CoFlow和CoFlow-X:现代化的油藏和生产模拟综合解决方案 CoFlow & CoFlow-X: Modern Solutions for your Integrated Reservoir-Production Modelling Challenges



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#### Agenda

- Introduction to Integrated Modelling
- CMG's Integrated Production Systems Modelling (IPSM) solutions
- CoFlow for IPSM
  - Case studies and demos
- CoFlow-X for IPSM
  - Case studies and demos
- CoFlow and CoFlow-X on the Cloud
- Conclusions









#### Why Bother with Integration?

Are you considering cross-disciplinary data for your predictions and results?



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#### CMG Offers Implicit AND Explicit Solution





#### What CoFlow and CoFlow-X Achieve







## CoFlow: The Modern IPSM Solution







## CMG's IPSM Solution 1: CoFlow

CMG's Integrated Reservoir, Production System Modelling Environment

#### **Objectives**

- Better engineering for high-stakes plays
- Reduce the cycle time from concept to field
  - Foster collaboration amongst disciplines
  - Guided task workflows with ability to customize

Ultimately

- Accelerate and Maximize cash flow
- Optimize large capital investments







#### The Dilemma



Coupling of reservoir models and production systems is important – but difficult and time consuming

- Multiple tools: by different vendors
- Siloed users: ineffective communication between disciplines
- Data management
- Data Consistency at Multiple Fidelities





### Case Study – IPSM in CoFlow (SPE 181427)



- Vast development area
- Multiple reservoirs, fluid systems, facilities
- FPSO based development (production limit = 150,000 bbl/d)

#### Carbonate Reservoir:

- 201.5 k active cells
- 10 wells planned
- High level of Heterogeneity
- Multiple facies

Sandstone Reservoir:

- 101.2 k active cells
- 7 wells planned
- Low level of Heterogeneity





CoFlow allows users to tailor the rigor of fluids calculations to the place where it is needed

CoFlow users can easily see the properties and behaviour of various fluid models and blends

## Fluid Blending





Phase Boundary





### Well Design & Nodal Analysis

Well modelling

- Fidelity in pressure drop calculations
- Fidelity in heat calculations

RE-PE collaboration to pick well locations

PE based workflows to pick optimum well equipment (e.g. Nodal analysis)

Pick robust well locations based on geological uncertainty as well as dynamic nodal analysis







## Facility

- High/Med/Low fidelity for each equipment
- Carbonate single riser to FPSO
- Sandstone Each well with individual riser
- Gas separation, compression, and reinjection into Carbonate



Identify bottlenecking Equipment





# **IPSM Modelling for an Offshore Asset**



#### **Robust IPSM Optimization Workflow**





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#### Case Study – Robust Production System Design under Geological Uncertainty (SPE 181427)







## **Robust Production Design Under Geological Uncertainty**





#### Results: Effect of Carbonate Well Artificial Lift – ESP





#### **Results: Effect of Carbonate Riser Size**







#### Results: Effect of Sandstone Well Risers' Size



**Result:** 

- Base design: 6 in.
- Robust design (with uncertainty assessment): 6 in.





COFLOW

## Workflow Summary: Traditional vs. Modern





Parameterize anything, at any step, achieve end-to-end uncertainty assessment and optimization



# CoFlowX: The Bridge to IPSM







Production engineer can enjoy all the tools of CoFlow while allowing the reservoir engineer to keep using CMG tools that they love.



#### Benefits of CoFlow-X



#### Benefits of Coupling CoFlow with IMEX and GEM

Recovery process modelled on industry leading simulators Any complex recovery process can be modelled

Couple CoFlow & other CMG software to the workflow



Connect the CoFlow surface network (with blended fluid) to any number of IMEX and/or GEM dynamic models



NFRs, HFs, cEOR...etc

Explicitly coupled to improve performance



Production engineer can enjoy all the tools of CoFlow

Integrate existing CMG reservoir models with CoFlow production models instantly



#### At Hand-Shaking Time (Coupling at the bottom-hole)



- Wells Constraints (STO, BHP,...)
- Injection Fluid Compositions
- Injection Temperature
- Suggested Next Hand-Shaking Time
- ...



- IPRs & Mole Fractions Tables
- Reference Layer (Drawdown)
- Reference Phase
- Suggested Next Hand-Shaking Time

• ...







#### **Smart Identification of Coupling Time**





**Next Coupling Time:** 





#### Case Study – IPSM in CoFlow-X









# CoFlow-X for IPSM Modelling of an Offshore Asset



#### CoFlow-X Summary

- Modern user interface to couple reservoir and production models
  - No need for tedious scripts
- Very easy to use
  - Absolutely no changes needed in your datasets!
- Smart software
  - Automatic well coupling, intelligent coupling time selection
- No limit on the number of reservoirs
  - Any number of IMEX, any number of GEM, or a mix of the two



### CoFlow & CoFlow-X on the Cloud



#### Benefits

- Instantly scalable and flexible hardware and software options
- No need to buy additional hardware
- Availability of the latest version of all our simulators
- Immediate availability, no queuing is required for large numbers of runs
- Instant access, 24/7 to fulfill your projects on time





## **CoFlow & CoFlow-X on the Cloud**



#### CoFlow & CoFlow-X Deployments





#### **Bottom Line**

- All your IPSM needs met with a single tool
  - Any reservoir recovery mechanism
  - Any production design and optimization
- Solve complex problems in a new way
  - Implicit AND explicit solution
  - Multi-user, multi-disciplinary collaboration
- Solve problems we previously couldn't
  - End-to-end uncertainty assessment and optimization
  - Multi-fidelity at every component of integration
  - Complete fluid consistency
- A platform to reduce risk and improve ROI
  - Full collaboration and data consistency  $\rightarrow$  reliable forecasts
  - CoFlow on the cloud!





# **Vision:** To be the leading developer and supplier of dynamic reservoir and production technologies in the **WORLD**

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