Oil & gas (3) : surface Processes

ADVANCED MODELLING & SIMULATION – AMS –

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Offer of services

Pöyry AMS group:

— Pöyry’s reputation in engineering services is worldwide acknowledged

— Pöyry’s AMS has expertise in the 3D simulation (CFD & CMFD) of oil & gas flows using their own simulation platform TransAT

— The AMS group adapts and implements models required by the clients to meet their interests and solve their pressing problems

— New projects are ongoing with potential customers.

Our Offering:

— If there is an interest in consulting then Pöyry AMS can prepare a project work and financial plan

— Alternatively, Pöyry can license its TransAT CFD/CMFD tool under competitive conditions to the clients.

Typical O&G Application Areas requiring CFD/c*m*fd

O&G Key Areas

Production
Equipment, Reservoir
Choke/ICD/Gas Lift Valve

Drilling
Design/Fluid Modelling
Cuttings Transportation

Process/Facilities
Platform Design
Equipment/Component
Pumps/Turbine

Flow Assurance
Slugging, Hydrates
Wax, Asphaltene, Black Powder
Erosion, Sand & Scale Deposition

3- Process/Facilities

Issues & Challenges:

- Sustainable production and delivery require continued surface operations for extraction, process & export:
  - Separation
  - Gauging & control equipment
  - Over and under-production
  - Distribution, line problems.
- Expansion of existing facilities

Benefits of using CFD/CMFD:

- Ability to predict complex transient situations in real configurations
- Better understanding of flow processes
- Intervention decisions can be efficient, minimizing risks and reducing costs.

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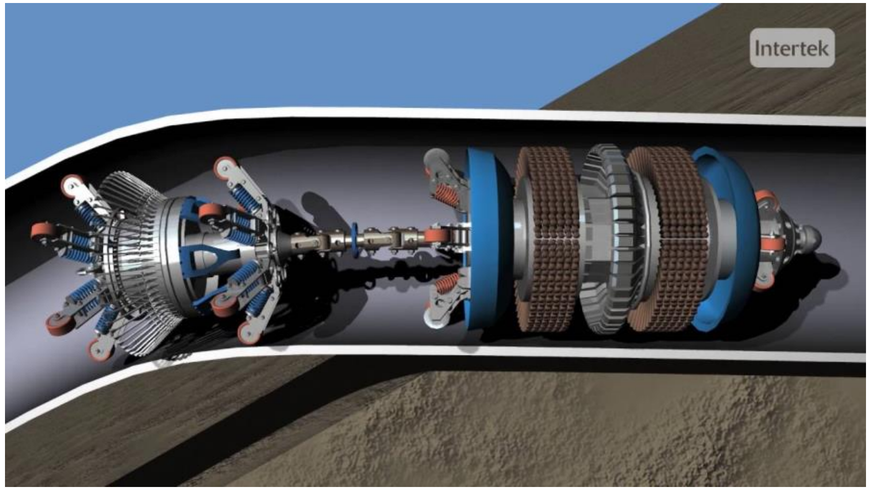
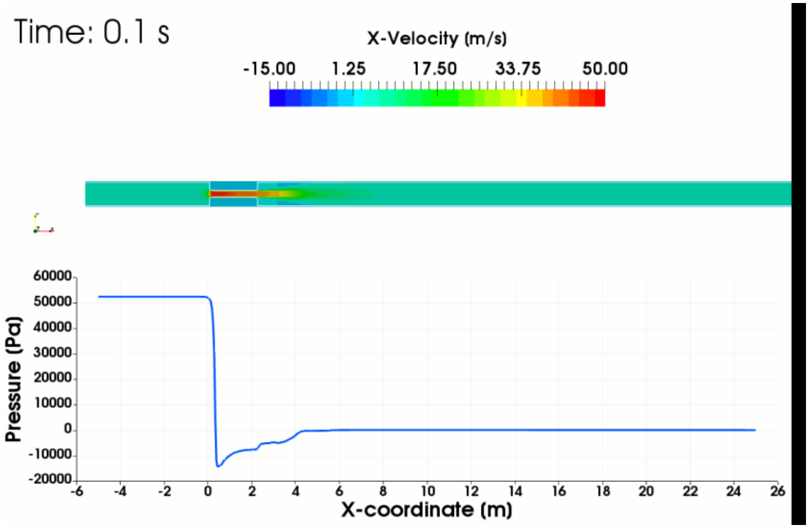
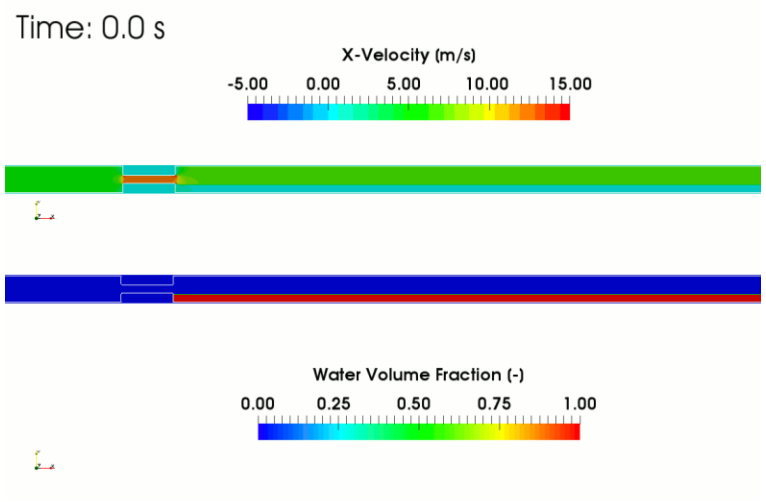
Pigging of gas and oil pipelines





