SPT GROUP

Optimizing Well dynamics for enhanching the performance

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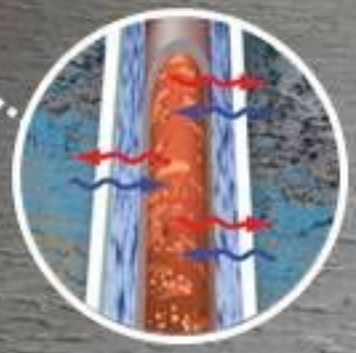
Why is transient well flow simulation important?

Thermal Transients



Liquid Loading

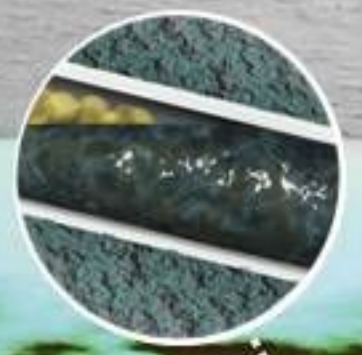
Artificial Lift

Cross Flow

Slugging & Surges

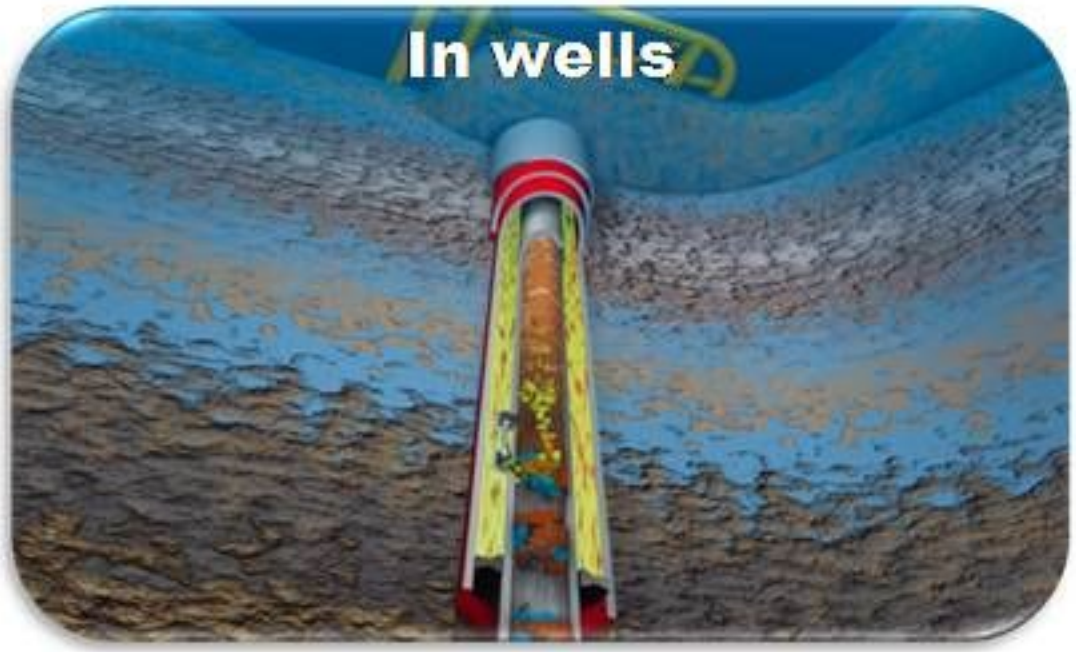
Near Wellbore Effects

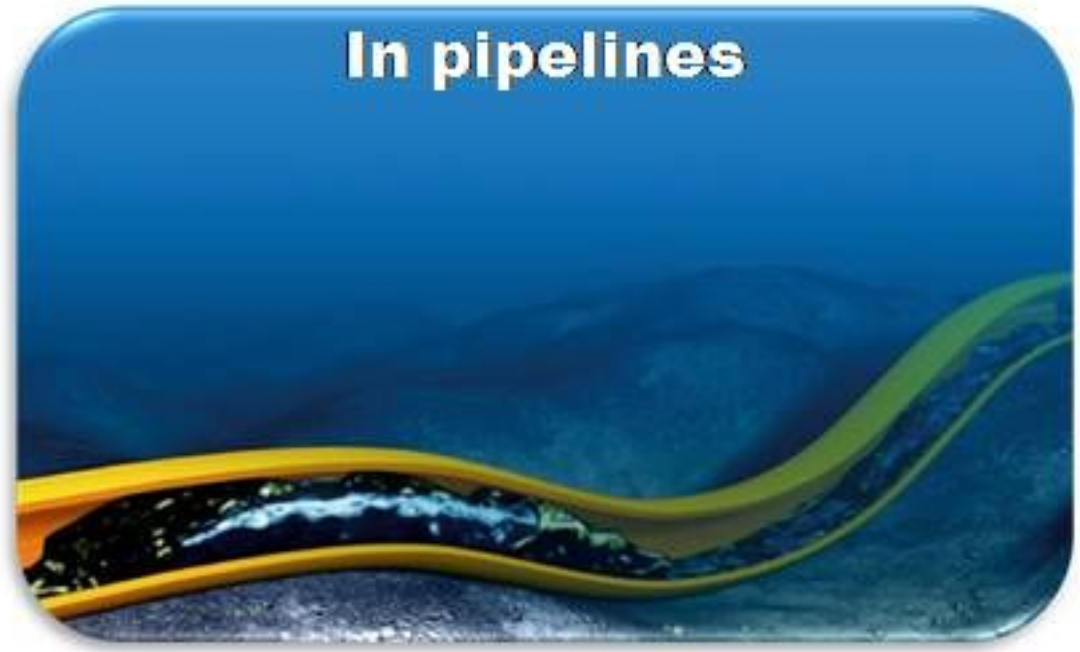
Liquid Accumulation

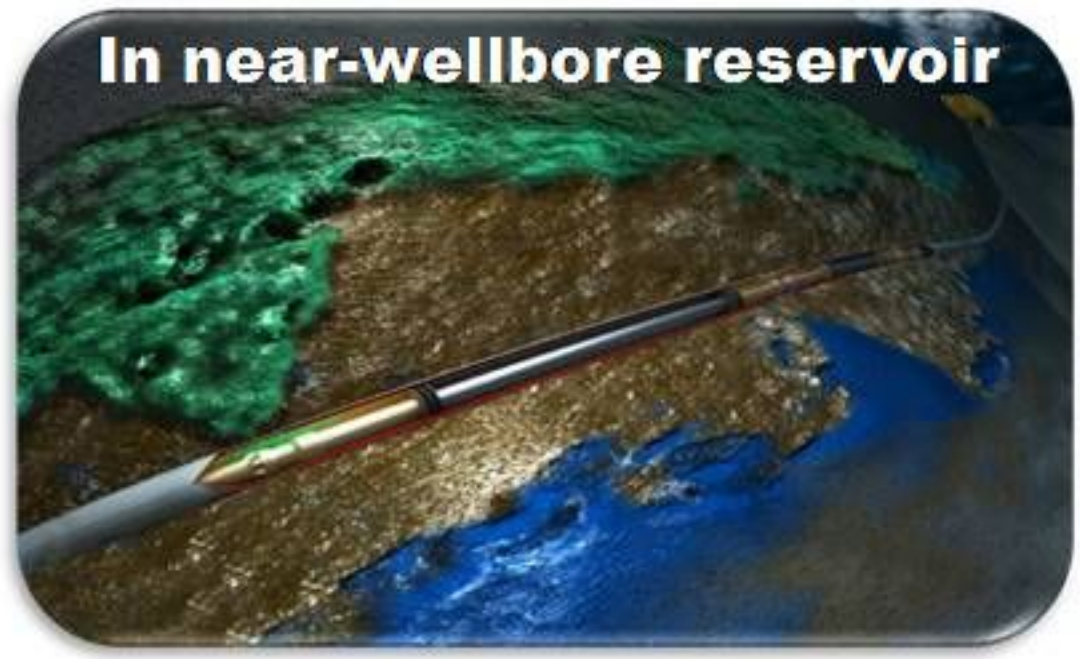


Stagnant Mud

OLGA – A Comprehensive Transient Multiphase Flow Simulator





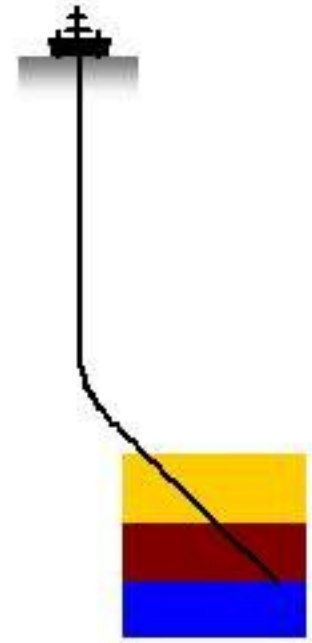


OLGA's modeling capabilities

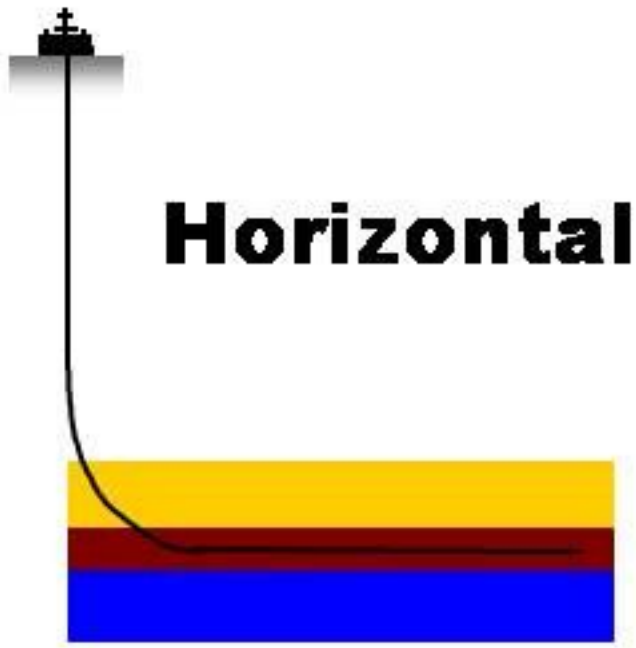
Accurately representing the well trajectory

