UDC 622.24.051

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UTILIZATION OF MICROFLUIDICS AS A MODELS FOR STUDYING CO_2 INJECTION INTO DEEP SALINE AQUIFERS

The article discusses the problems of utilization of microfluidics as a models for studying CO_2 injection into deep saline aquifers. long term effects of capture and storage (CCS) technology are considered.

CO_2 capture and storage will be essential for Europe to become climate neutral, but so far has been economically unprofitable.

The justification for CO_2 capture and storage (CCS) is stronger than ever, because CO2 removal is now acceptable as an unavoidable component of climate action if the countries wants to meet the Paris Agreement goals.

The Paris Agreement (2015) and the EU's internal regulations set targets to reduce emissions from the combustion of fossil fuels, including negative emissions, i.e. CCS technology.

The new financial system, the credit system after 2021 based on the taxonomy and the ETS system, encourages states to use CCS technology through subsidies for the implementation of demonstration projects or compensations;

Support for research and activities focused on increasing the competitiveness of the use of CCS technologies.

CCS technology has next long term effects. CO_2 capture and storage technology is important in the assessment of the IEA (Technology Roadmap). CCS in the long run may even lead to a significant reduction in CO_2 emissions generated in the combustion of coal/biomass/gas.

The interface between the injection well and the storage reservoir may provide maximum CO2 permeability if injectivity impairment mechanisms can be successfully avoided (fig. 1).

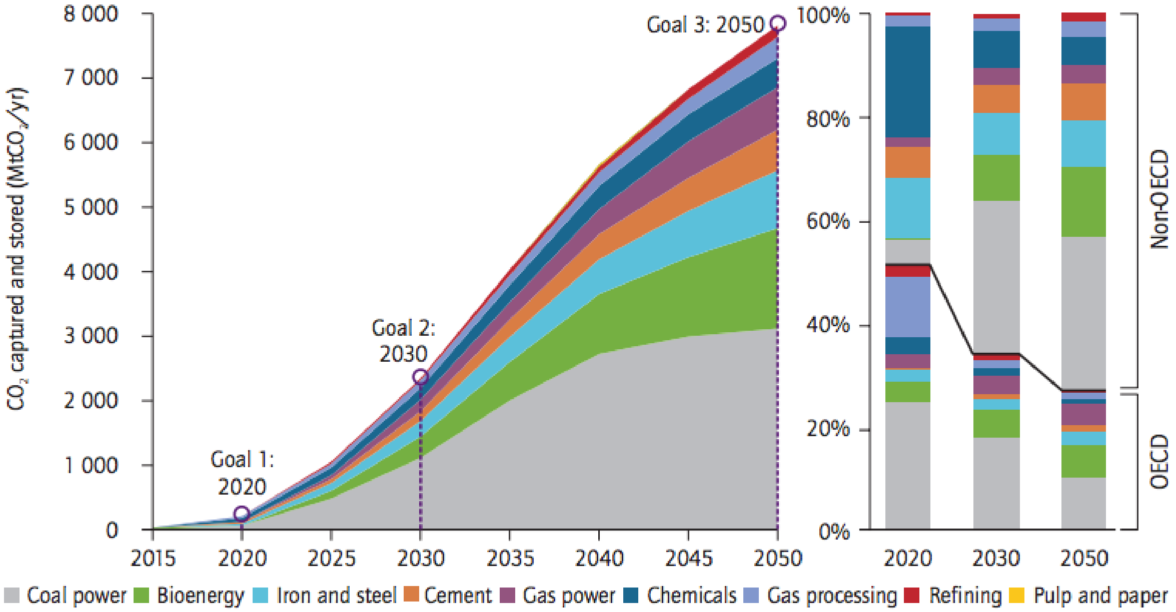


Fig. 1 – Long-term effects of CCS technology CO_2 storage and injectivity

The future of technology is believed to depend primarily on CO_2 transport and storage infrastructure with shared access and tariff control. The basis of all this is building a European CO_2 transport infrastructure that connects emitters across Europe with storage sites – ZEP.

