SPE WORKSHOP

Consistent Fluid Management from Reservoir to Sales Point

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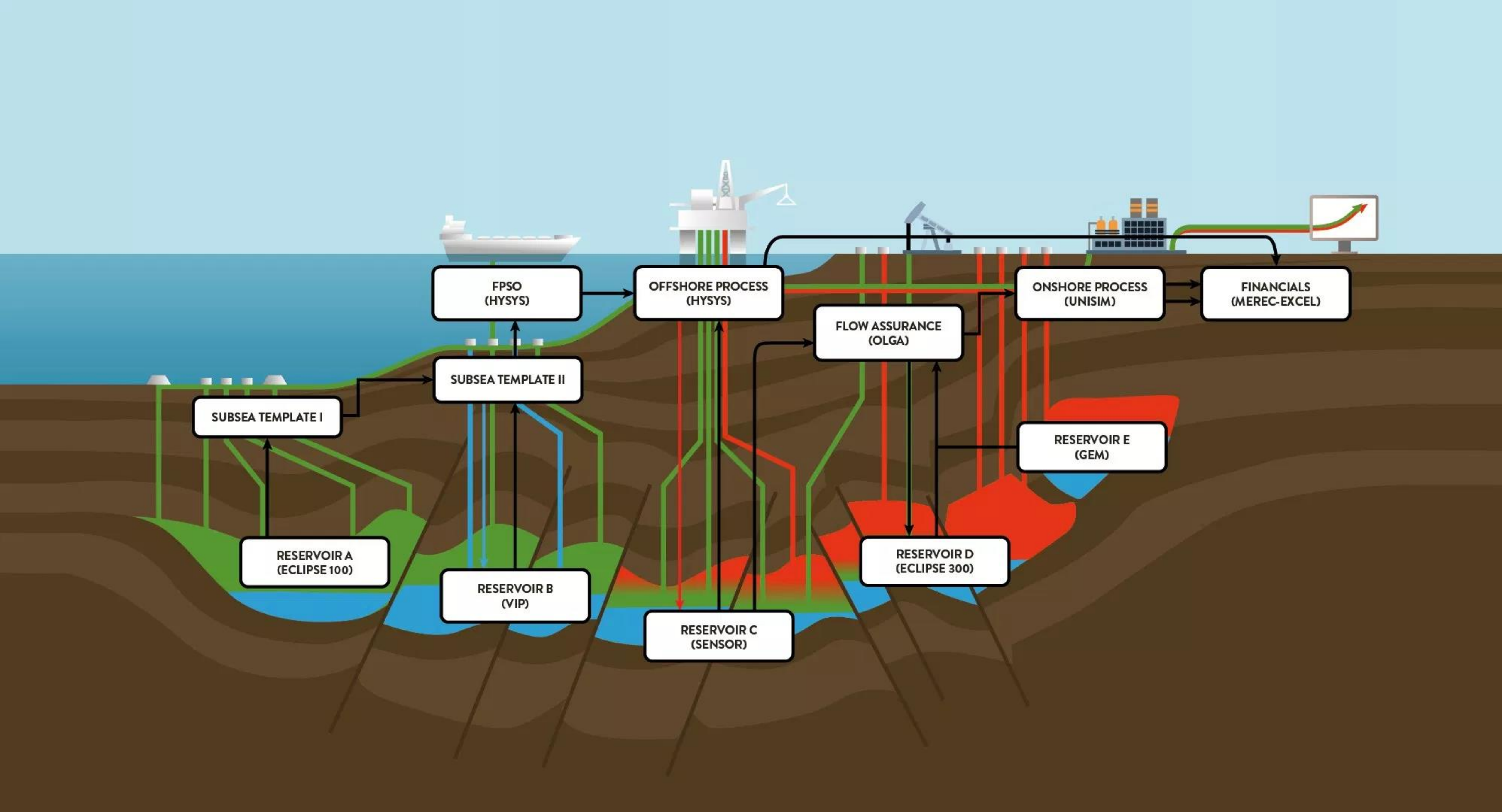
Whitson AS

12-14 February 2019



Courtesy: Petrostreamz

Problem Statement

"Often different fluid models are used to describe the same physical fluid at different points in the system"

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“What can be done to ensure consistency of fluid description throughout the value chain?”