Vertical

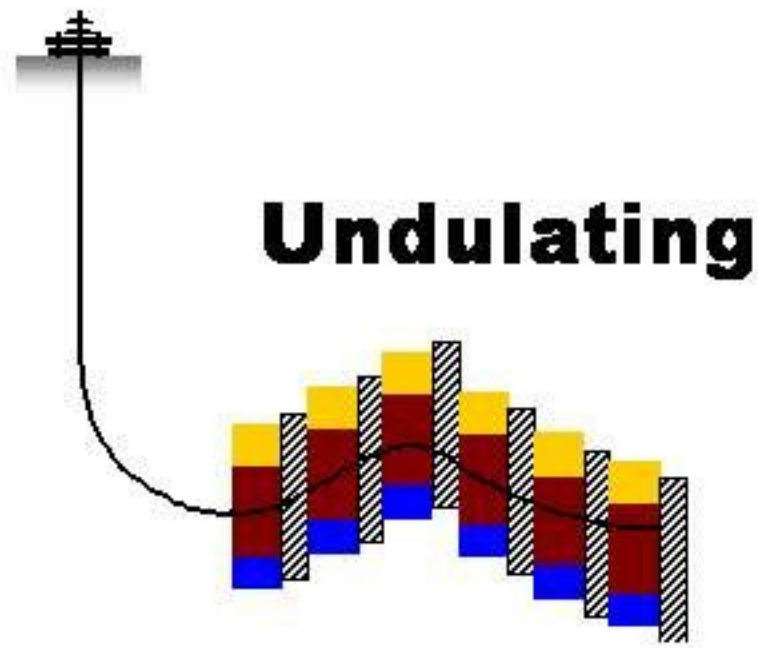
Slanted



Horizontal



Undulating

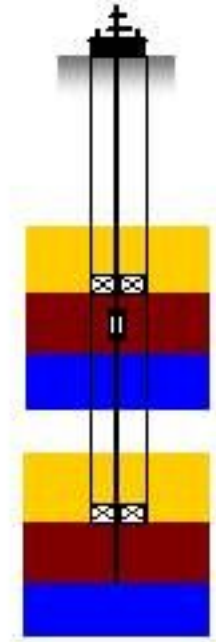


OLGA's modeling capabilities

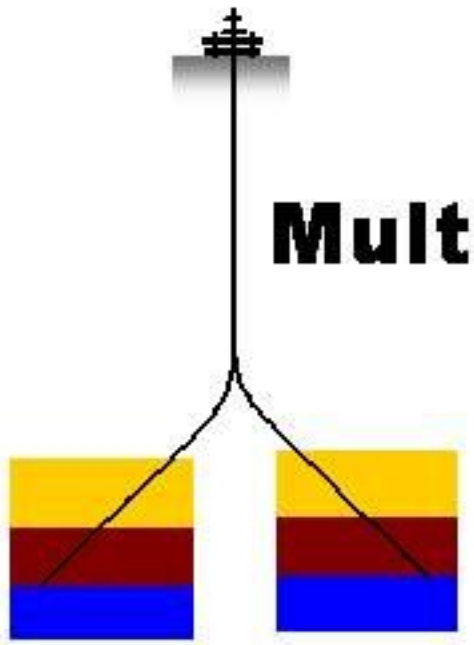
Accurately representing the well completions

Multi-string

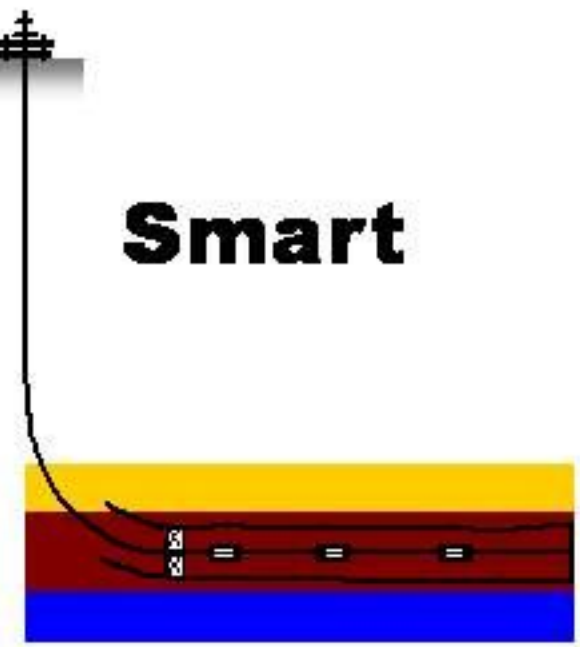
Multi-zone



Multi-lateral



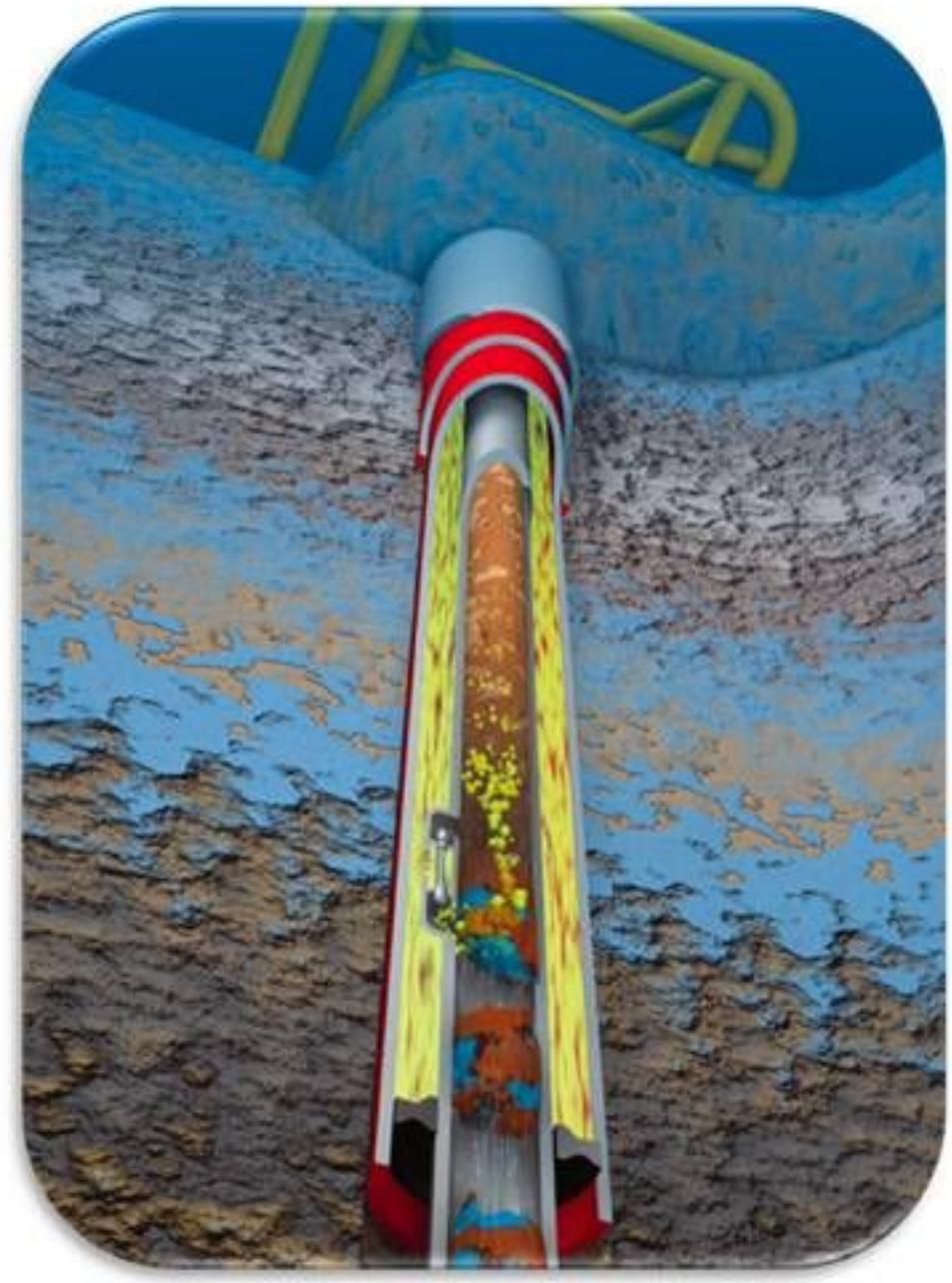
Smart



OLGA's modeling capabilities

Accurately calculating…

- Transient multiphase flow in both tubing and annulus
- Heat transfer through tubing-casing annulus to and from formation
- Joule-Thomson effect of inflow from reservoir to wellbore
- Compositional effect and local concentrations of tracked chemicals
- Co-flow of reservoir fluid and complex non-Newtonian fluid e.g. the drilling/completion mud
- Transient drilling and coiled tubing hydraulics using the moving grid scheme



Application areas
of transient well flow simulations

Well Flow Assurance

- Hydrate
- Wax
- Heavy Oil

Well Flow Dynamics

- Drilling Hydraulics
- Completion Design
- Cleanup
- Well Testing
- Artificial Lift
- Gas Well Deliquification
- Horizontal & Multilaterals
- Well-Pipeline Interaction
- Well-Reservoir Interaction
- Injection
- CO_2 Storage
- SAGD

