Ensuring integrity of shale gas wells in Europe

M. Torsæter, K. Gawel, J. Todorovic, A. Stroisz, R. Skorpa and A. Lavrov

SINTEF Petroleum Research, Trondheim, Norway
Wells are most probable leakage paths!

Weak wells not fracking caused US gas leaks into water

By Matt McGrath
Environment correspondent, BBC News

A new study suggests that the contamination of drinking water by shale gas is due to faulty wells and not hydraulic fracturing.

Researchers in the US analysed the gas content in 130 water wells in Pennsylvania and Texas.

The researchers used noble gases to trace the path of methane as these inert chemicals are not affected by microbial activity or oxidation.

By measuring the ratios of the noble materials to the methane they were able to accurately determine the distance to the likely source.

The scientists analysed content from 113 wells in the Marcellus shale in Pennsylvania and 20 in the Barnett shale in Texas. They found eight clusters of wells with problems.

"The mechanism of contamination looks to be well integrity," said one of the authors, Prof Robert Jackson from Stanford University.

"In about half the cases we believe the contamination came from poor cementing and in the other half it came from well casings that leaked."

Well integrity closely correlated to public acceptance!
Well integrity: *From drilling to plugging*

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Well integrity: *From drilling to plugging*

Drilling

Cementing

Operations

Plugging

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Unavoidable geological issues:
- Natural fractures
- Elevated pore pressures
- Sharp pressure changes
- Laminated rock
- Reactive clays

**PRD:** Methods for better understanding in-situ conditions (including 3D mapping of fractures)

**Documented:**
- Borehole instability
- Poor hole cleaning, strong torque & drag on pipe, packoffs, bit balling, low rates of penetration, casing placement probs.
- Gas influx during drilling
- Lost circulation, formation fracturing higher up in hole (last casing point)

Use oil-based mud, perform thorough characterization of both reservoir and overburden
Well integrity: *From drilling to plugging*

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Shale cementing problems

Documented:
- Naturally fractured laminated rock (anisotropic stresses)
- Loss of cement
- Boreholes are rarely circular (breakouts)
- Poor mud displacement
- Reactive clays: Casing cemented off bottom
- High pore pressures: Gas migration through cement during setting

Use centralizers, tailor cement/mud/spacer properties, log frequently.

PRD: Develop log/method that can verify cement barrier sealing ability.
Well integrity: From drilling to plugging

Drilling

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Shale well operational damage

Documented:
- Pipe corrosion/erosion.
- Sustained casing pressure due to mechanical damage to cement after setting.
- Casing diameter changes
- Formation motion
- Casing deformation (well intersects plane on which displacement is induced during production: weakness, fracture, fault)

**PRD:** Enable continuous non-invasive well integrity monitoring

Tailor barrier materials, continuously monitor sustained casing pressure
Well integrity: *From drilling to plugging*

Drilling

- Cuttings
- Mud
- Annulus
- Drill Pipe
- Drill Bit
- Drilling Mud

Cementing

- Cuttings
- Annulus

Operations

- Operations

Plugging

- Plugging
Shale well long-term safety

Documented:
- Degradation of well barrier materials.
- Poor quality of plugs.
- Methane leakage to surface.
- Global differences in plugging standards.

It is still unknown how leakage rate development varies with time.

**PRD: Ways to assess and remediate plugged wells**

Find out what works: Perform leakage monitoring at well site after plugging.
Prediction of problems in Europe

Properties of U.S. gas-bearing shales (depth, temperature, composition, etc.)

Compare, find analogue

Properties of European gas-bearing shales (depth, temperature, composition, etc.)

Properties behavior

Drilling and well-integrity challenges in the U.S. shale plays

Project U.S. experience onto European shales

Drilling and well-integrity challenges expected in European shale plays
Well Integrity predictions for European shales

Upper Ordovician & Silurian shales in the Baltic-Podlasie-Lublin Basin

- Borehole instability
- Lost circulation during drilling/cementing
- Bit balling, poor hole cleaning and packoffs due to high clay content
- Cement integrity problems due to high temperatures and great depth

Haynesville

Midland Valley

- Shallow gas influx during drilling
- Poor performance of water-base mud
- Problems getting casing to bottom
- Incomplete cementing
- Influxes and lost circulation in shale
- Poor hole cleaning
- Sustained casing pressure

Bowland shale

Barnett

Weald/Wessex Basin

Haynesville

Marcellus

Barnett

Midland Valley
General recommendations

• **General:** Data sharing is necessary, we need openness about successes and failures in the field.

• **Know the subsurface:** Thorough characterization of not only reservoir but also overburden.

• **Do it right the first time:** Implement best drilling practices. Think about the whole well life cycle when choosing fluids and materials.

• **Always try to improve:** We suggest several Prioritized Research Directions (PRDs) for improving well integrity in shale gas wells.
Thank You For Your Attention!

Contact:
Malin Torsæter, SINTEF Petroleum Research
Malin.torsater@sintef.no