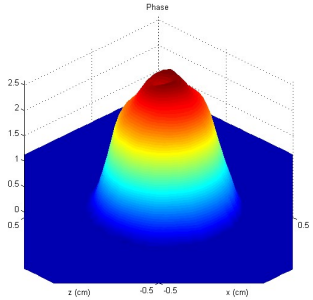
EASYWAX JIP

A JIP DEDICATED TO WAX DEPOSITION

Myriam DARBOURET
(myriam.darbouret@ifpen.fr)



WAX DEPOSITION CONTEXT

Responsible oil and gas

Current tools and methods

Modeling predictive tools

Several models available (MWP, Olga, TuWax, Leda…)

A criterion of 2 mm thickness before pigging

Dispersed results Which one to trust?

Experimental means

Flowloops equipped with pressure drop measurements, and sampling methods.

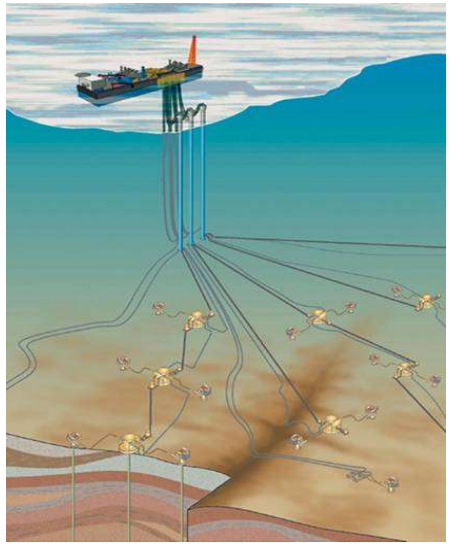
Tests under high temperature gradients (Representativeness?)

Field monitoring

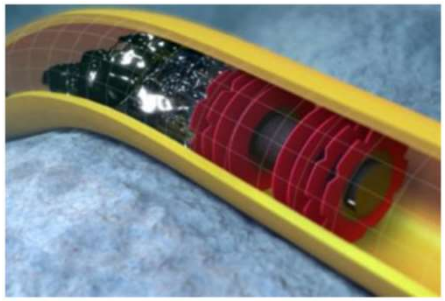
Only through pressure drop (too late?)

➔ Pigging frequency optimized depending on the amount of materials scraped by the pig

No reliable real time monitoring of wax deposit thickness



Onshore / Offshore production lines



Pigging operation

REMAINING CHALLENGES

Responsible oil and gas

During **design** phase

A need for reliable **predictions** of wax deposit

- **To reduce safety margin**
  - **Optimized insulation thickness needed**
  - **Optimized remediation strategy**

During **production** phase

A need for reliable **estimates** of wax deposit thickness

- **To optimize production operations**
  - **Pigging frequencies**
  - **Chemical dosages**

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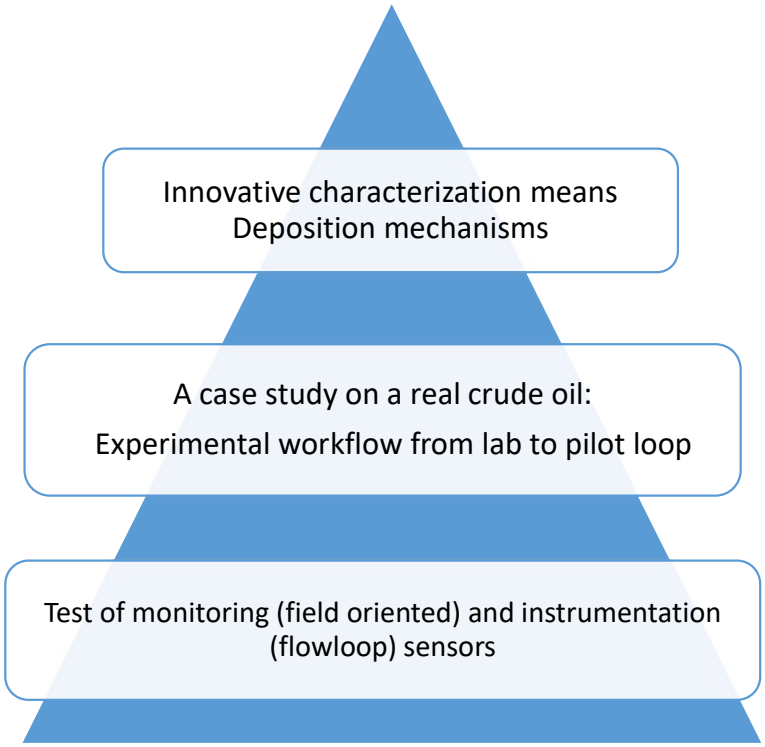
Main objectives