Well Integrity

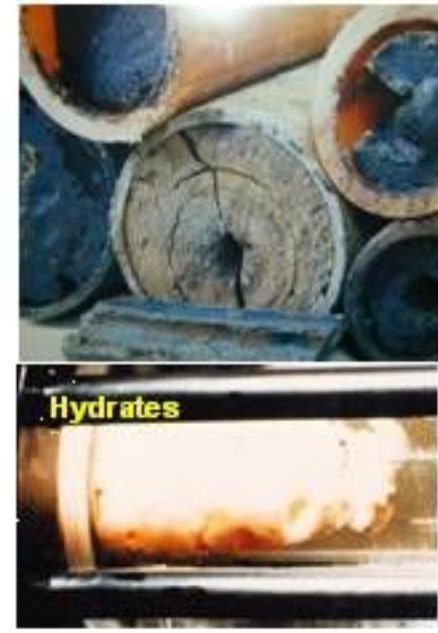
- Annulus Pressure Management
- Leakage
- Erosion
- Corrosion
- Equipment Integrity
- Temperature
- Well Control

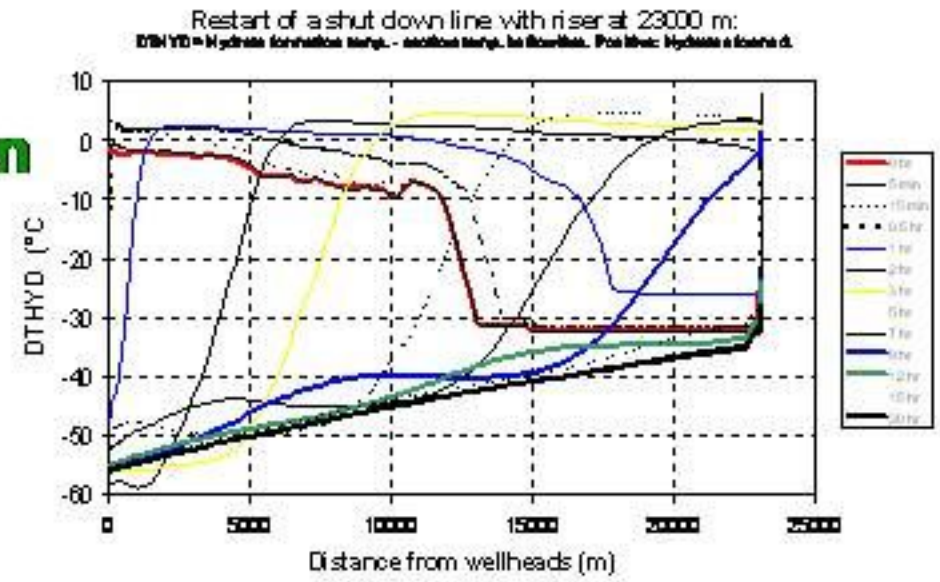
Well Surveillance

- DTS
- PLT
- Online/Offline Soft Sensing
- Water Monitoring

Thermal calculations (flow assurance)

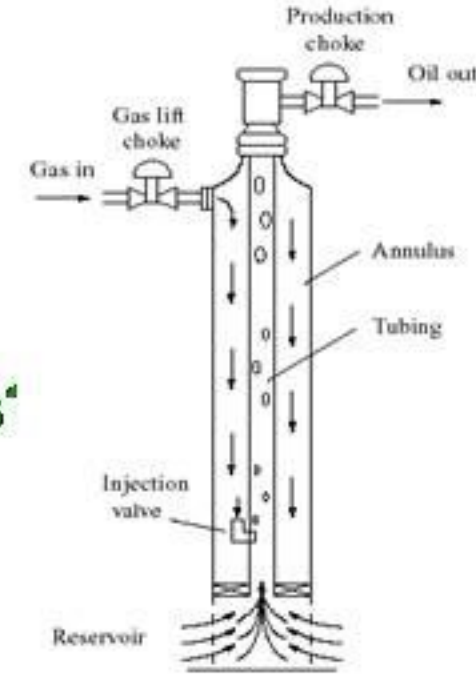
- **Determine where and when hydrate and wax problems will occur**
  - **Location of SSIV**
- **Determine the best flow assurance solution**
  - **Pressure Control, Temperature Control**
  - **Remove supply of water**
  - **Hot and Cold restart**
  - **Flowline depressurisation**
  - **Inhibitor injection, where and when**



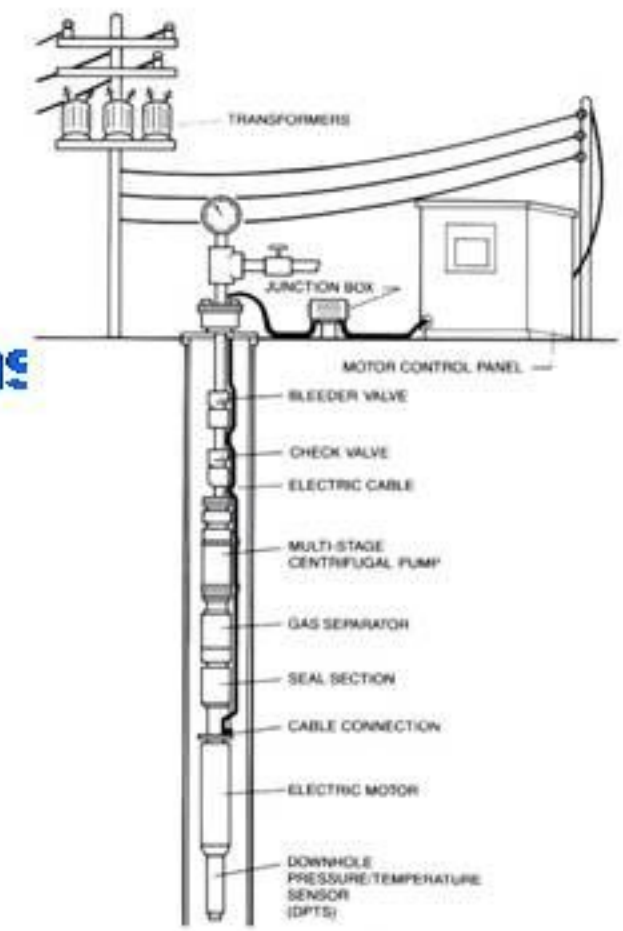


Artificial lift design

- **Gas lift stability analysis**
  - **Annular heading? GLV choke size? Compressors'**
  - **Density wave instability?**
  - **Multi GLV design or Single injection point?**
  - **Riser instability? Riser GL?**
  - **GL Well unloading?**

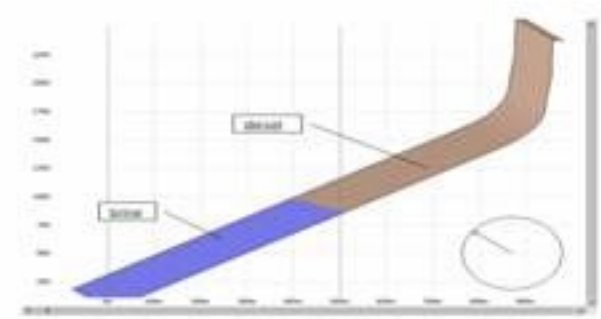


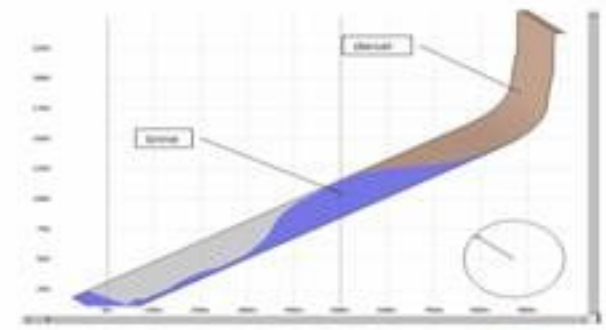
- **Optimise ESP design & operating conditions**
  - **Determine flow conditions at ESP depth**
  - **Calculate Slug Size (free gas volume) and frequency**
  - **Optimise Liner-Tubing-Casing ID**

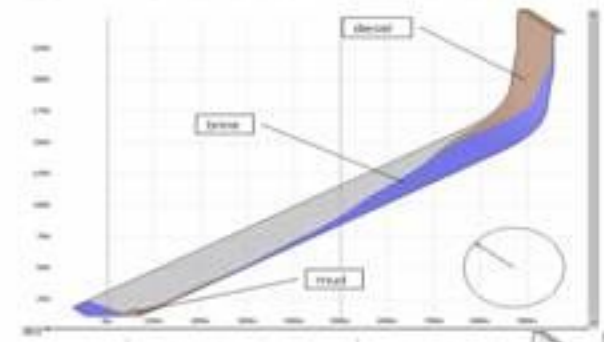


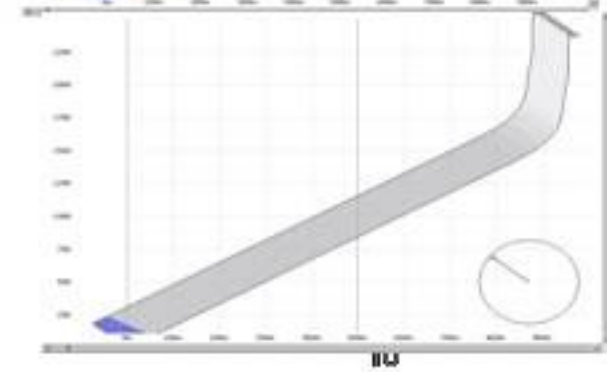
Well clean-up and kick off

- Calculate minimum rate and time to clean-up the well
- Determine minimum choke size
- Decide on clean-up to MODU or FPSO
- Determine if Gas Lift is necessary
- Evaluate the effect of an ESD or trip
  - Unloading problems?
- Compare different completion designs