The **idea** of the SaltPreCO_2 project is:

– to measure thermodynamic properties (such as minimal miscibility pressure, bubble/dew point and determine the phase equilibrium curve) of CO2/water, CO2/brine systems using an HPHT microfluidic Raman system;

– address nucleation, precipitation, and growth of salt crystals within the liquide phase or on the interface of the gas stream and solid surface.

Research methods.

We rely on the achievements of oil and gas field engineering developed for decades.

We use over a hundred years of experience in underground natural gas storage:

– the first UGS in the world - Canada, 1915 ;

– the first UGS in Poland - 1954

We use the most advanced deposit engineering tools - computer simulators allow us to analyze the behavior of the reservoir / storage site in various operating conditions and make long-term forecasts for the exploitation of deposits and warehouses.

Laboratory experimental setup microfluidic & RS 532 for determination CO2 solubility in water and brine is shown on fig. 2.

Results of these experiments are shown on fig. 3-8.

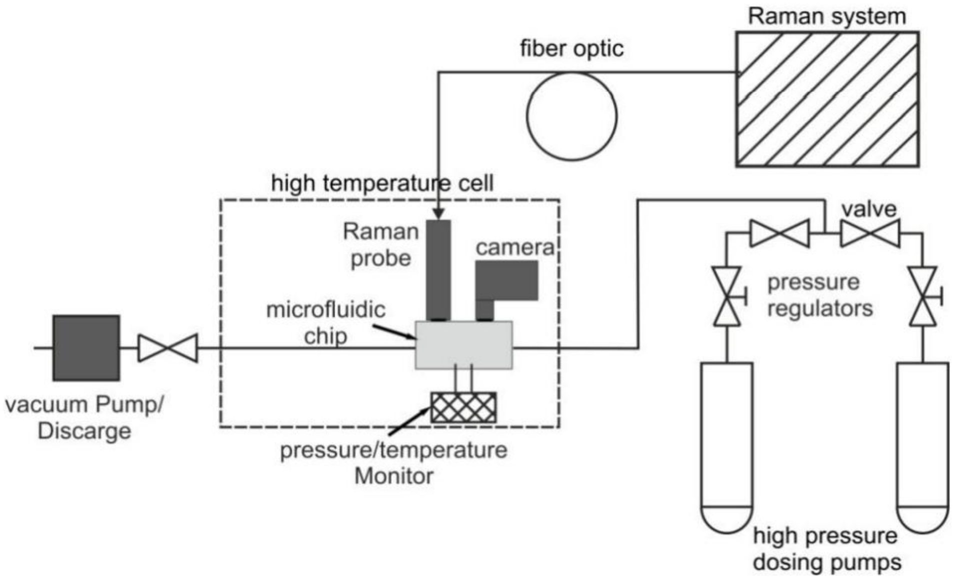


Figure 2. – Laboratory experimental setup microfluidic & RS 532

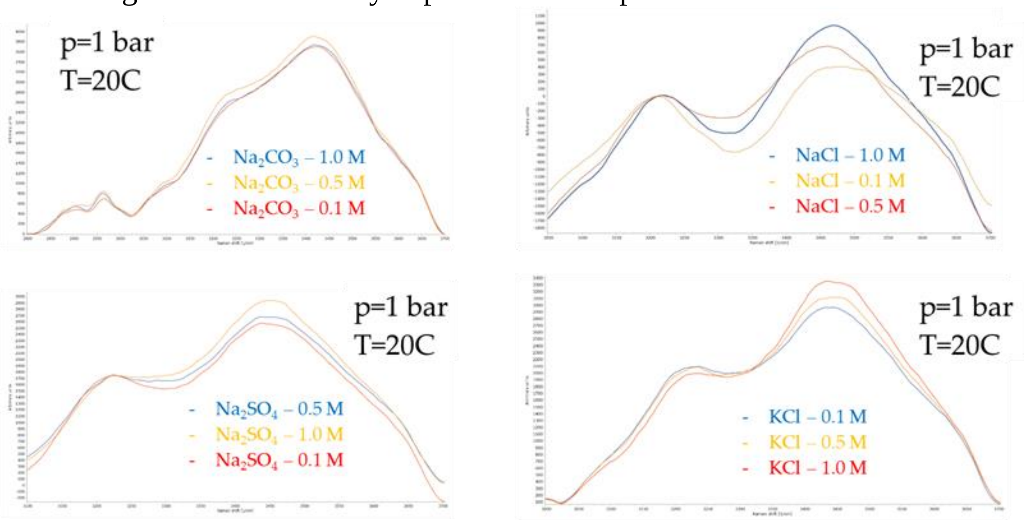
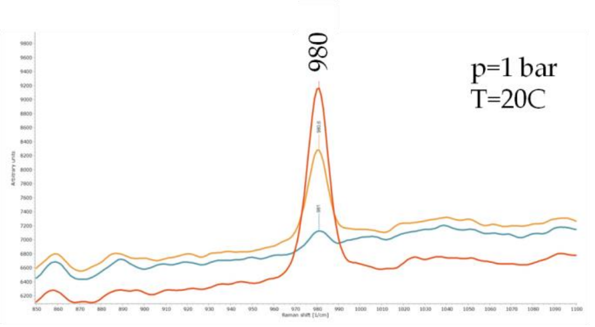


Figure 3. – Different salts solutions (beaker). Influence on H_2O band



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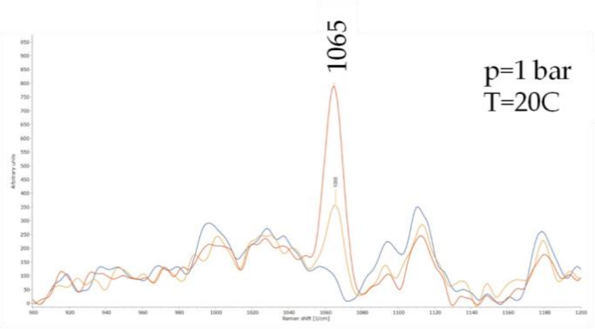
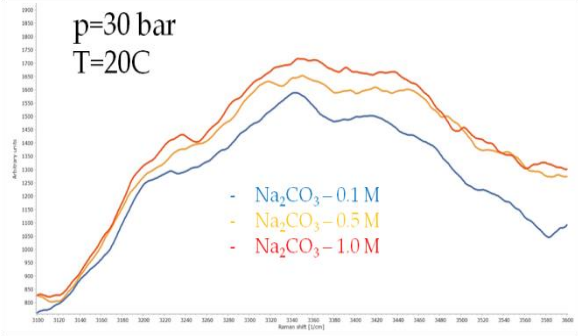


carbonates

Figure 5. – Different salts solutions (beaker)



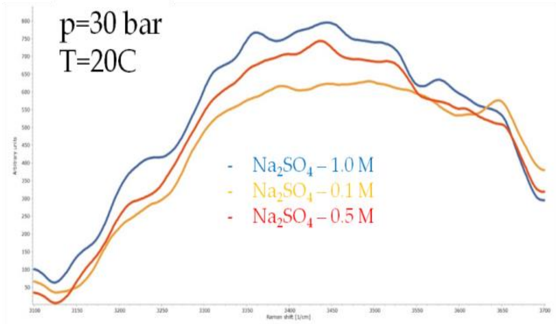
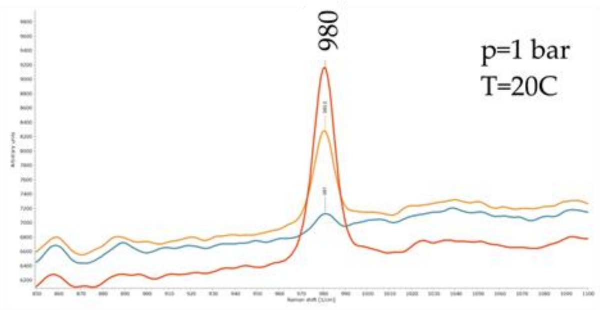


Figure 6. – Different salts solutions (geochip). Influence on H_2O band



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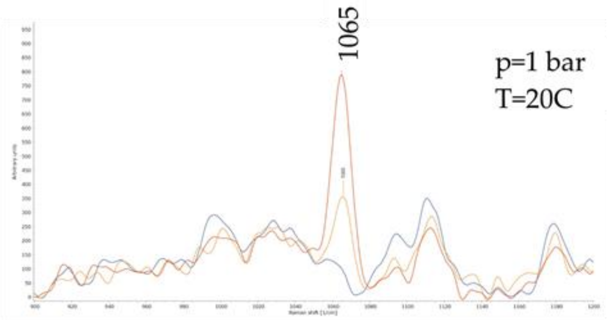

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Figure 7. – Different salts solutions (geochip)

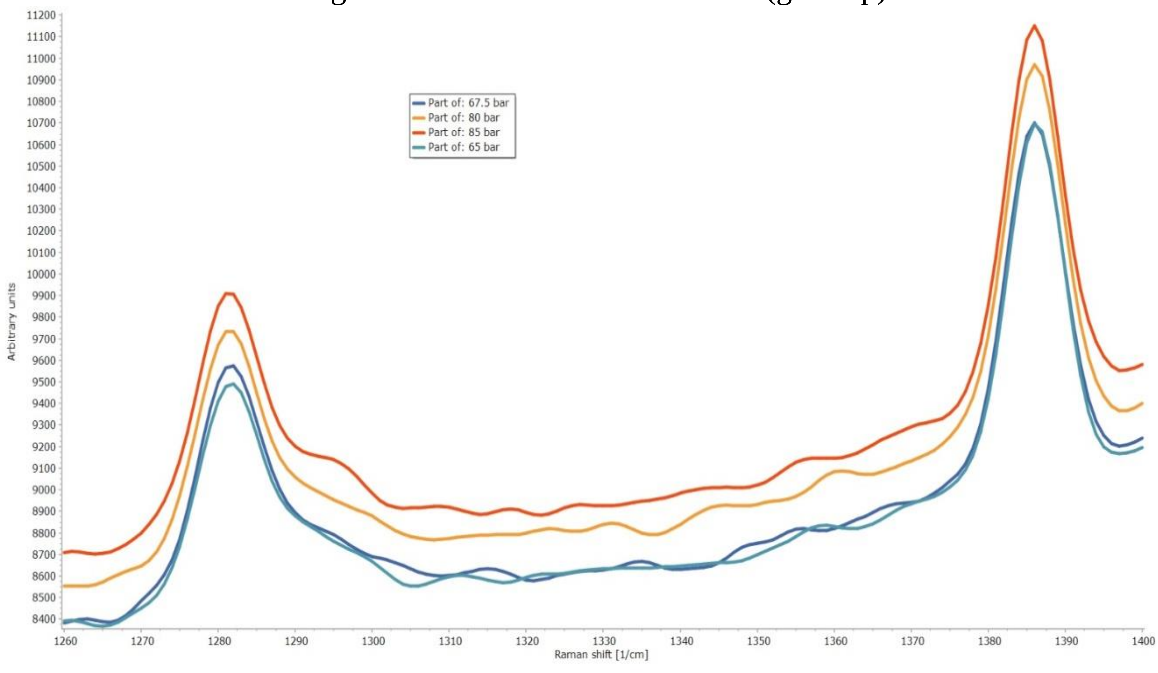

Figure 8. – CO2 bands on geochip

Summary and further work:

1. Underground injection of large volumes of supercritical CO2 that is undersaturated with respect to water causes evaporation of formation water which increases concentration of dissolved salts in brine pores and salt crystals will form in the porous or fractured media.
2. The salt precipitation can severely reduce the reservoir permeability around the well, induce excess pressure build-up, and cause a decline in injectivity.
3. Further lab resesearch on geomaterial microfluidic system with Raman spectroscopy to real-time CO2 concentration determination.
4. Measure thermodynamic properties of CO2/water, CO2/brine systems using an HPHT microfluidic.
5. Raman system such as minimal miscibility pressure, bubble/dew point and determine the phase equilibrium curve. Address nucleation, precipitation, and growth of salt crystals within the aqueous phase or on the interface of the gas stream and solid surface.

References

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