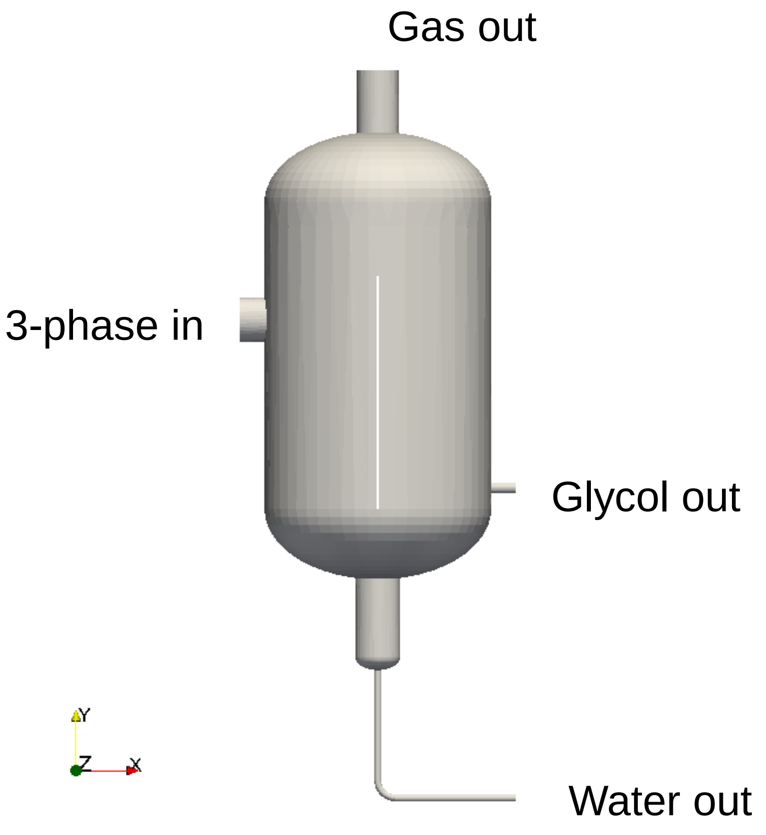


Gas pipelines

Oil Pipelines

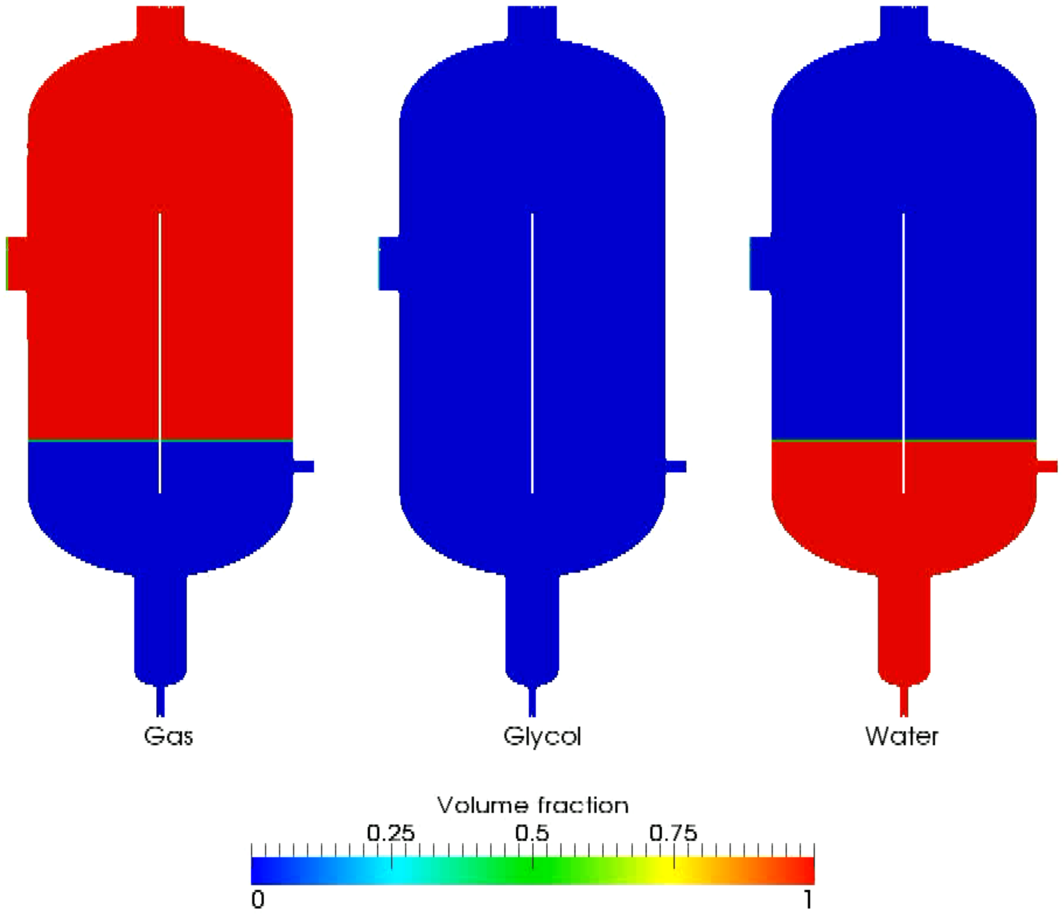
Case study 1: Zadco's vertical separator

- **Objectives:**
  - The aim of the project is to assess the performance of these type of vessels.
- **Points of interest:**
  - Best position of the gas demister at the upper section (used only for gas demisting). In the lower section there is no demister for liq/liq separation
  - Best position of the gas and liquid demisters at the upper and lower sections, respectively.
  - Changing the inflow mass flowrates of the 3 phases.
  - Changing the separation chamber to help improve the separation efficiency.
- **Solutions:**
  - Use the N-phase model in TransAT