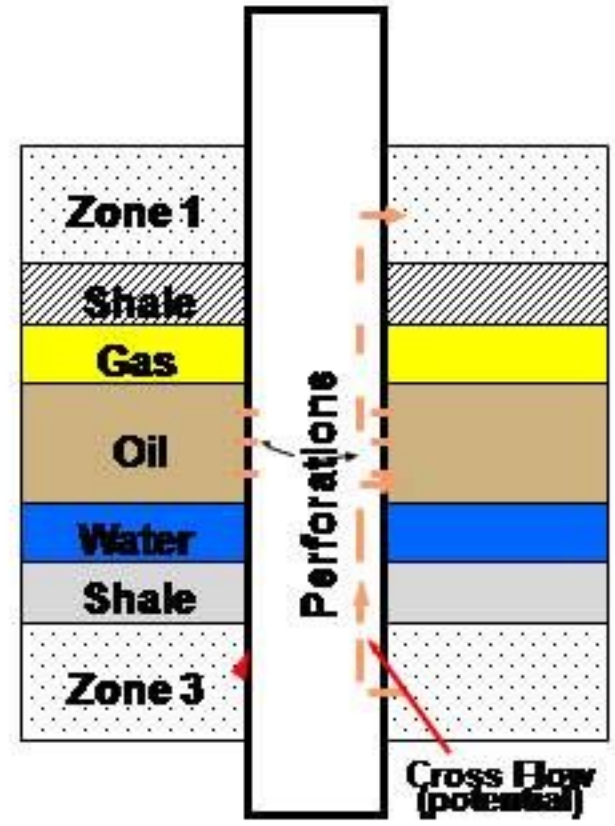


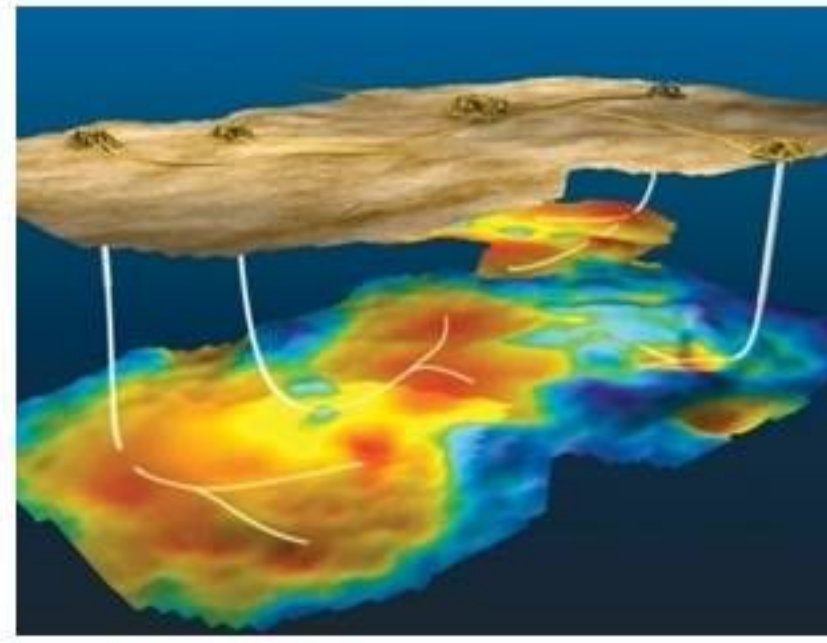
Shut-in/Start-up Watercut limits

- **Calculate the watercut limit for which the well will not kick-off after a shut-in**
  - **Future kick-off problems**
  - **When is Gas Lift required**
- **Gas Lift will be required at some time in the future**
  - **Use OLGA to determine the optimum gas lift implementation schedule and increase NPV**

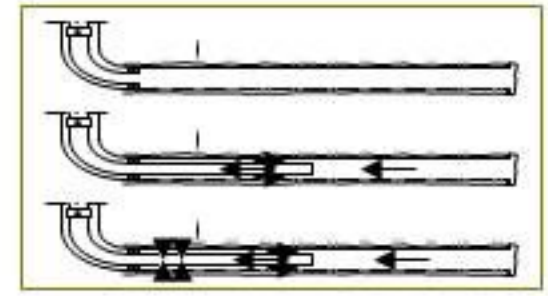
Crossflow/Commingling fluids

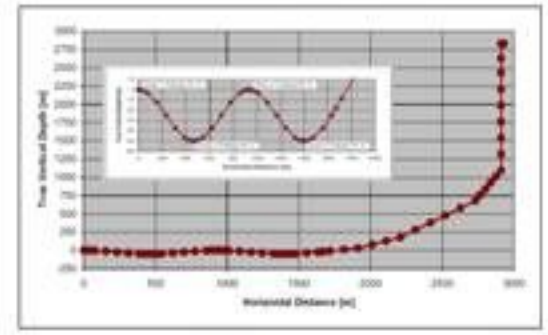
- **Analyse crossflow between productive layers?**
- **Are very different fluids merging?**
- **If there are significant P&T differences bottom and top layers what will be the WHT effect if the hotter bottom layer production is favoured?**
- **What will be the fluid composition and P&T resulting from different production rates, Wc and GOR, from each layers? (smart wells)**



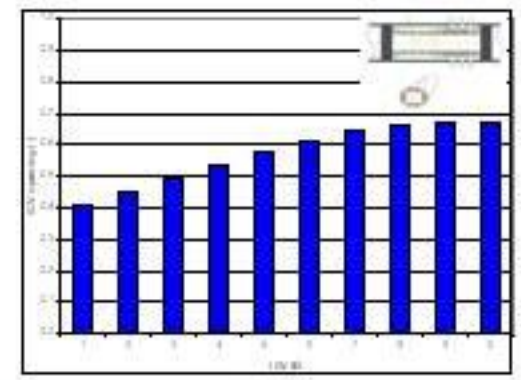


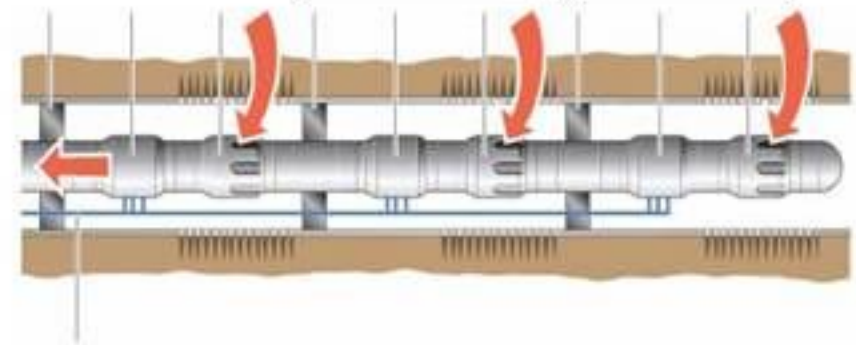
Horizontal Wells/Smart Wells



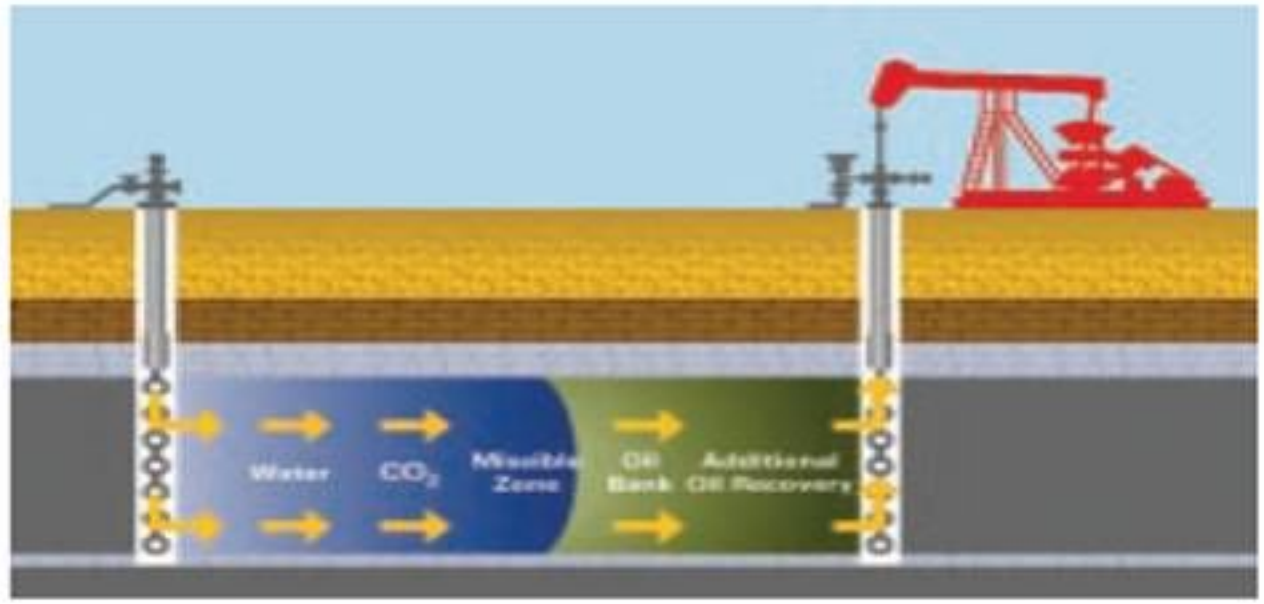


- Analyse the effect of water accumulation
- Model multiple production zones
  - Reasonable number of inflow points required
  - Matching production logs and DST
  - Gas/Water sources (Gas/Water coning)
- Determine optimum ICV combinations
  - Best clean-up
  - Total oil rate
- Optimise completion design
  - Best clean-up
  - Total oil rate