PVT in Value Chain

PVT

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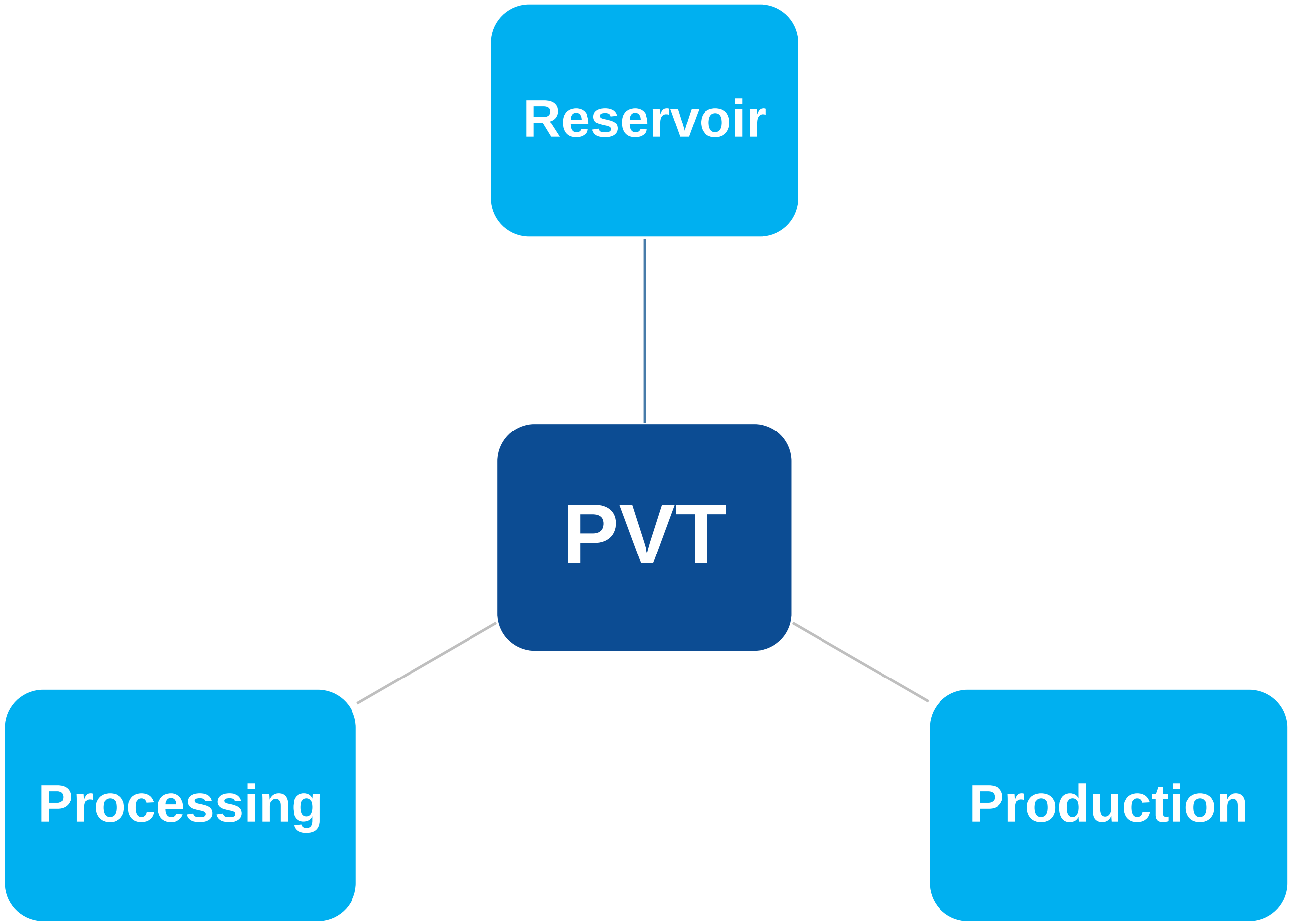
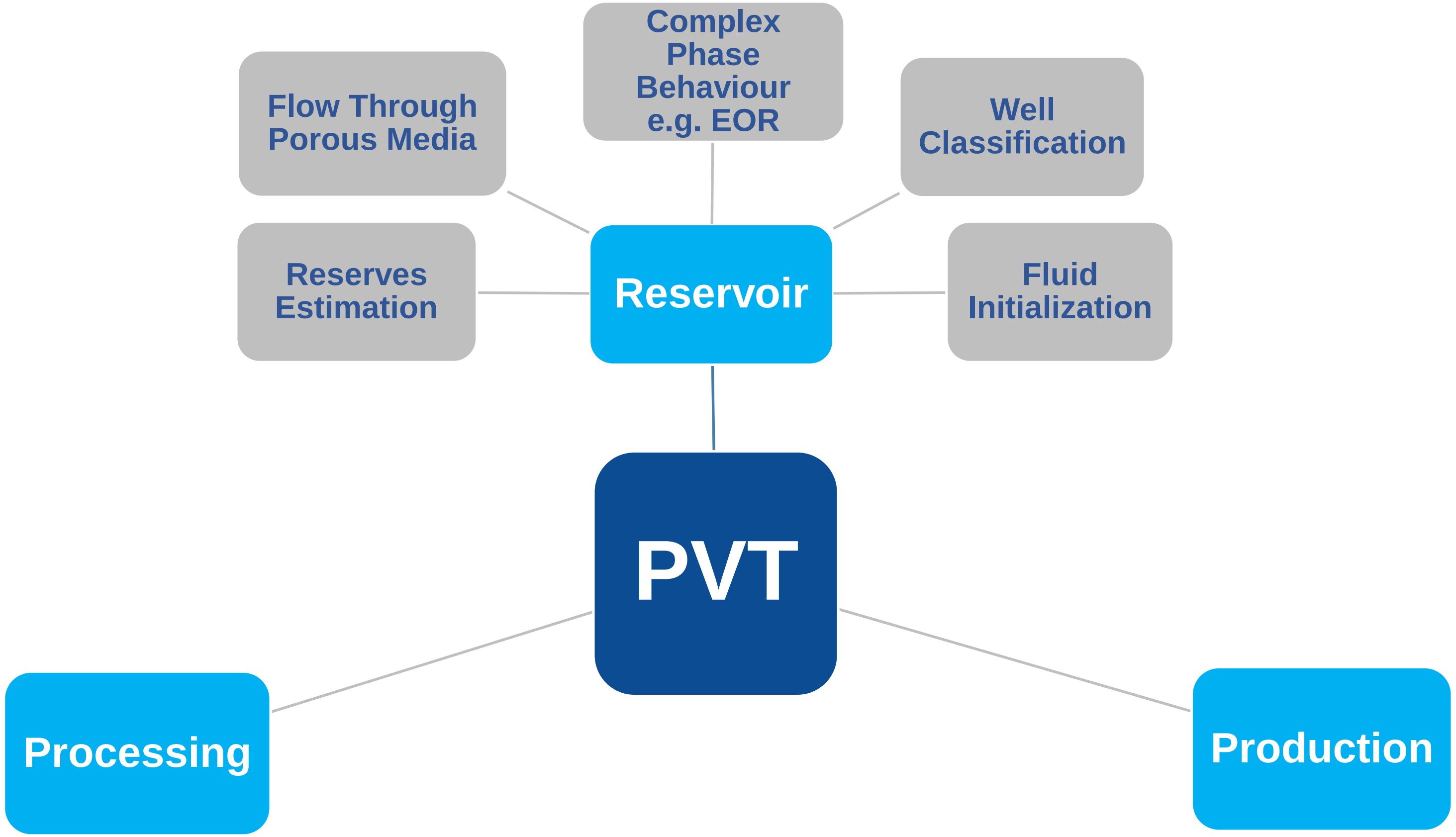