RESPONSIBLE OIL AND GAS

- **Provide recommendations for Design phase**
  - Identify the predominant mechanisms in wax deposit growth
  - Propose a characterization workflow that provide a reliable estimate of the input needed for predictive tools
  - Obtain a database using a heavily instrumented pilot scale flowloop that can be compared to the results of predictive codes used by sponsors in single and multiphase flows
  - Assess the efficiency of partial melting as a remediation technique
- **Explore monitoring techniques for Production phase**
  - Survey the literature and assess the most promising monitoring techniques for wax deposition detection
  - Test a pilot loop prototype
  - Assess the performance of specific new sensors in various flow conditions (single phase, multiphase)



An ambitious program to tackle the whole challenges of wax deposit

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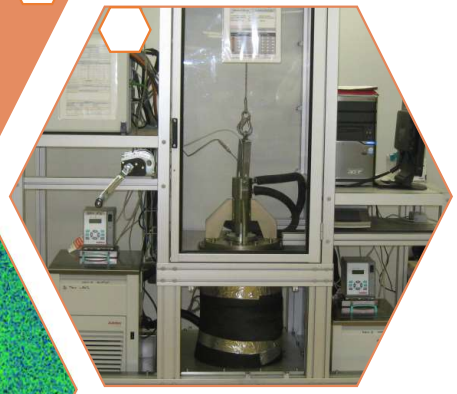
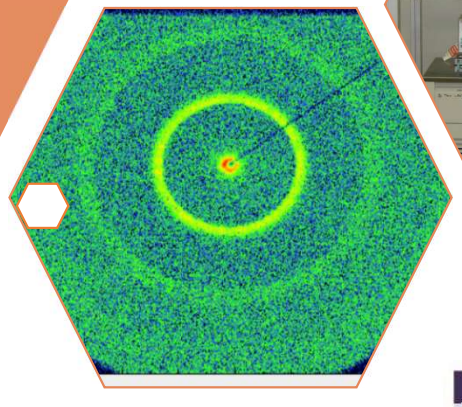
An ambitious project built on IFPEN unique multiscale, multi-techniques capabilities

Heavily instrumented multiphase pilot loop

Coupling Modeling and experimental studies



Innovative characterization techniques



Multiscale set-up: from lab to pilot scale

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WP1 :Predominant mechanisms in wax deposition

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Updated Litterature/ Technology watch

modeling, monitoring/detection, characterization

Deposition mechanism

Theoretical study with model fluids (visualization set-up)

Deposit structure

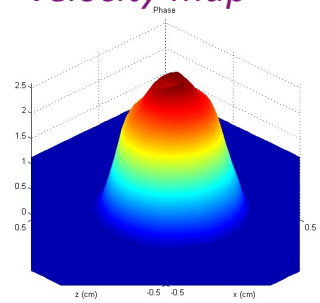
Innovative characterization means (SAXS/ WAXS, MRI)

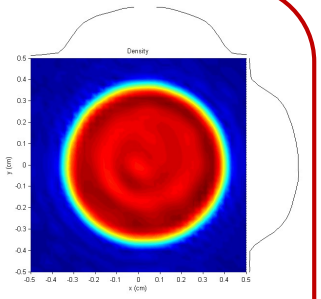
Remediation techniques (optional)

(Rheometer and SAXS/WAXS)

MRI techniques

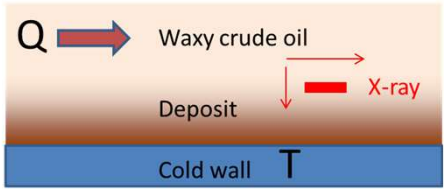
Velocity map





Density map

SAXS/WAXS techniques



Profiles accross the deposit (Chain lengths, concentration,..)