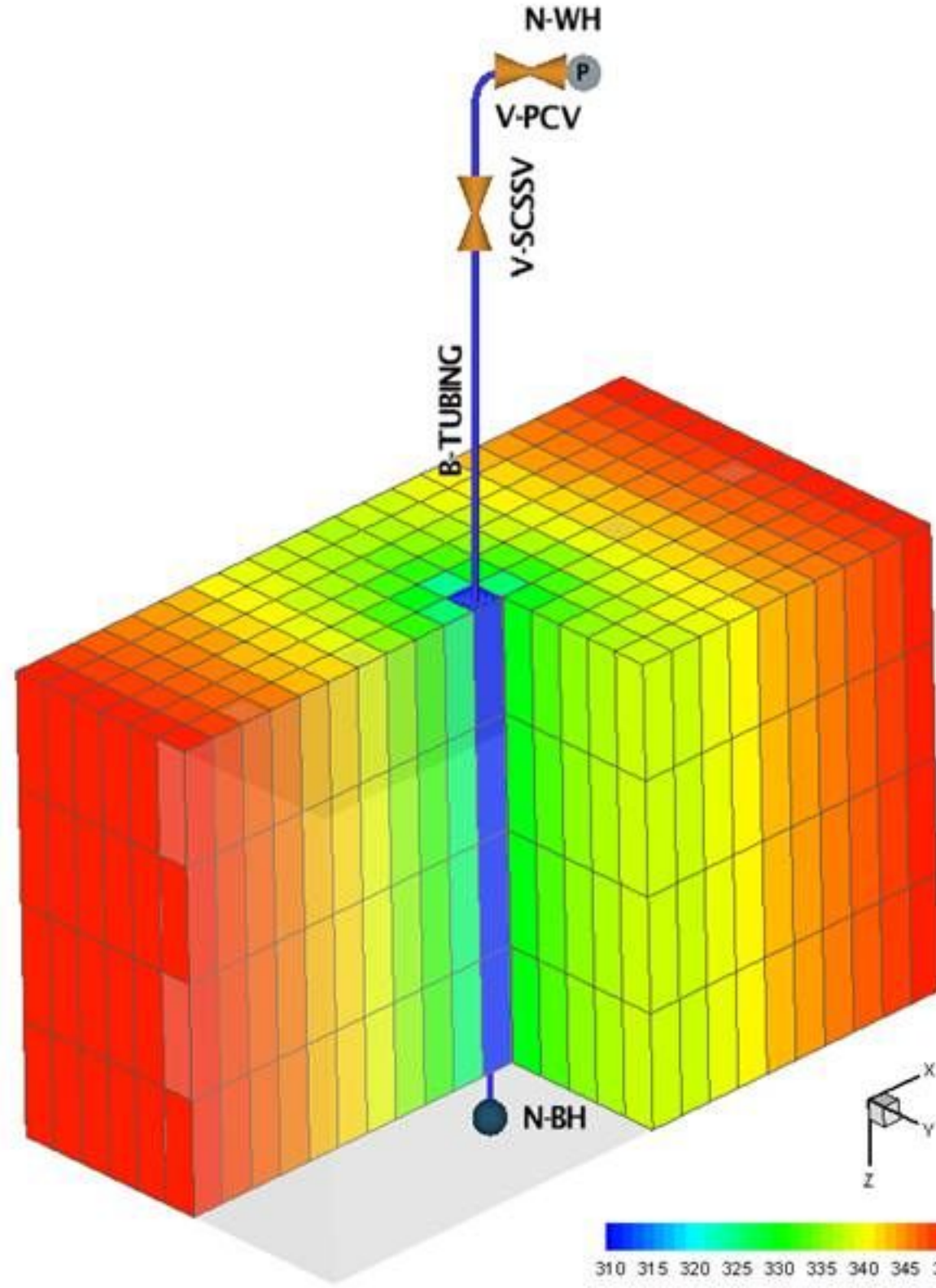
WAG Injection Solutions



- **Gas is injected at the well head with a much higher pressure than water to keep the BHIP constant**
- **Bullhead displacement with high pressure pump?**
- **Is the fromation fracture pressure exeeded?**
- **Is possible to vent the tubing to below water injection pressure?**
- **Should resting be performed between bullheading and venting?**

OLGA-ROCX Coupled model

- **ROCX is…**
  - **3 phase**
  - **3 dimensional**
  - **Newtonian Darcy flow**
  - **Rectangular / Cylindrical grid**
  - **Stand alone / Coupled**
- **Common fluid file**
- **OLGA Near-wellbore source coupled to each ROCX layer**

