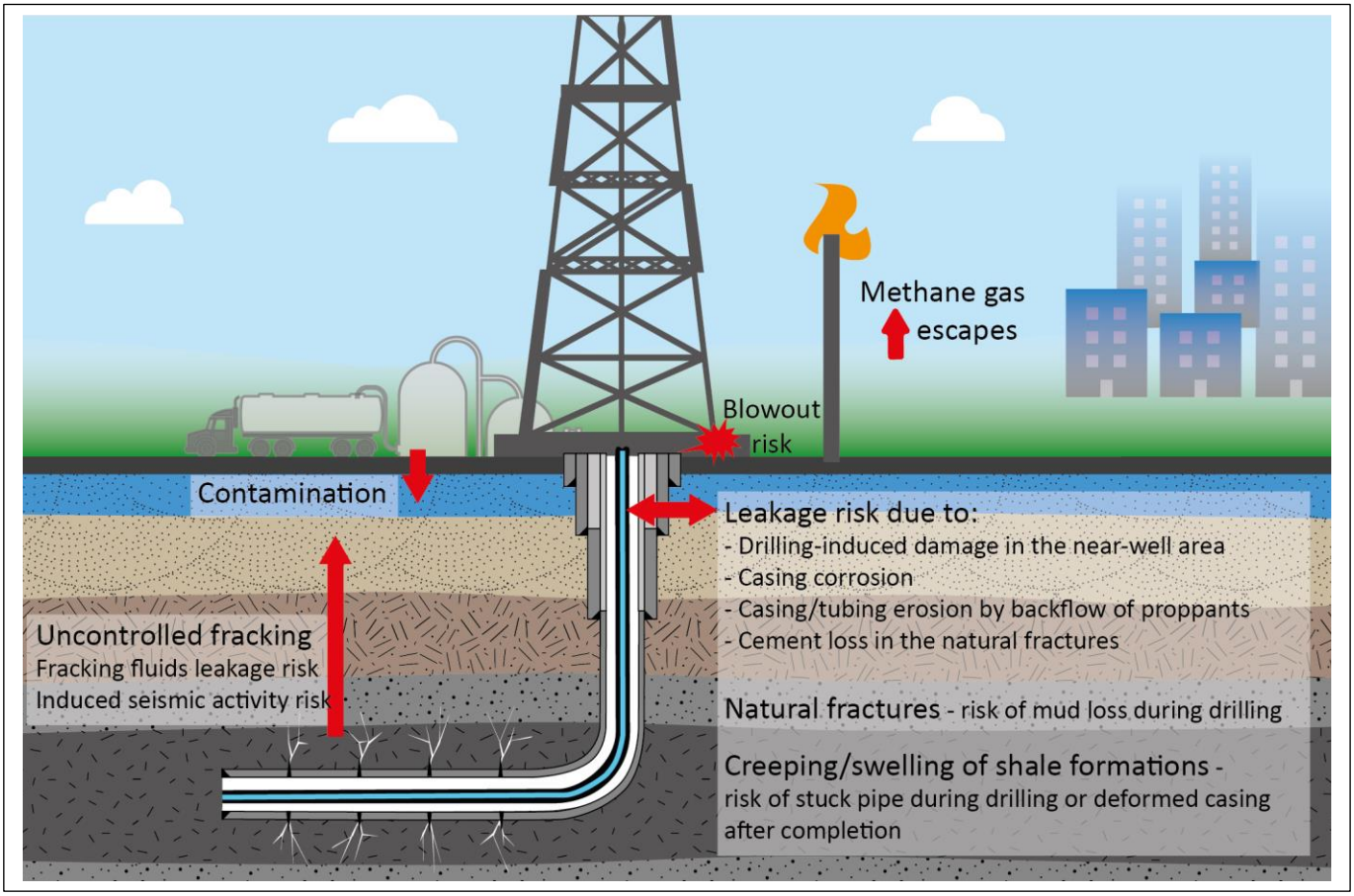
MINIMIZING RISKS AND IMPACTS OF SHALE GAS DRILLING, COMPLETION AND PRODUCTION IN EUROPE

A. LAVROV, R. SKORPA, A. STROISZ, M. TORSÆTER



Background

Through novel well drilling and stimulation techniques (horizontal drilling and multi stage hydraulic fracturing), shale gas resources can be economically developed today.

Several unique technological challenges are related to shale gas drilling, completion and production. Maintaining shale gas well integrity from drilling to abandonment requires understanding of how various parameters/choices impact safety.

We here provide an overview of these, together with a collection of operational recommendations for how to best prevent and mitigate problems.

Study

We have studied the current best practices and emerging technologies for shale gas well drilling, completion, production and abandonment with particular focus on:

- Current state-of-the-art
- Emerging methods and materials
- Avoiding and remediating problems
- Potential regional differences

Our goal was to compare available shale gas data from Europe with data from more mature shale gas regions like the US and Canada. This was done to find analogies and **predict possible well integrity issues that can be encountered in Europe**. Such an assessment is important in order to prepare for avoiding and mitigating such problems. The study draws upon published scientific literature, standards and best practices.