Liquid /liquid separation for ZADCO's separation vessels 248-V-006 & 009

Zadco's vert. separator



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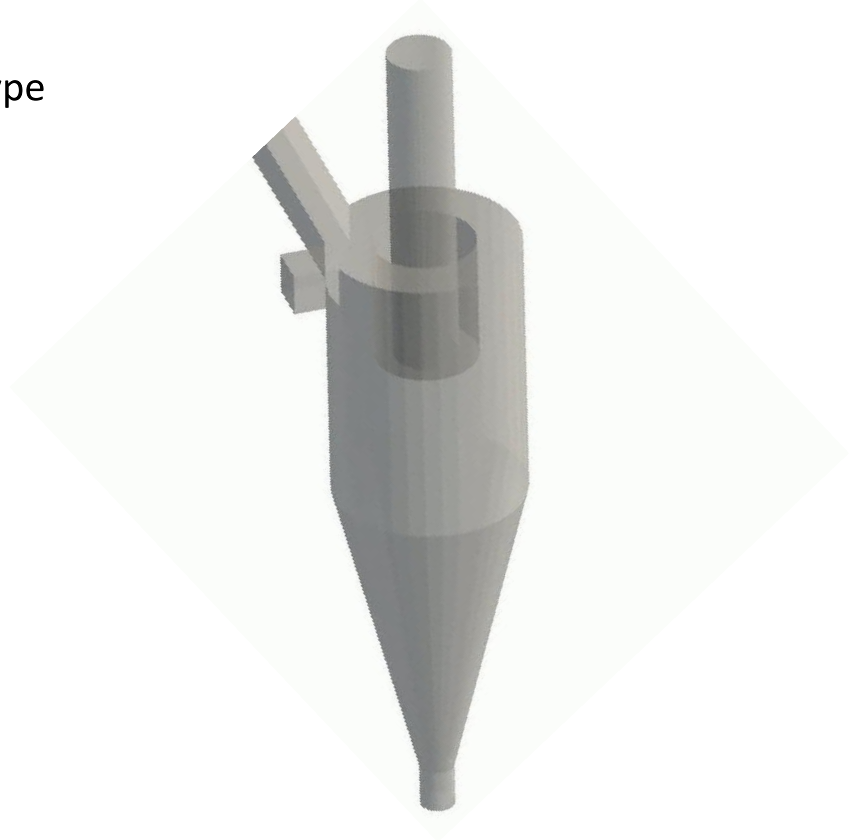
Case study 2: Aspen's cyclone separator

- **Objectives:**
  - The aim is to analyse the performance of these type of separators for variable flow conditions.

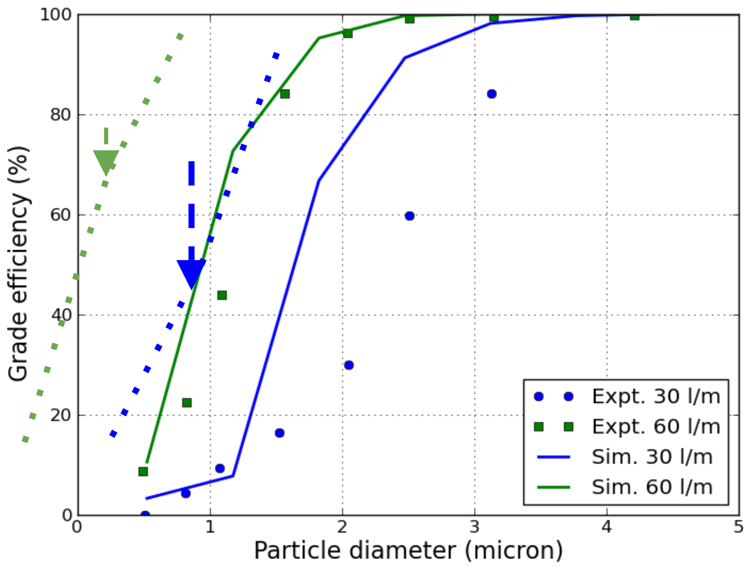
- **Points of interest:**
  - Optimize the inflow conduit
  - Analyse the deflecting mechanism to enhance mixing efficiency
  - Modifying inflow mass flowrates
  - Repeat for various particle diameters.

