NorTex Petroleum Cluster

– Large Scale Collaboration Emphasizing Mobility Control and CO2 EOR in Field Pilots in Texas

by

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Rice University's Consortium for Processes in Porous Media, Houston, TX, USA, April 29th, 2013.
NorTex Petroleum Cluster

✓ Texas and Norway leading regions within petroleum research and education
✓ Common interests
✓ Complementary expertise
✓ Energy and Environment

http://www.nortexpetroleum.org
Petroleum research relations between Texas and Norway

1. MoU between Rice University and Petroleum Research School of Norway
2. MoU between UT Austin and Petroleum Research School of Norway
3. MoU between UiS and U. of Houston
4. MoU between NTNU and UT Austin
5. Several research collaborations between universities in Norway and universities in Texas
6. Statoil's support of UT Austin, with possible expansion
7. Energy initiative E2I at Rice University in 2012
Research Partners:

4 Universities in Texas, USA
- Rice University, Houston, TX, USA
- University of Houston, Houston, TX, USA
- University of Texas at Austin, Austin, TX, USA
- Texas A&M University, College Station, TX, USA

4 Universities in Norway:
- University of Bergen, Bergen Norway
- University of Stavanger, Stavanger, Norway
- University of Oslo, Oslo, Norway
- NTNU, Trondheim, Norway

Industry partners
- Statoil Petroleum ASA
- Schlumberger
International and Inter-institutional Collaboration

- Work Force
  - PhD students (400+)

- Communication and Information
  - Adjunct Profs. from Counterpart Country

- Industry Challenges Exposed to Academia
  - Industry lecturers
Nasjonal forskerskole i petroleumsfag (NFiP)

Petroleum Research School of Norway

www.NFiPweb.org

Prof. Arne Graue
Chairman of the Board

Dept. of Physics and Technology
U. of Bergen
Objectives

Strengthen and coordinate petroleum research and education in Norway and Texas.

Emphasize industry challenges in academia.

Facilitate industry funding for adjunct and chair positions at the collaborating universities; especially emphasizing the NorTex collaboration for innovative results.
NorTex Petroleum Cluster Board Members and Deputies

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Energy Poverty is Widespread

- Million people without electricity
- Million people without clean cooking facilities

1.3 billion people in the world live without electricity & 2.7 billion live without clean cooking facilities
The Global Energy Challenge

- More energy
- Cleaner energy
- Energy security – oil & gas
Length Scales

$10^{-5}-10^{-3}$ m

$10^{-3}-10^{-2}$ m

$10^{-1}-10^{0}$ m

$10^{1}-10^{3}$ m

$10^{4}-10^{10}$ m

Microscopy

MRI and CT

Nuclear Tracer

Numerical Simulations

GRIDBLOCK SCALE

BLOCKSCALE

CORESCALE

IMAGING techniques
Next Generation CO₂ Flooding

According to a US White Paper on CO₂ EOR, based on a report requested by US DOE from Advanced Resource International Inc., US import of foreign oil may be reduced by 30% if a "next generation CO₂ EOR technology" based on mobility control can be achieved.

Economically, based on an oil price of US$ 85 and a CO₂ price of US$ 40 per metric ton, 68 billion barrels of oil may be produced and will correspond to an increased oil production of 1,35 billion barrels of oil every year in the US for 50 years. Similar results on increased oil production may be obtained elsewhere, either based on CO₂ or other miscible gases like HC-gas; which was very successfully used in the North Sea pilot on the Snorre Field.

CO₂ for Enhanced Oil Recovery (EOR) within Carbon Capture Utilization and Storage (CCUS) represents a win-win situation; obtaining significant increased oil production while sequestering CO₂. Early CO₂ breakthrough and poor sweep efficiency are the main challenges in CO₂ EOR and up-scaling of laboratory EOR to field performance is the ultimate challenge for the oil industry.
CCUS as EOR:
Integrated EOR (IEOR) for CO₂ Sequestration

CO₂ Foam for Mobility Control for EOR in Fractured Reservoirs in Texas

Collaboration: 11 Universities in France, The Netherlands, UK, USA and Norway

Coordinator: Arne Graue, Dept. of Physics, University of Bergen, NORWAY

Funding: The Research Council of Norway and oil companies

Lab to pilot field test

MRI of CO₂ injection

Complementary NTI & MRI facilities
CO$_2$ Foam for Mobility Control for EOR in Fractured Reservoirs in Texas

Project advantages:
- CO$_2$ is commercially available
- Foam and mobility control: quantum leap within EOR
- Researchers from 11 reputational universities
- Up-scaling; major challenge in oil recovery
- Fraction of costs of off-shore field tests
- Fast results: short inter-well distances
- 30 years experience in Texas on CO$_2$ EOR
- 4D seismic; seismic surveys before, during and after CO$_2$ injection establishes a field laboratory
- Mobility control may establish next generation CO$_2$ EOR flooding providing less than 10% residual oil in swept zones; establishing a new era in EOR; 137 billion barrels of oil will be the target in USA.
Research Collaboration on CO$_2$ Foam for Mobility Control for EOR in Fractured Reservoirs
Coordinator: A. Graue, UoB

**Upscaling:**
- Micro models
- Core analysis
- Blocks of rock
- Grid scale
- Field pilots

**Targets:**
- Sor pore level
- Sor makro
- ROZ
- Heterogeneities
- Fractures

**Collaboration: 11 universities**
- Rice University
- University of Texas at Austin
- Texas A&M U.
- Stanford U.
- Imperial College, London
- TREFLE, Bordeaux, France
- U. of Kansas
- New Mexico Tech
- TU Delft, The Netherlands
- NTNU, Trondheim, Norway
- University of Bergen, Norway
Thank you!