Multi-segment wells and well modeling

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Outline

Introduction to well modeling

Multi-segment wells

Re-factoring of well models

Summary



A typical reservoir simulation procedure









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Oil saturation





Oil saturation

PROD01

Oil saturation





Oil saturation



Oil saturation













Well related equations

For **each well** we have four primary variables (threephase blackoil model)

$$Q_w, \quad Q_o, \quad Q_g, \quad P_{bhp}$$

Mass balance equations

$$Q_{p,w} - \sum_{j \in w} q_{p,j} = 0, \quad p = w, o, g$$

Well control equation Inflow
– BHP control

$$P_{bhp,w} - P_{bhp,w}^{target} = 0$$

- Rate control (oil)

$$Q_{o,w} - Q_{o,w}^{target} = 0$$



Inflow equations





Some of the advantages and limitations

- Advantages
 - Relatively simple
 - Hydrostatic pressure drop between connections
 - Crossflow is described
- Limitations
 - A single set of variables for the whole wellbore
 - Multilateral wells
 - Horizontal wells
 - friction pressure gradient



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An example of multilateral well





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Multi-segment well representation





Segment structure









Inflow equations



from Eclipse Technical Description



Pressure equation for each segment



- Options to calculate the pressure drop
 - Homogeneous flow model
 - Built-in 'drift flux' slip model
 - Pre-calculated Vertical Flow Performance (VFP) table



Pressure (control) equation for the top segment

- The pressure of the top segment is BHP for the well
- The rates of the top segment are the well rates

BHP control

$$R_{4,top} = P_{top} - P_{bhp}^{target} = 0$$

Rate control (oil)

$$R_{4,top} = Q_{o,top} - Q_o^{target} = 0$$





Example 1















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What we can get with multi-segment wells

More detailed and fexible well-bore simulation

Horizontal and multilateral wells

Advanced inflow control devices

Pipeline networks

Fracturing



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Now







Now







Now





Multi-segment wells + polymer





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Multi-segment well + polymer



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Summary

- Conventional well model
- Multisegment wells
- Refactoring

- Some features are still yet to be developed
 VFP, drift-flux, ICD, etc.
- Major efforts have been focused on framework development
- A solid foundation for future development



Thank You