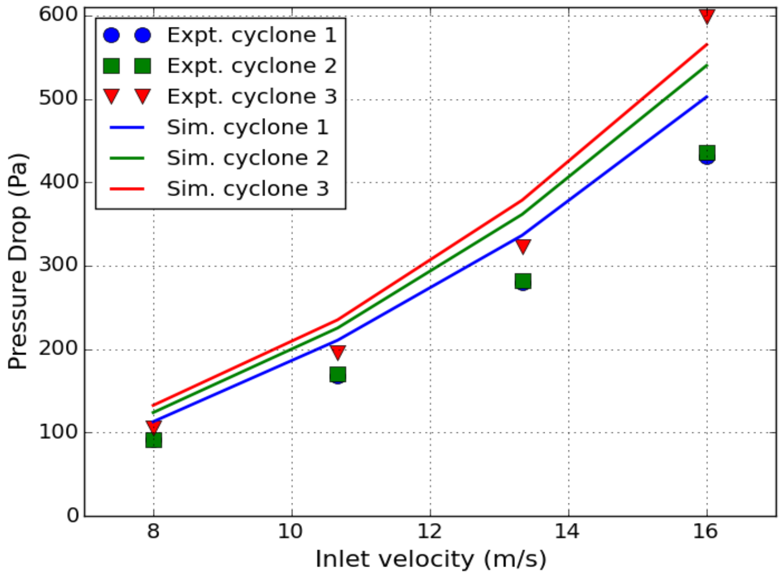
- **Solutions:**
  - Use the N-phase model in TransAT using the Eulerian-Lagrangian model.



Pressure drop & grade efficiency

— TransAT uses the RNG model with curvature modification of Lakehal and Thiele (2001); Fluent’s model correction is ‘undocumented’





Comparison with Xiang experiment

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Case study 3: Aramco's 3-phase gravity separator

Objectives:

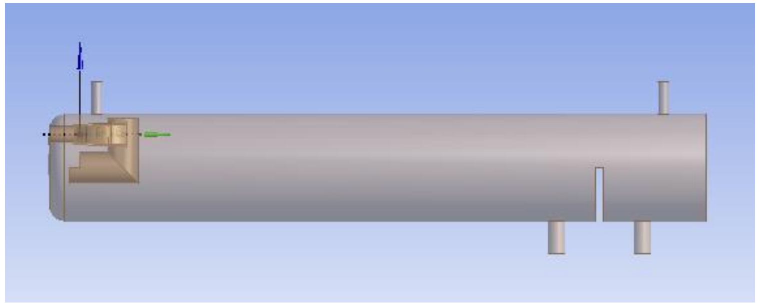
- The aim of the project is to study several new designs for inflow momentum-breaker mechanisms.

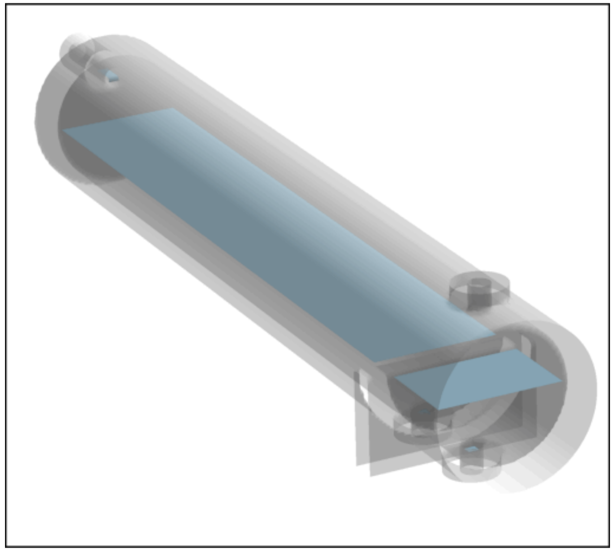
Points of interest:

