pressure. The stirred cell extends the experimental range to elevated pressures. Additionally measurement of viscosity, density can be performed at the conditions used to measure the kinetics. Finally, N_2O solubility into the studied solvent can be measured to determine the physical solubility of CO_2 using N_2O analogy.

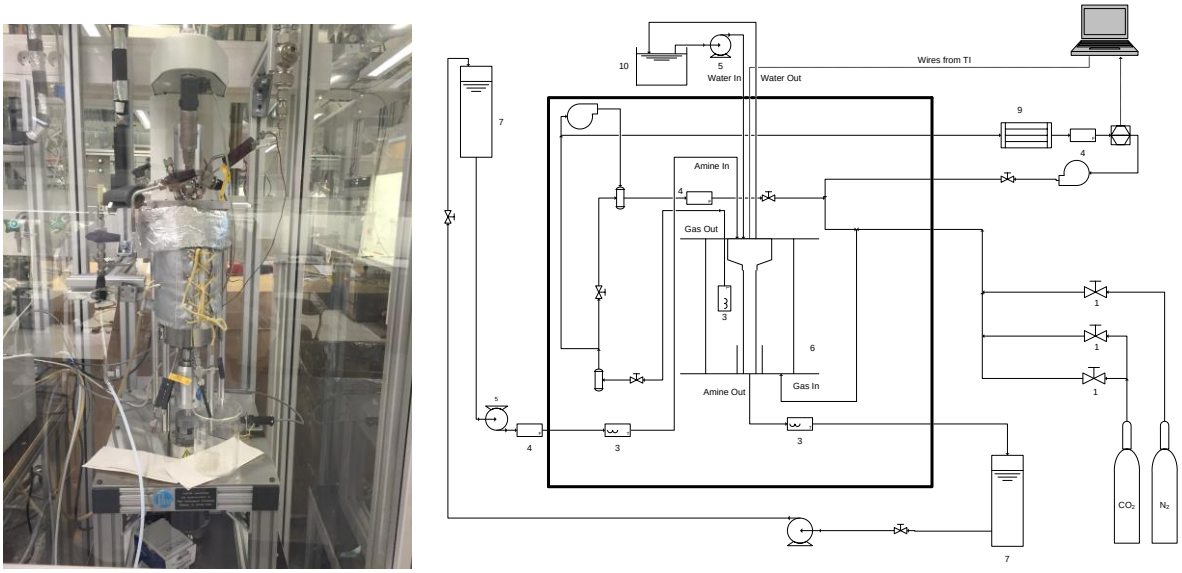

Figure 1 Stirred cell setup on the left hand side and drawing of the wetted wall column setup on the right hand side.

State of the Art, uniqueness (if applicable), and any specific advantages (e.g. technical, economic etc)

- The installations C1.3, C1.4 and C1.5, designed for CO_2 capture research, are located in the same campus making it possible to combine kinetic experiments with solvent degradation or gas-liquid equilibria studies.
- The laboratory has a close co-operation with external analytical laboratory (SITNEF Industry) offering services to analyse liquid samples for degradation products and specific amines.

Scientific environment (related and potentially available scientific and technical services at RI's location e.g. analysis, material preparation etc.)

Measurement of thermodynamic data, like VLE and heat of absorption, needed for example in process modelling can be performed. Absorption kinetics including measurement of physical properties is needed for sizing of absorber. Part of experimental apparatuses have been / are used in EU-funded projects like CASTOR, CESAR, DeCarbit, ENGAS, iCAP and HiperCAP. There is a close co-operation with SINTEF Materials and Chemistry and a long history of collaboration with the Department of Thermal Engineering, Tsingua University, Beijing and the Department of Chemical Engineering, University of Austin, Texas through exchange of PhD students and research personnel. In the last 8 years, more than 50 peer reviewed journal publications has been published presenting data from these installations.

CCS PROJECTS:

EU-funded CCS projects:

- ALIGN-CCUS,
- HiPERCAP,
- iCAP, CASTOR, CESAR, DeCarbit and ENGAS

Other CCS projects:

- Norwegian CCS Research Centre (NCCS),
- 3rd Generation solvent membrane contactor (3GMC),
- Evolutionary de novo design of absorbents with optimal CO_2 capturing properties (DeNOVO),
- Low Energy Penalty Solvents (LEPS)

Main/major non-CCS projects:

SFI SUBPRO (http://www.ntnu.edu/subpro)

Patents:

Selected publications:

- Putta, K. R., Pinto, D. D. D. Svendsen, H. F., Knuutila, H. K. 2016. CO2 absorption into loaded aqueous MEA solutions: Kinetics assessment using penetration theory, International Journal of Greenhouse Gas Control 53: 338-353.
- Garcia, M., Knuutila HK., Gu, S. Determination of kinetics of CO2 absorption in unloaded and loaded DEEA+MAPA blend. Energy Procedia, XXX (13th International Conference on Greenhouse Gas Technologies, GHGT13, 14 - 18 November 2016, Lausanne, Switzerland).
- Hartono A. et al. Solubility of N2O in aqueous solution of Diethylenetriamine, J.Chem Eng. Data 2008, 53, 2696-2700
- Juliana G.M.-S. Monteiro, Hammad Majeed, Hanna Knuutila, Hallvard F. Svendsen, Kinetics of CO2 absorption in aqueous blends of N,N-diethylethanolamine (DEEA) and N-methyl-1,3-propane-diamine (MAPA), Chemical Engineering Science, 129, 2015, Pages 145-155
- Gondal, S., Asif, N. Svendsen, H.F. Knuutila, H. 2015. Kinetics of the absorption of carbon dioxide into aqueous hydroxides of lithium, sodium and potassium and blends of hydroxides and carbonates. Chemical Engineering Science, 123, 487-499.
- Knuutila, H et al. Kinetics of the reaction of carbon dioxide with aqueous sodium and potassium carbonate solutions. Chemical Engineering Science, Volume 65, Issue 23, 1 December 2010, Pages 6077-6088.
- Luo, X et al. Comparative kinetics of carbon dioxide absorption in unloaded aqueous monoethanolamine solutions using wetted wall and string of discs columns. Chemical Engineering Science 2012 ;Volum 82. s. 31-43.

FACILITY AVAILABILITY:

Unit of access:

Week

Availability per year:

Minimum 4 weeks

Expected duration of single experiment:

4 weeks

OPERATIONAL OR OTHER CONSTRAINTS:

Specific risks:

Legal issues: