IMPACTS

The impact of the quality of CO_2 on transport and storage behaviour

3rd Newsletter, July 2014

Dear reader,

Before you is the third edition of the IMPACTS newsletter, covering the period January – Juli 2014. The newsletters inform partners and stakeholders on the developments in the EU FP7 IMPACTS project[1]. You can navigate through this document by clicking on the elements of the content list (below).

Previous newsletters:

- **Newsletter 1, January – July 2013**
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About IMPACTS

IMPACTS is a collaborative project co-funded by the European Commission under the 7th Framework Programme. The goal of the IMPACTS project is to close knowledge gaps related to transport and storage of CO_2-rich mixtures from various CO_2 sources to enable realisation of safer and more cost-efficient solutions for CCS. The results of IMPACTS will help to ensure safe and reliable design, construction and operation of CO_2 pipelines and injection equipment, and safe long-term geological storage of CO_2. The project started on 1 January 2013 and has a duration of three years. It has 12 research performing partners and 5 funding partners. You can find more information on the project website.

[1] If you wish to receive this newsletter, but are not on the mailing list, please send an e-mail to an.hilmo@sintef.no.

Events & meetings

Visit to the CO2Quest project, 14-15 April at University College London

The coordinator of the EU FP7 project CO2QUEST invited the IMPACTS project to an open dissemination workshop on the 14 and 15 April 2014, hosted at University College London. Other EU FP7 projects related to CCS were invited to participate and give a presentation:

- IMPACTS
- OCTAVIUS
- CO2 MUSTANG
- CO2 Panacea
- CO2 PipeHaz
- IOLICAP
- CO2 TRUST

The SP1 and SP2 leaders, Alexandre Morin and Charles Eickhoff were given the opportunity to present the IMPACTS project as a whole, the work within modelling of flows in pipeline and the techno-economic analysis of the CCS chains. The agenda, as well as a report of the event are available at the UK CCS Research Centre website.

Consortium technical meeting, March 25 2014, Burgos, Spain

The second EB meeting (see below) was used to organise a project-wide technical meeting. All work packages presented the work done so far in the project, informing all partners of successes reached and of the planning for the next period.

Part of the meeting was a visit to the Hontomín research site. Part of the IMPACTS consortium combined the visit to Burgos with a site visit of the Ponferrada site, to see the CIUDEN CO_2 transport rig where the dynamic tests of IMPACTS are going to be held.

The IMPACTS team at the Hontomín site

IMPACTS consortium at the CO_2 Transport Test Rig in Ponferrada

Executive Board meeting, March 26 2014, Burgos, Spain

The second EB meeting was held in March, in Burgos, hosted by CIUDEN, immediately following the consortium technical meeting on the day before.

Workshop on 25-26 June at TNO, Utrecht, The Netherlands

A workshop was organised to discuss the translation of results from the work done in the 'technical work packages' to input for the techno-economic model of CCS chains. The technical work packages focus on the study of CO_2 mixtures in such areas as fluid properties and behaviour, corrosion and transport and injection. In IMPACTS, the results from these studies are to be used to reach conclusions about the relation between the quality of the CO_2 stream and the design and operation of CCS chains – the project's goal a study of the trade-off between mixture quality and the cost of building and operating a CCS chain.

During the meeting, the relation between detailed technical results from the different areas of technical study and the high-level parameters of a techno-economic study was discussed. The discussions resulted in a clearer definition of the relation between the results obtained by the technical work packages (such as corrosion rates and CO_2 mixture phase behaviour) and the list of CAPEX (investments) and OPEX (operational costs) items, which are the typical inputs for a techno-economic model.

A second workshop on this topic is planned for September 2014.

Current activities

Thermophysical behaviour of CO_2 mixtures

The work in thermophysical behaviour of CO_2 mixtures is now ongoing at Ruhr Universität Bochum (RUB), SINTEF and Tsinghua University, following the workshop with groups from all over the world that was held at the start of the project (see Newsletter 1).

In the past period, two reports were published (see below, under Publications).

Transient fluid dynamics of CO_2 mixtures

At SINTEF, the implementation continues of the thermodynamic routines for mixtures of CO_2 with impurities.

SINTEF, CSM and TNO are also continuing the benchmark study simulation of tools for flows of CO_2 with impurities. A report on this work, focusing on transient phenomena in pipelines and installations (see also the report described below in the section on Publications), will be issued later in 2014.

Corrosion potentials in CO_2 infrastructure

A literature overview of corrosion work and corrosion models was finished and published as an IMPACTS report (see below, under Publications). Current work concentrates on the selection of materials and mixtures; corrosion experiments are ongoing.

Chemical and physical effects of impurities on CO2 storage

The main result obtained in WP1.5 of IMPACTS project is the compilation of a report that summarises the identified knowledge gaps of both chemical and physical effects of impurities on CO_2 storage based on a comprehensive literature review. The report summarises the effects of impurities in CO_2 streams on reservoir and seal formations, as well as effects related to technical installations and issues concerning site management and well operation. Further achievements comprise the definition of a work plan including impurity species, impurity concentrations, solid rock and cement samples, pressure and temperature conditions for experiments to be conducted within WP1.5 in order to close the most significant knowledge gaps. For the modelling part, data has been exchanged for setting up geo-engineering models including implementation of updated equations of state for relevant gas mixtures. A first set of batch and flow-through experiments has been completed and solid as well as fluid data has been collected. These data are currently being processed and analysed to be available for interpretation soon.

Further work done during this period includes the performance of laboratory experiments, by CIUDEN and GFZ, according to the test matrix agreed and discussed with the partners. The first experiments with CO_2 mixtures, using SO_2 as impurity, have been completed. In parallel, modelling activities, by CIUDEN and TNO, have started with the aim of defining the effects of common

impurities in CO_2 streams when interacting with reservoir rocks, brine or cements. CIUDEN will use the Hontomín site as a case study while TNO will focus on the Ketzin site.

Operational and material effects of impurities in CO_2 streams

After the successful performance of the work related to the injection of N_2-CO_2 at the Ketzin site during the last summer, field scale activities within IMPACTS are planned in relation at the Hontomín site. The wells in this facility have been instrumented, with diverse systems installed into the drilled wells: pressure and temperature sensors all along the wells, a DTS (distributed temperature sensor) line and different geophysical devices, including arrays of ERT (electrical resistance tomography) electrodes and a line of hydrophones for seismic monitoring, as well as a U-tube system to acquire deep fluid samples from the reservoir. This is especially interesting once the push-pull tracer test takes place. Geophysical and hydraulic characterization tests, including CSEM (controlled-source electro-magnetic method), cross-hole tomography and gravimetrical monitoring, have been successfully carried out so far, generating further geo-electrical and gravimetric baselines and precise hydraulic data for improving the characterization of the storage complex.

The IMPACTS consortium was offered a site visit to the Ponferrada site, as part of the March Burgos meeting. The site visit was arranged to the CIUDEN CO_2 transport rig where the dynamic tests of IMPACTS are going to be held.

CO2 Injection well (H-1, left) and U-tube system (control board, right) at Hontomín.
The CO_2 pipeline leading to the well head is clearly visible in the centre of the image.

Hontomín site, showing the CO_2 pipeline from the storage tanks to the injection well

Panoramic view of the Hontomín site, showing the CO_2 storage tanks (just right of centre), the injection well (inside the small building on the left) and water storage reservoirs (at the far right).

Techno-economic analyses of impacts of CO_2 quality

The preparation of the analysis of the impact of CO2 quality on the design and performance of CCS chains continues. A number of reference cases were defined and described in *Establishment of typical CCS chains and their parameters* (for an outline, follow this link) and outline costings for each of these are being developed, mainly from public data sources. The analysis will study the various

elasticities of CCS chain costs versus the impacts of CO_2 quality, such as corrosion rates and injection rates. Information about the technical impacts of impurities will be provided from other parts of the IMPACTS project and the arising changes in costs will be derived through dialogue and specialist knowledge of project partners. The workshop held at TNO in June (see above) was dedicated to discussing this interaction within the project.