- Modify the existing/base design of the inflow device used in all Aramco's oil fields
- Introduce an inflow momentum-breaker mechanism capable to ensure the shortest residence time in the vessel
- Repeat the simulations for several inflow conditions, for low water-cut rates and gas mass flow rates.
- Compare to experiments conducted at KFUPM.

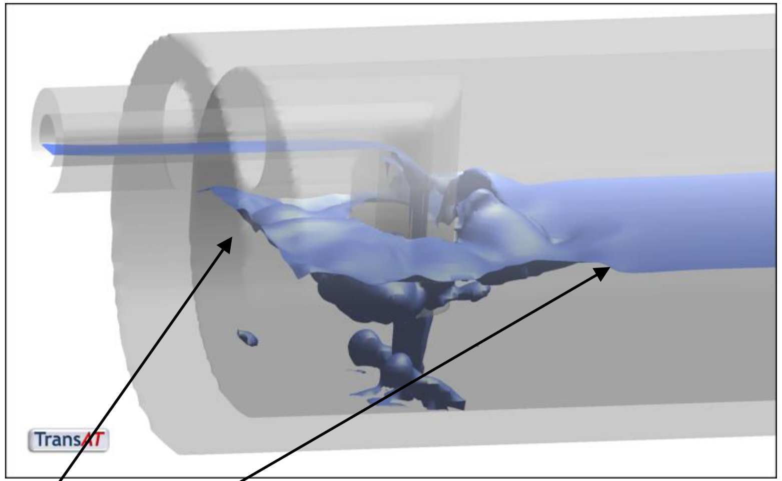
Solutions:

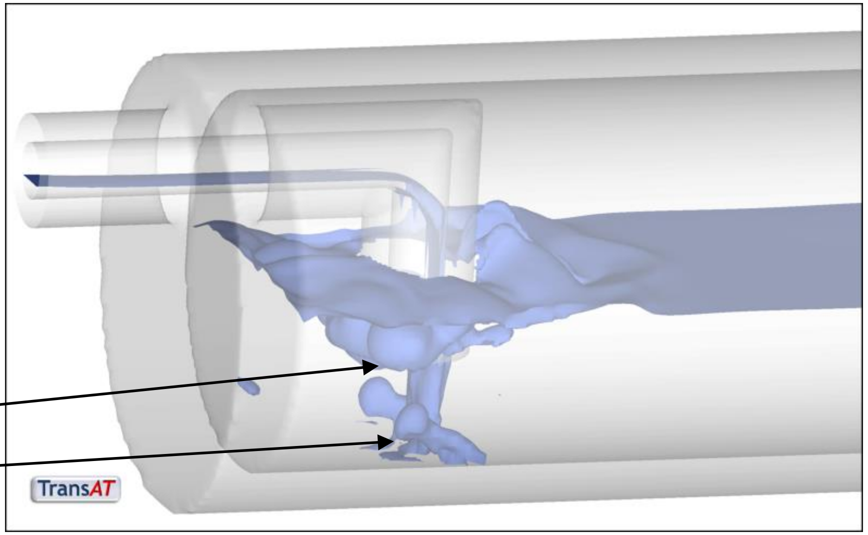
- Use the Level Sets to separate interface between 'crude' and gas
- Eulerian model for 'crude' to separate oil & water
- Effective viscosity using non-Newtonian models
- Setling velocity for water droplets: Newling's model





Aramco’s 3 phase gravity separator





- a clear sharp interface between gas and liquids
- gas bubble formation, mixing, entrainment
- bubbles penetrate down to the bottom vessel