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WP2 :A multiscale experimental workflow – a case study

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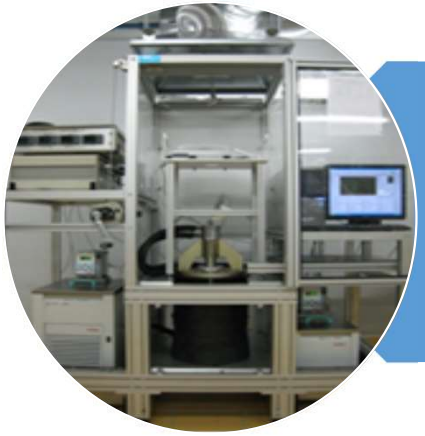
Which tests to characterize the deposition mechanism?

A multi-scale experimental workflow

Lab scale: Crude oil* and deposits characterization

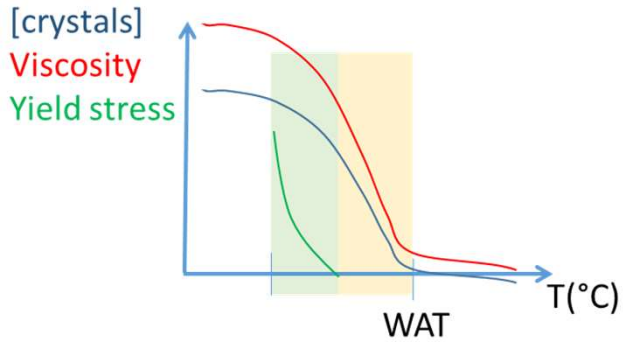
- WAT, solubility curve (DSC)
- Wax content (GC)
- Rheology (impact of solid wax crystals content on yield stress and viscosity)

**Crude oil sample provided by one of the sponsors*



Middle-scale: Wax Deposit formation

- Controlled temperature gradient and shear rate
- Kinetics of the deposit growth
- Diffusion coefficient determination



Impact of experimental conditions on wax deposition

- ❑ Impact of gelation at the wall and of crystals in bulk
- ❑ Link between T_{wall} and deposit composition and rheology
- ❑ Tests at different T_{wall} between PP and WAT

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WP3 :Pilot scale: Lyre loop tests and tests of monitoring

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A multi-scale experimental workflow

Lab scale: Crude oil and deposits characterization

inputs

Middle-scale: Wax Deposit formation

WP2

inputs

WP3

Crude oil sample and chemicals provided by sponsors

Pilot-scale: Lyre loop tests

- Single phase and multiphase flow conditions
- Real-time monitoring of wax deposit thickness
- Test a pilot loop prototype
- Performance of specific new sensors in various flow conditions (single phase, multiphase)
- A Database to be compared with the predictions from modeling tools
- Assess partial melting as a remediation technique

Comparison

From Sponsors:
Available Predictive tools
Olga
LEDAFlow
Michigan Wax predictor…
Field data

EASYWAX JIP *Benefits*

Responsible oil and gas

- A multiscale approach: from lab to pilot scale
  - Innovative characterization means to study the deposit microstructure and deposition mechanisms
  - Overlapping conditions for experiments with different techniques and scales
  - Well-chosen experimental conditions regarding the wall temperature gradient
- Open-minded approach regarding deposition mechanisms
- Building on existing softwares to define their domain of validity and optimal workflow
- Insight on most promising monitoring techniques
- Assess the efficiency of partial melting as a remediation technique

Innovating for energy

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