Risk assessment

The work on risk assessment of the transport and storage of CO_2 mixtures has started during the past period. As a first task, an inventory of the current state-of-the-art in risk assessment is being set up.

Publications

In the past period a number of deliverables has been produced.

D 1.2.5 *Validation of the Current Version of the Reference Model for Thermodynamic Properties* by Stefan Herrig and Roland Span

A new mixture model for thermodynamic properties of CO_2-rich mixtures common for Carbon Capture and Storage applications was developed and presented by *Gernert (2013)*. The model allows calculations of mixtures containing carbon dioxide, water, nitrogen, oxygen, argon, and carbon monoxide. Within WP 1.2 a thorough validation of the new model was carried out. *More*…

D 1.2.8 *Investigation of models for prediction of transport properties for CO_2 mixtures* by Anders Austegard, Jakob Stang, and Geir Skaugen.

Several models for transport properties that are suggested in the literature are investigated and compared with collected experimental data on mixtures of CO2. Binary mixtures of CO2 with the impurities Ar, CH4, CO, H2, N2, N2O, O2 or SO2 in temperature, pressure and concentration range relevant for transport, capture and storage. Models for viscosity, thermal conductivity and diffusivity are compared. The standard models available in the NIST Reference Fluid Thermodynamic and Transport Properties Database (REFPROP Version 9.0) are also included in the comparisons. New regressed parameters for use with existing models are also found and presented. *More* …

D1.3.3 *Benchmark cases for CO_2 transport simulation tools* by Alexandre Morin, Jeremy Veltin, and Giorgio Melis.

In IMPACTS, three CO_2 transport simulation tools are available to the partners:
-The commercial simulator OLGA at TNO
-The SINTEF in-house code
-Fluent with a CO_2 thermodynamic library at CSM

The present memo describes a series of test cases which are designed to test the three tools in situations relevant for the design and operation of a CO_2 transport pipeline network. *More*…

D 1.4.1 *Corrosion resistance of Carbon steel pipelines in presence of CO2 mixtures: literature review* by Andrea di Schino, Zhe Wang, Massimo di Biagio and Yong Xiang.

In this document a literature survey has been conducted focusing on the experience of the Oil & Gas industry in environments containing CO_2 and relevant impurities. Moreover a review of corrosion models has been carried out.
This literature review presents the available models that permit to predict the corrosion rate of steel

in the presence of CO_2. *More* ...

D 2.1.4 *Operational regimes and mixtures to be assessed for economic impact* by Charles Eickhoff, Timea Kovacs, Sebastian Fischer and Ignacio Llavons.

This report sets out the operational regimes and mixtures which will be used in the experimental work within WP2.1. The report draws on the envelopes of anticipated operational regimes in the benchmark CCS chains and within which certain CO_2 mixtures will have impacts on flow or materials in the transport and in the reservoir and storage parts of the chain. Those involved in the experimentation have collated this information and overlaid it with knowledge of the experimental and injection facilities available to the IMPACTS project.
The conditions derived will be used in experimental work to derive actionable impacts data about the effects of impurities on transport and storage materials to other WP's, in particular WP2.2.

D 4.2.1 *WEBSITE* by An Hilmo, Astrid Lilliestråle and Astrid Lundquist

As a part of the running dissemination activities a website for the IMPACTS project has been established. The objective of the website is to be a channel of information to the public domain and where all project information and results that can be made public can be found. The web-address is http://www.sintef.no/IMPACTS. Information about the project like objectives, project overview, activities and partners is given. The website will be continuously updated with project news and project reports and publications with dissemination level public. *Go to website*…

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