Results

Four review reports have been written in the project covering the following topics:

- Summary of the state-of-the-art on shale gas drilling, completion and production in North America
- Overview of new and emerging methods and materials developed specifically for shale gas wells
- Description of current methods for avoiding and remediating shale gas well problems
- Predictions of the most likely shale gas well problems that can be encountered in Europe

The most important finding of the project was that there is a **need to share data**. Comprehensive, reliable and publicly available databases on shale gas plays (e.g. shale properties) and shale gas wells (e.g. completion solutions) is necessary to prepare for safe exploration and production.

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Science-based Recommendations

General

- A database and protocols must be prepared and continuously updated by the operators, with data pertaining to well integrity (e.g. lithology, shale properties, in-situ temperatures and stresses, well design schematics, leakage and sustained casing pressure data, well-integrity cases histories). The database should be available in public domain to facilitate research and monitoring performed by independent contractors and government authorities
- Long-term integrity monitoring of both active and abandoned wells

Pre-drill phase

- Measure the in-situ stresses to optimize location, orientation and design of the well. Optimize placement and design to eliminate detrimental effects of hydraulic fracturing in the near-well area
- Adjust parameters of the barrier (type, size and length) based on the subsurface conditions and purpose of the well
- Measure in-situ stresses, temperatures, and pore pressure distribution in the reservoir and in the cap rock during exploration
- Perform thorough characterization of fractures and faults within and around the reservoir, e.g. by routinely using image logs and formation pressure tests in wells
- Perform thorough rock mechanical characterization of shale and cap rocks
- Perform dedicated and comprehensive field tests, laboratory study and modelling to determine the in-situ conditions. Investigate the influence of pressure and temperature changes on surrounding formations and well cement. Identify the short and long term impact of corrosive agents on the barrier system and rocks. Select the materials most relevant for the conditions to maximize the lifetime of barrier. Source track and inspect the quality of materials before use
- Design wells to withstand not only a primary multi-fracturing, but also a potential re-fracturing

Drilling and production phase

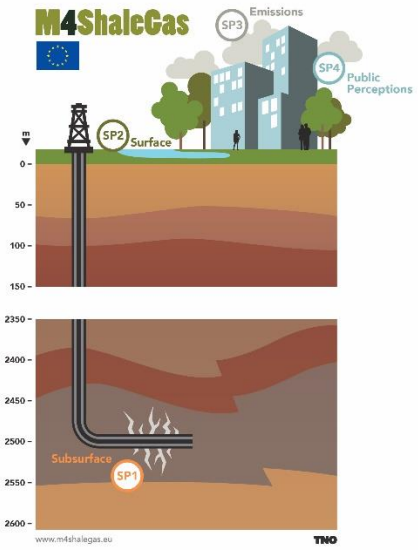
- Continuously update information about rocks and natural fractures during drilling and well construction
- Optimize mud properties to prevent borehole instabilities, mud losses, fluid influx, bit balling and hole pack-off
- Minimize future casing corrosion by using e.g. special coatings and materials
- Perform extended leak-off test at each casing point in order to quantify the fracture gradient; pressure test all the wells regularly
- Use image logs and other available information to mitigate losses into natural fractures during drilling and cementing
- Check quality of cement bonding and cement height in the annulus
- Keep casing as centralized as possible during cementing
- Prevent gas migration during cement setting in abnormally pressured formations
- Modeling tools to predict propagation of fractures in three dimensions are needed to optimize hydraulic fracturing in horizontal and deviated wells

Completion and abandonment phase

- The production tubing in the abandoned well should be plugged with cement to seal it. Also, top of the well can be cut below the surface, welded shut and buried
- Before complete termination, well should be tested for sustained casing pressure and gas migration within several months after cement plugging. The soil above should be surveyed for potential contaminations every several years
- Obligatory monitoring of abandoned wells should be financially secured in case of unforeseen events such as overtime barrier failure so that the responsibility does not rest with the state i.e. public funds.

The Project

M4ShaleGas examines the potential environmental impacts and risks related to **shale gas** exploration and exploitation in Europe with the goal to build a technical and social knowledge base on best practices and innovative approaches for **m**easuring, **m**onitoring, **m**itigating, and **m**anaging these impacts.



4 sub-programs:

- SP1-subsurface
- SP2-surface
- SP3-air emissions
- SP4-public perceptions

Funding:
The project that has received funding by the European Union's Horizon 2020 research and innovation programme under grant agreement number 640715.

Horizon 2020 Topic LCE-16-2014:
Understanding, preventing and mitigating the potential environmental impacts and risks of shale gas exploration and exploitation.

Project duration:
1 June 2015 – 30 November 2017

Coordination:

TNO

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