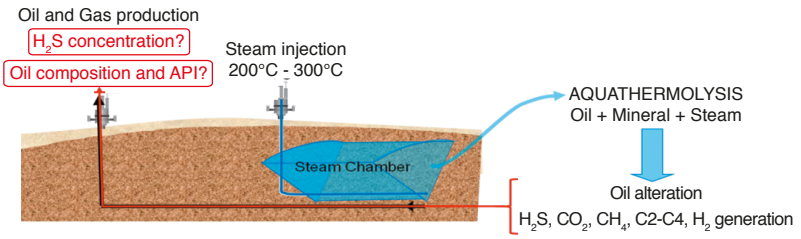
Forecasting H_2S production risk in thermal EOR projects



Heavy oils produced by steam injection EOR projects can be associated to H_2S production due to aquathermolysis.

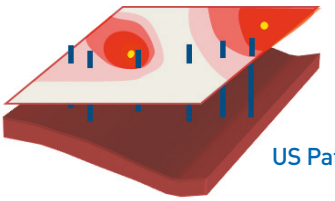
Hyne and al., 1986; Lamoureux-Var & Lorant, 2005

IFPEN solution: a tailor-made workflow to estimate H_2S concentration at the well-head and mitigate the associated HSE risks

Hot spots selection

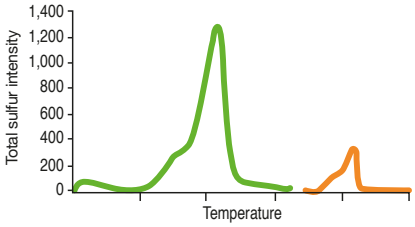
Characterization with unique lab equipment (Rock-Eval-Sulfur) and geomodel building – *adapted to any reservoir specifications*

- Areas of H_2S production risk
- Selection of the most relevant core samples for the laboratory study



US Patent No 9 940 413, EP 2.775.092

Organic sulfur → H_2S



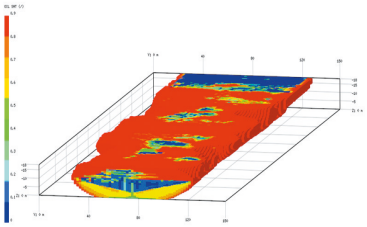
Laboratory study

Calibration of the kinetic model based on H_2S and oil data from aquathermolysis experiments on reservoir rock sample - *at different times and temperatures*

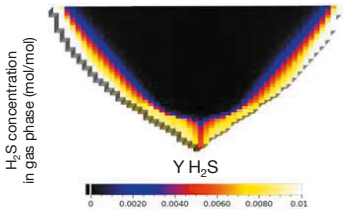
- H_2S yield (time, T, sulfur)
- Oil composition (time, T, sulfur)

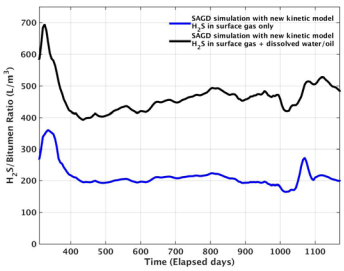
Reservoir simulation

Advanced EOR process simulation - *for steam injection, fluid flows, aquathermolysis, PVT*



- In the reservoir:
  - H_2S concentration
  - Oil composition
- All the well-head:
  - H_2S concentration
  - Oil composition and API





SPE Journal 174441-2017

Flexible to customer's needs and adaptable to any reservoir specifications

IFP Energies nouvelles (IFPEN) is a public research and training player. It has an international scope, covering the fields of energy, transport and the environment. From research to industry, technological innovation is central to all its activities.

IFPEN background

R&I since 2004:

PATENTED

4 patents and 13 publications

Among others:

- Sulfur-based kinetic model of H_2S generation
- SARA-based kinetic model of H_2S generation, compatible with reservoirs simulators

Proprietary reservoir simulator

PumaFlow™

Including compositional kinetic model for H_2S generation and oil conversion: entirely calibrated from aquathermolysis experiments

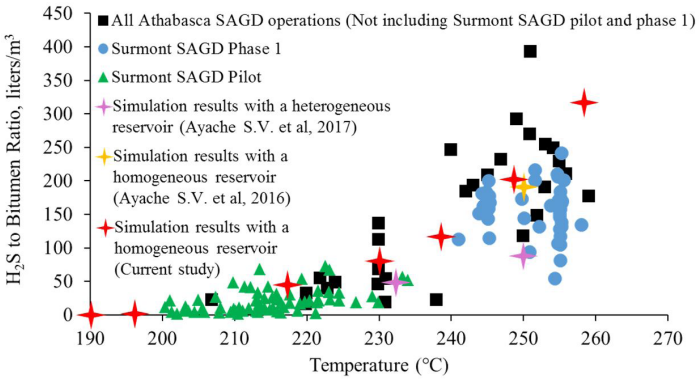
Calibration of the kinetic model and reservoir simulation performed on a unique simulator for a high accuracy

On-going research on compositional thermal reservoir simulation

Success stories

- Hangingstone heavy oil field: prediction of H_2S production in the context of steam injection
- Foster Creek asset: comprehension on the phenomena controlling the generation of H_2S in the reservoir during SAGD; successful prediction of H_2S production via reservoir simulation

Match with real SAGD H_2S production



From S.V. Ayache, J.D. Dorado et al., 2018 - Field data modeled after Kapadia et al. (2011, 2012)

IFPEN lab capabilities

Representative and accurate dedicated aquathermolysis experiments on reservoir rocks in gold bags:

- Followed by mass balances on atomic carbon and atomic sulfur
- Realized under inert atmosphere, with a wide range of test conditions (pressure: 4-12 MPa, temperature: 240-340°C, time: 1-52 weeks, oil/water ratio: 3/1-0.1/1)

On-going research on mineral effect

Rock-Eval-Sulfur

A unique lab instrument for geochemical characterization of reservoir rocks, used for quick localization of the areas of H_2S production risk

On-going research on sulfur thermal reactivity and reservoir characterization

Key benefits

- Identifying the possible H_2S sources
- Quantifying H_2S yield upon aquathermolysis conditions
- Prediction of H_2S production
- Avoiding costly remediation solution
- Limitation of HSE risks for selection of appropriate surface facilities

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