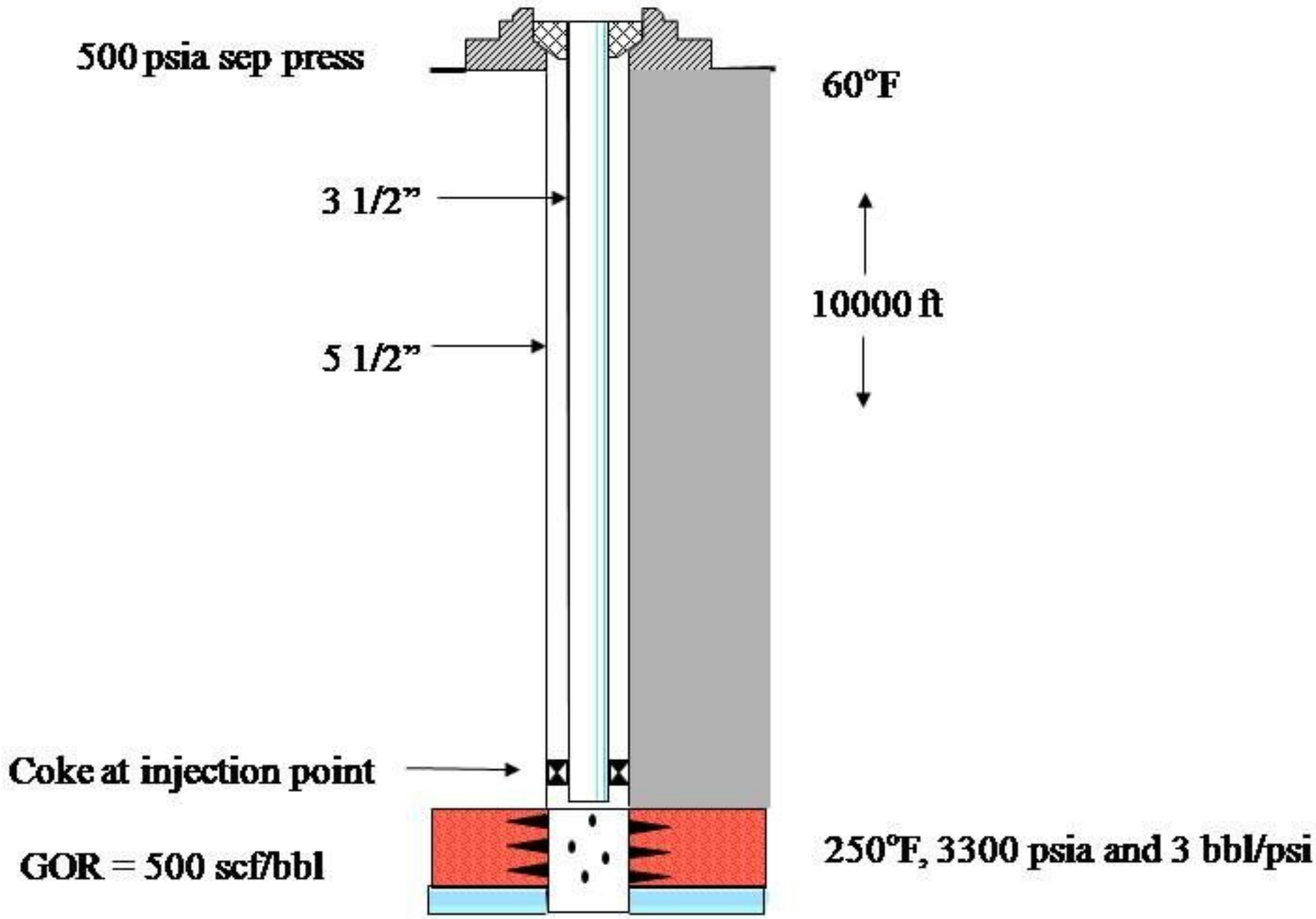


OLGA for Wells examples

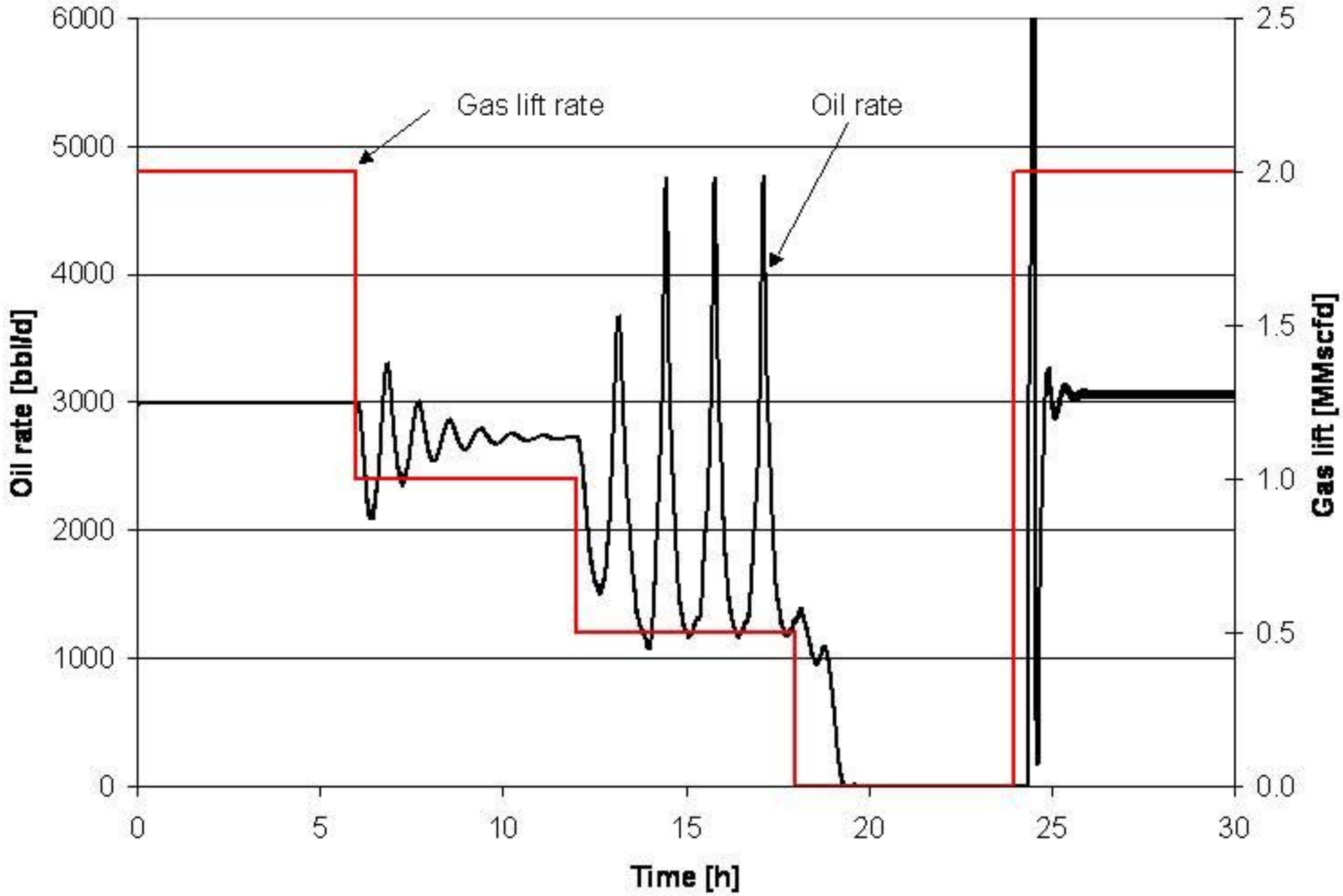
1) Oil well with annular gas lift

Example-1:

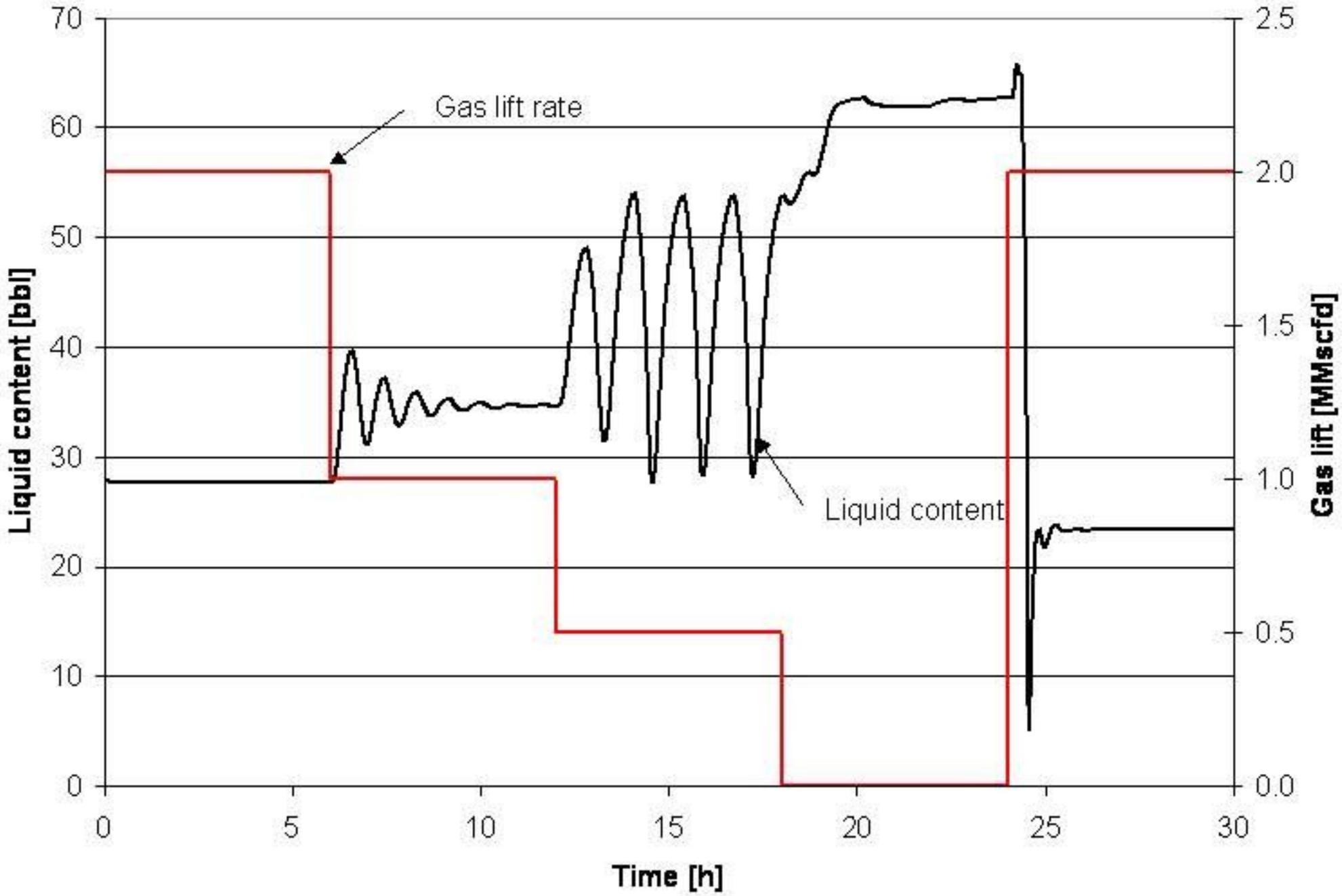
Oil well with annular gas lift



Example 1 : Oil production

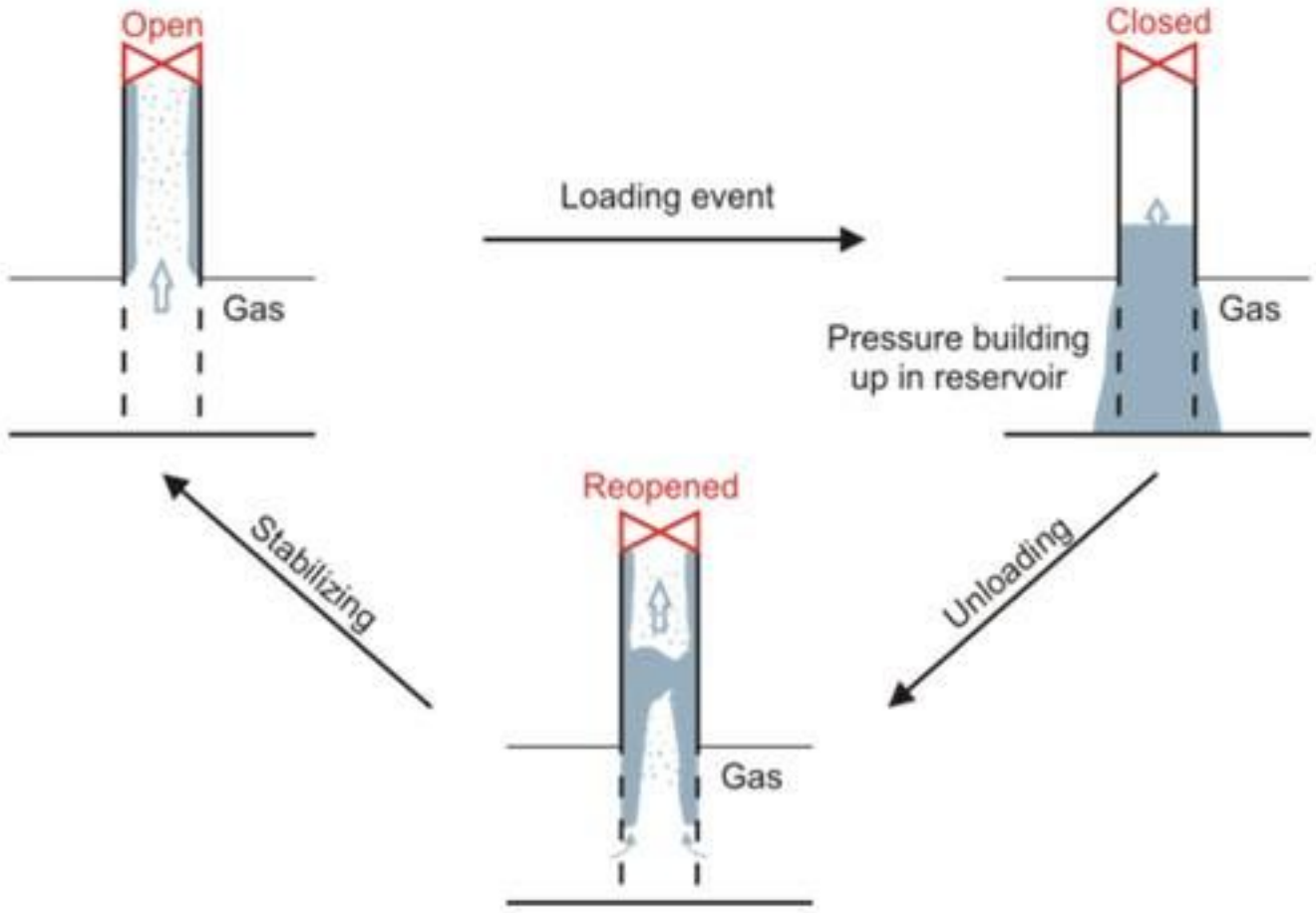


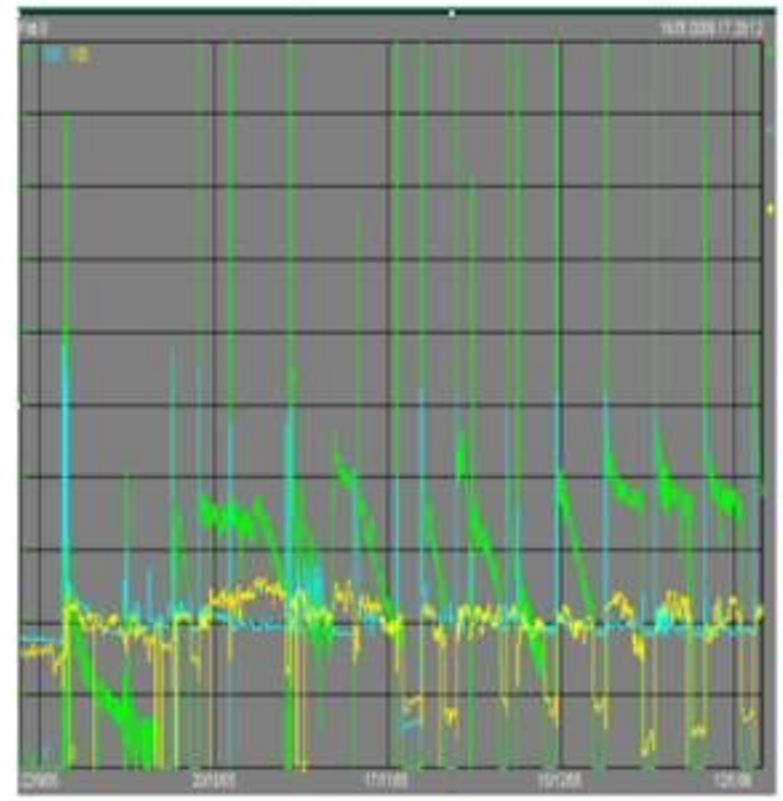
Example 1 : Liquid content



Example-2:

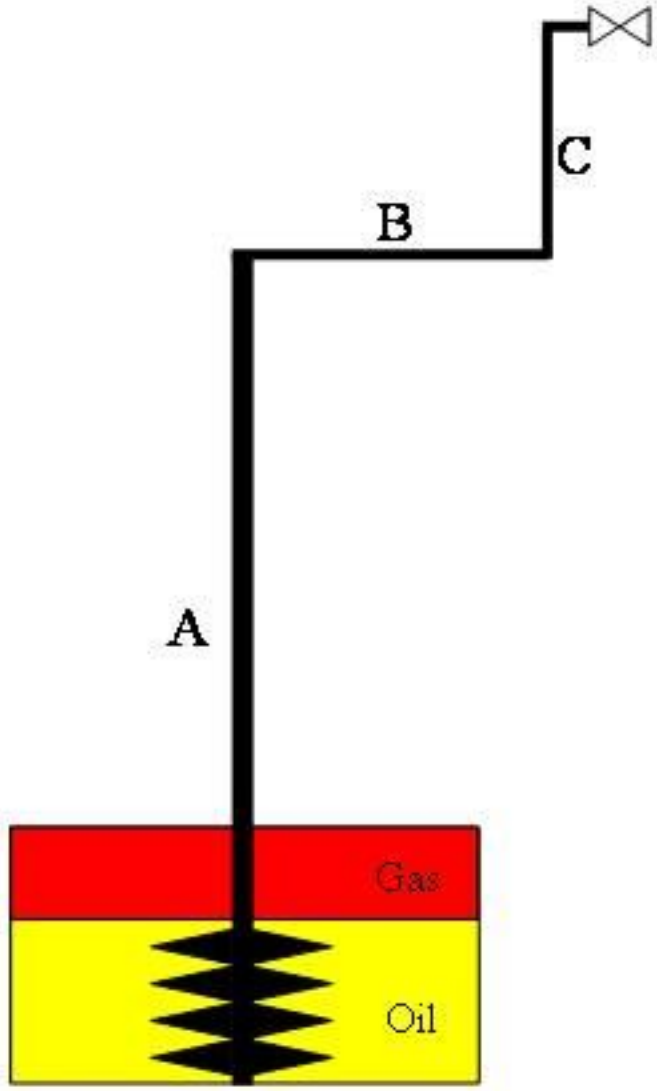
Intermittent gas-production (OLGA-ROCX)

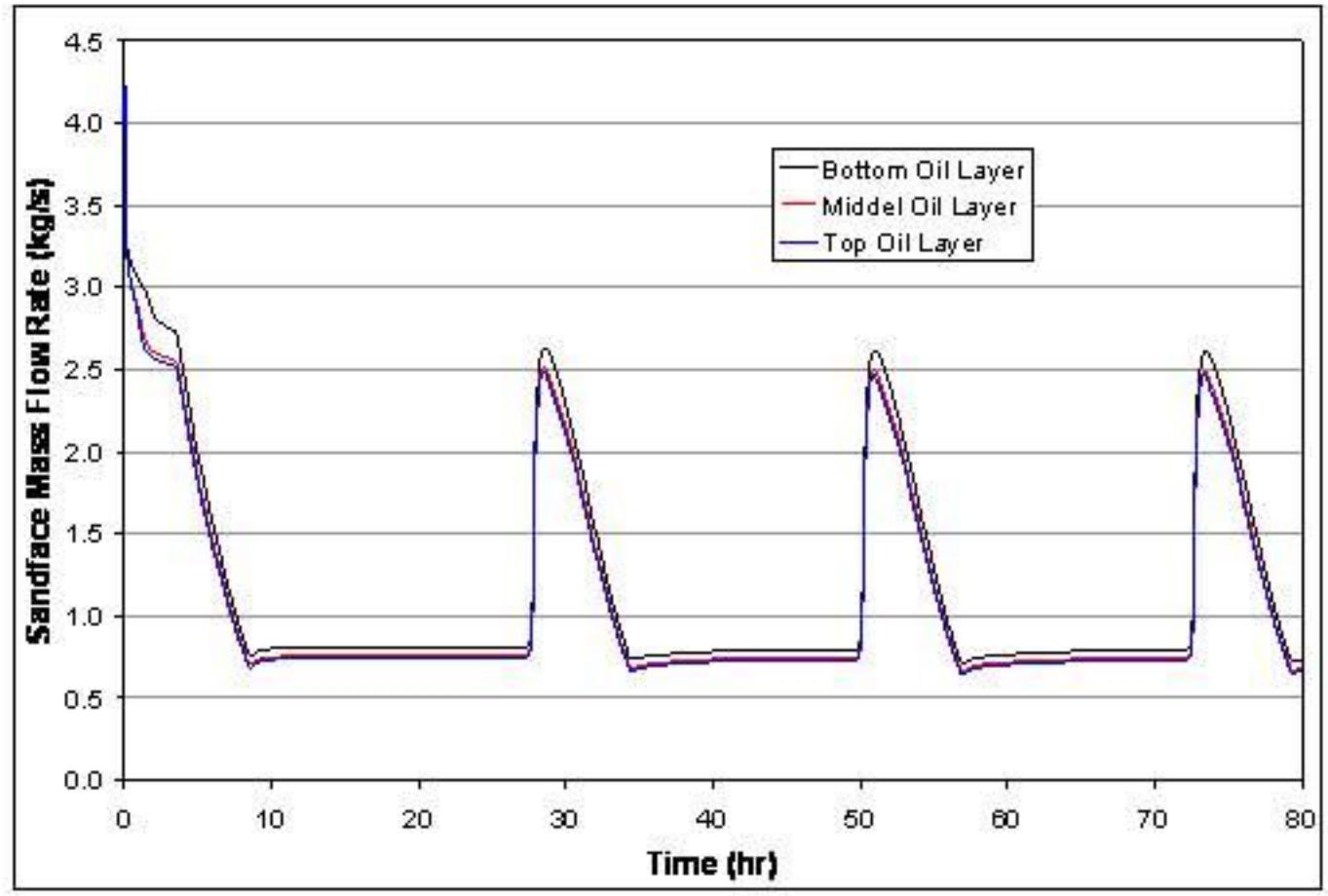




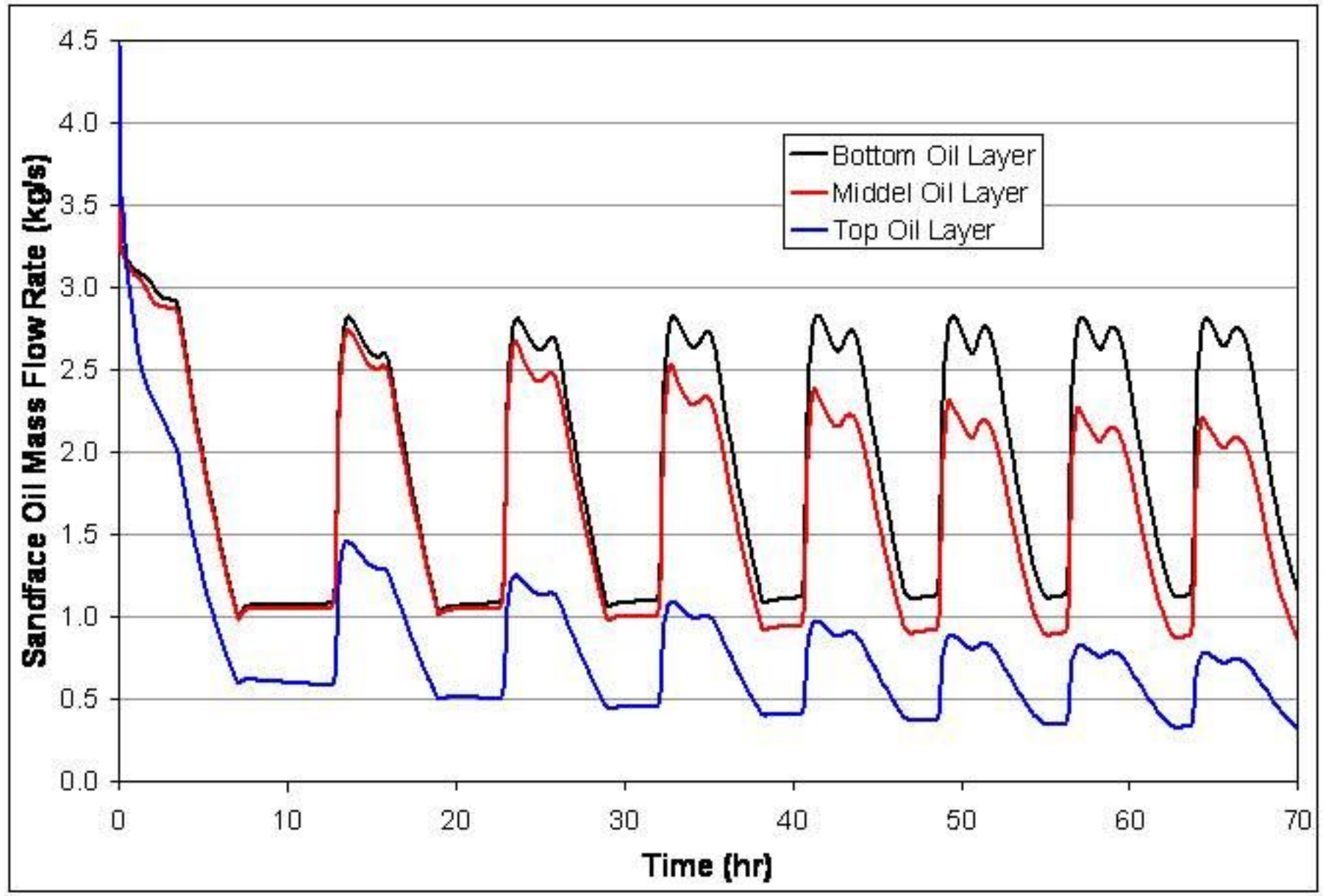
Example-3:

Dynamic gas coning (OLGA alone)

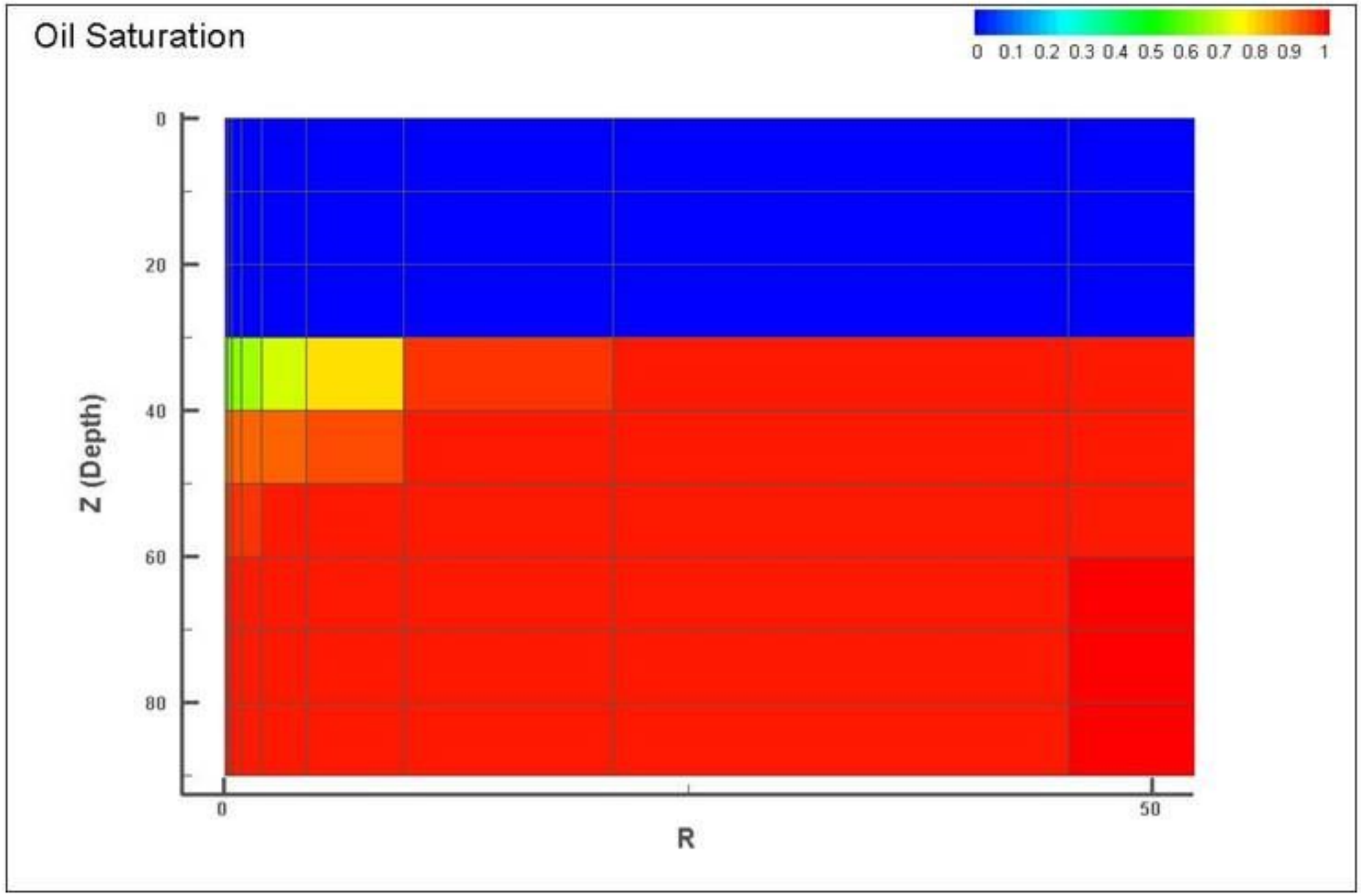




Example 3: Dynamic gas coning(OLGA-Rocx)

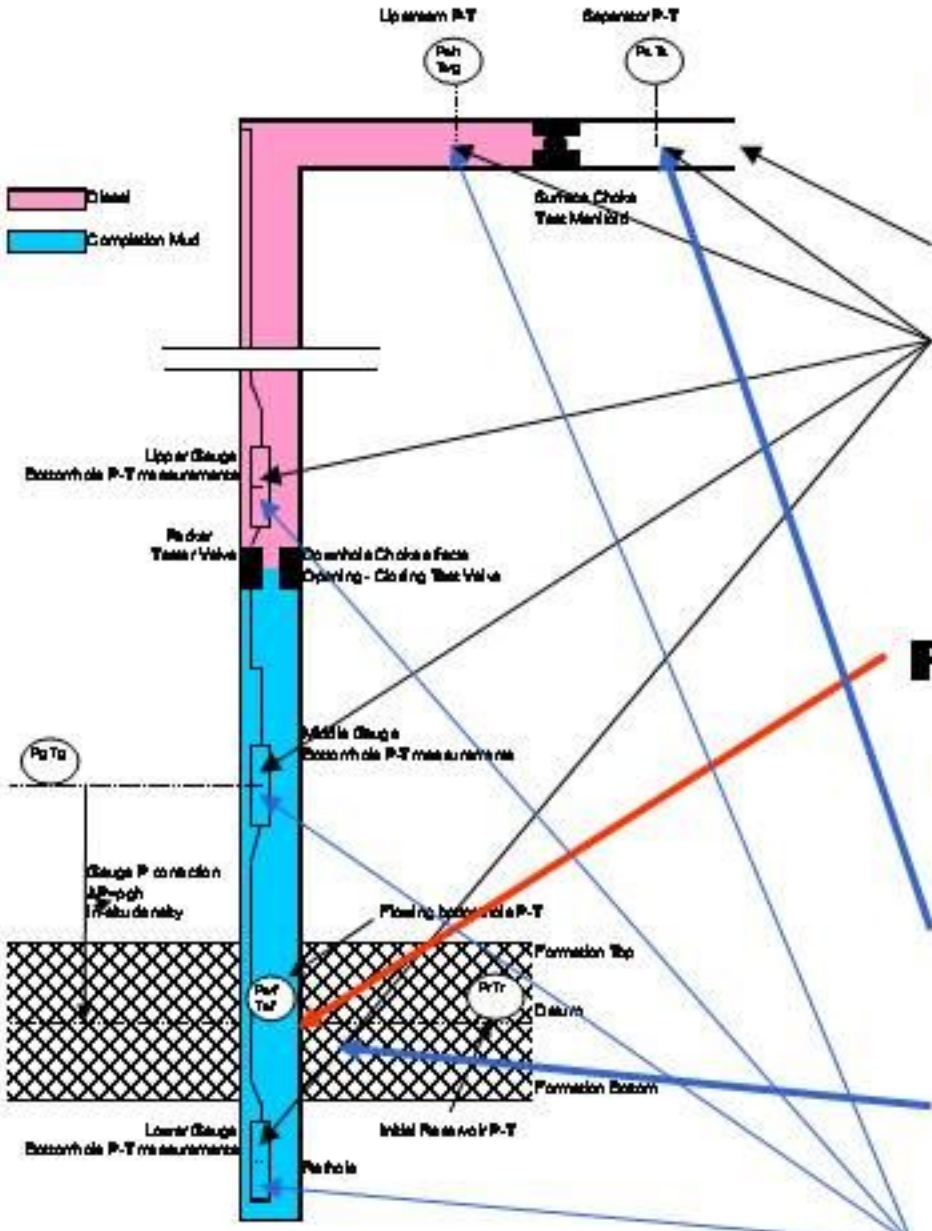


Example 3: Dynamic gas coning (cont.)



Example-4:

Downhole virtual metering for decovolution technique



What we know from measurement

Surface flow rate

Pressure & Temperature

What we don't know, but have to know

Pressure & Flow Rate at the sandface

How to know it?

Use this pressure signal as the outlet boundary condition in the model

Tune the quasi-dynamic IPR to match the other pressure measurements

OLGA
be dynamic
SPT


SPT
be dynamic