INTERFACE PROBLEM

- Multi-product pipelines are standard in the Oil&Gas industry
- The mixing zone or Interface is not marketable
    - Requires large stockyard for reclassification/correction
- Mixing should be minimized for product quality
- Euro 6 norms are stringent
- Accurate prediction of interface length is necessary

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MOTIVATION FOR CFD STUDY

- Currently very simplistic correlations are being used to predict the Interface Length
- The correlations are only valid for straight pipe
  - Do not include effect of terrain
- 3D simulations can be used to create a multi-product scheduling software that takes into account various factors such as,
  - Pipe diameter, length, terrain variation
  - Pipe wall roughness
  - Different product amounts that need to be delivered
- Software output:
  - Proposes how to sequence the products which minimizes mixing for the given pipeline configuration.
  - Change of diameters as a function of terrain variations.
  - How long each product should be dosed?

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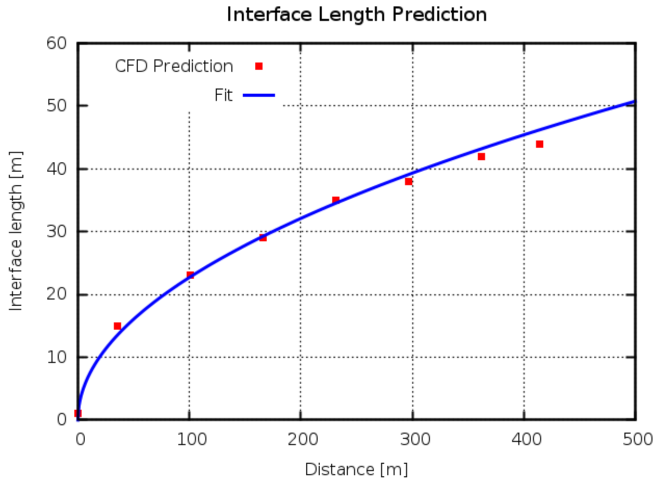
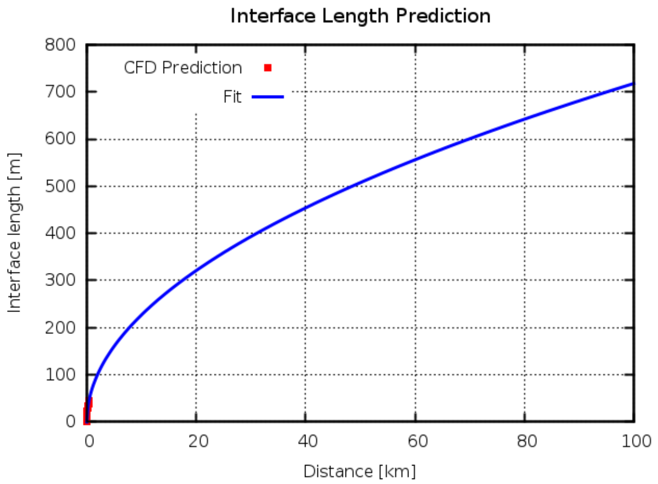
DEMONSTRATION

- 2-phase compressible model
- RANS turbulence model
- Initially filled with Petrol, replaced by Diesel
- Interface length for 100 km pipeline predicted using fit to CFD results: 700 m

Parameter	Value
Pipe diameter	18 inch
Petrol flow rate	0.407 m^3/s
Petrol Velocity	2.48 m/s
Diesel flow rate	0.372 m^3/s
Diesel Velocity	2.269
Pipe length simulated	457 m





Animation: Interface growth over 457 m. Interface defined as volume fraction of Petrol [0.01:0.99]. Note each section of pipe is 100 m long.

WHAT CAN BE PREDICTED?

- Effect of terrain on interface length
- Pipe diameter, wall roughness
- Explore ideas to minimize interface length
- Streamlining operation by predicting real time the expected interface length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