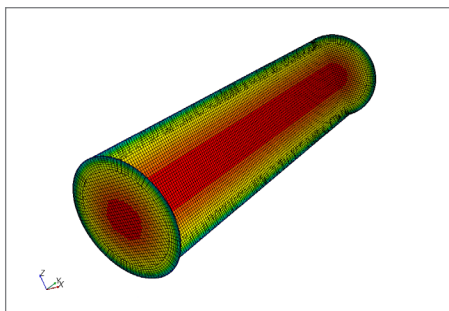


Multiphase flow assurance: BP

The Background



BP uses sophisticated technologies and industry proven techniques to find oil and gas under the earth's surface but the search remains complex and success is never certain. Each project can cost tens of millions of dollars or more. So before BP drills, it does as much planning as possible.

To extract oil from the sea bed in areas such as offshore Angola, BP will have to pump a mixture of oil, water and sand to the oil rig. Wax, present in the oil, may deposit in the riser pipe bends. BP needed to know whether these wax deposits would clog up the pipes. If so, they would have to periodically remediate the problem by soaking the tubing in hot oil. This would require an intervention in the affected producing well, which would lead to revenue loss. They needed to know more about the likely scale and frequency of wax deposition.

The Challenge

From an engineering perspective this posed a challenge. Ideally, BP would conduct laboratory studies to model the process but, because of the scale of the problem, loop flow studies in laboratories would not give an adequate representation and this was not feasible.

Instead, to meet its tight timelines, BP decided to attempt to model and simulate the problem using Computational Fluid Dynamics (CFD) and, on the recommendation from a BP colleague, contracted Renuda to undertake the project.

“Renuda’s simulations gave us the confidence to manage the wax deposition scenario effectively”

Paul Ravenscroft

Production Chemistry Advisor

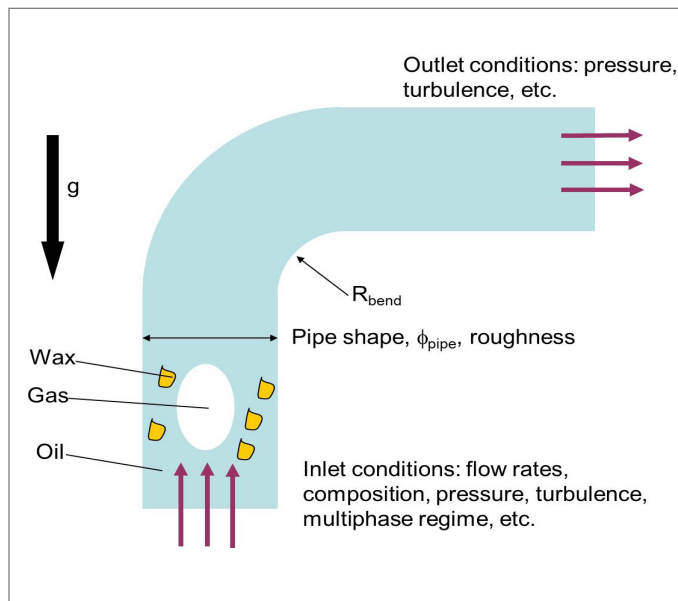
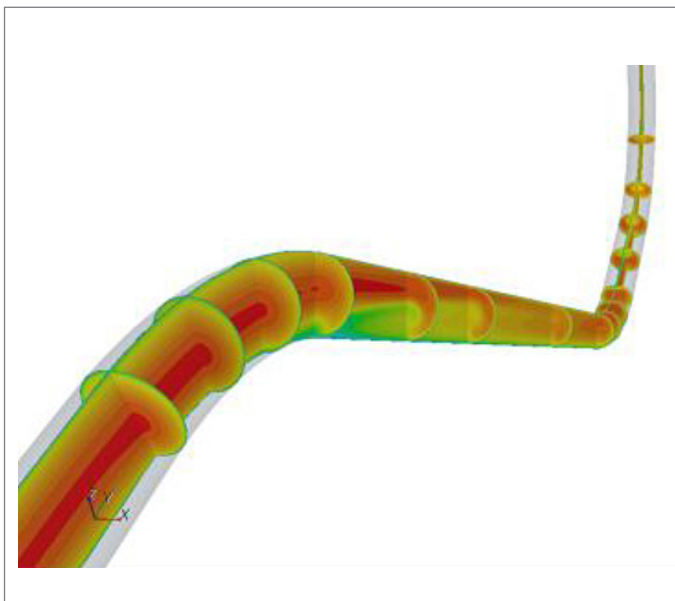
BP

The Solution

- The first step in the project involved working with BP to carefully establish a matrix of possible scenarios in order to obtain a map of results which would make it possible to evaluate the likelihood of wax deposition under realistic conditions.
- Using input data from BP's flow assurance and optimisation consultants, Renuda planned and conducted 12 simulations to determine how much wax would be deposited under different permutations of 4 particle sizes and 3 mass flow rates.
- In the second step, Renuda prepared the CFD models required to simulate the multiphase flow of the mixture of oil, water, gases and wax through the riser.
- The multiphase CFD model was based on the Eulerian-Lagrangian framework in order to follow accurately the trajectories of individual clumps of wax particulates as they are entrained in the flow through the riser and may come in contact with the walls.

“Renuda’s simulations provided evidence that mitigation will be required only periodically: this makes the project more economically viable”

- As preparations for the multiphase simulations of the riser bends, straight pipe simulations were first conducted to derive the correct flow profiles and appropriate inlet boundary conditions for each setup. These initial simulations made it possible to define the mesh cell sizes and computational mesh densities required for accurate simulations. .
- User coding was then developed to inject the Lagrangian parcels into the flow, and multiphase simulations were carried out.
- The simulations made it possible to visualise the flow through the riser and to quantify the behaviour of the wax particulates for each scenario, to construct an understanding of the likelihood of wax clogging for the operational matrix.



How BP Benefited

- Renuda's simulations gave BP the confidence to manage the wax deposition scenario effectively.
- The information provided by Renuda's CFD calculations was built into BP's wax management strategy for this particular development.

Unexpected Benefits

- Renuda produced visualisations of the proposed architecture from their CFD simulations. The pictorial nature of the output helped technical experts to get their points across clearly in presentations to engineers.

“We needed to do something unusual in the CFD area. Renuda’s consultant was very straight talking; he explained clearly what we could and couldn’t sensibly do with CFD in this situation”

Why did BP choose Renuda?

- The quality of their planning: before submitting a proposal Renuda worked with BP to make sure that they clearly understood the requirement. Even before they were appointed, they helped BP design the programme of work, setting a realistic expectation of what could be achieved.
- Renuda's incisiveness: they understand the issues and how CFD could assist with resolving the problem
- Timeliness: Renuda is very responsive and quick to react
- Renuda's willingness to communicate ensured a good working relationship with BP and other consultants on the project.

“Renuda didn’t try to oversell the capability of CFD. This gave us a lot of confidence in Renuda.”
Paul Ravenscroft

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