PVT in Value Chain



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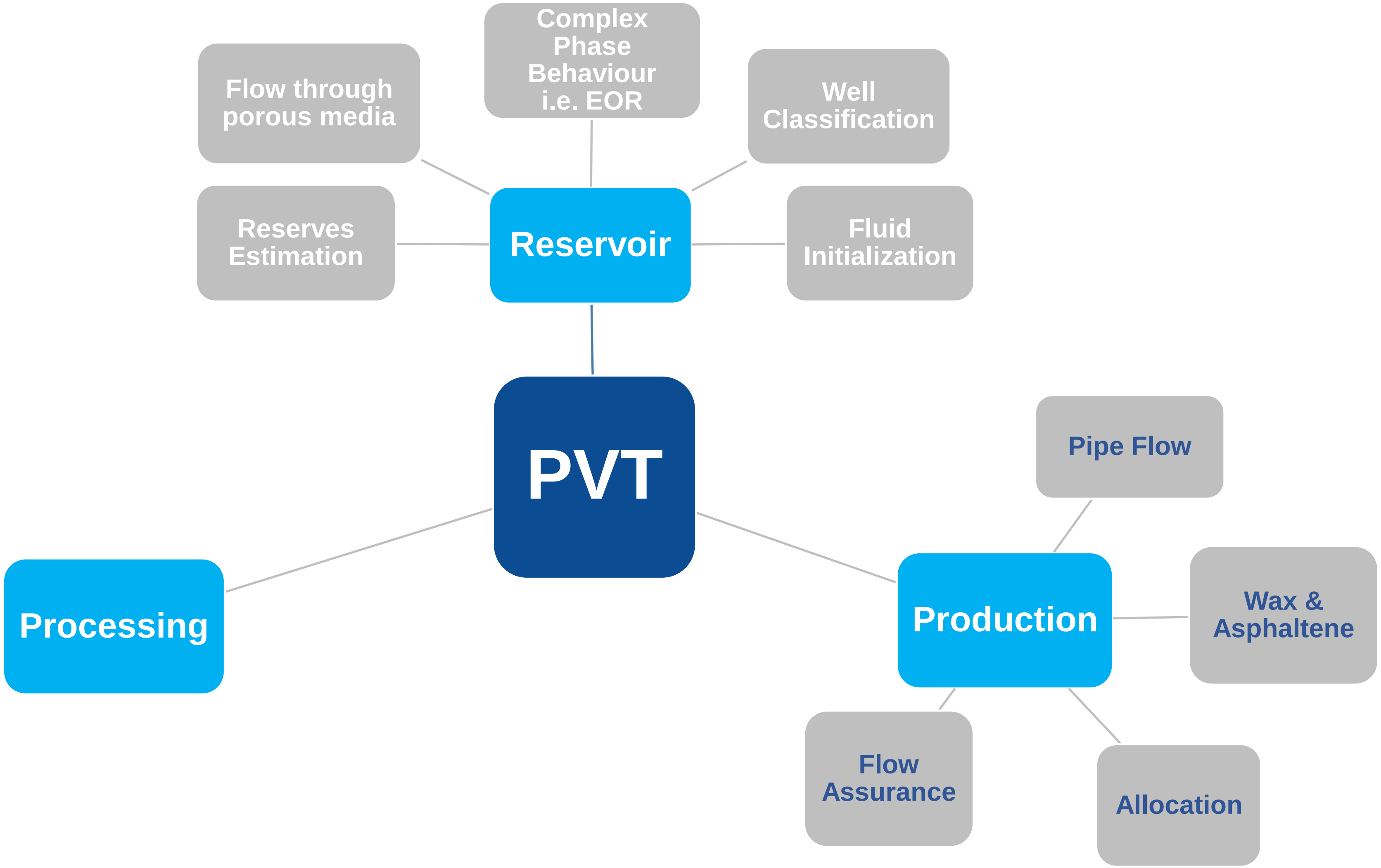

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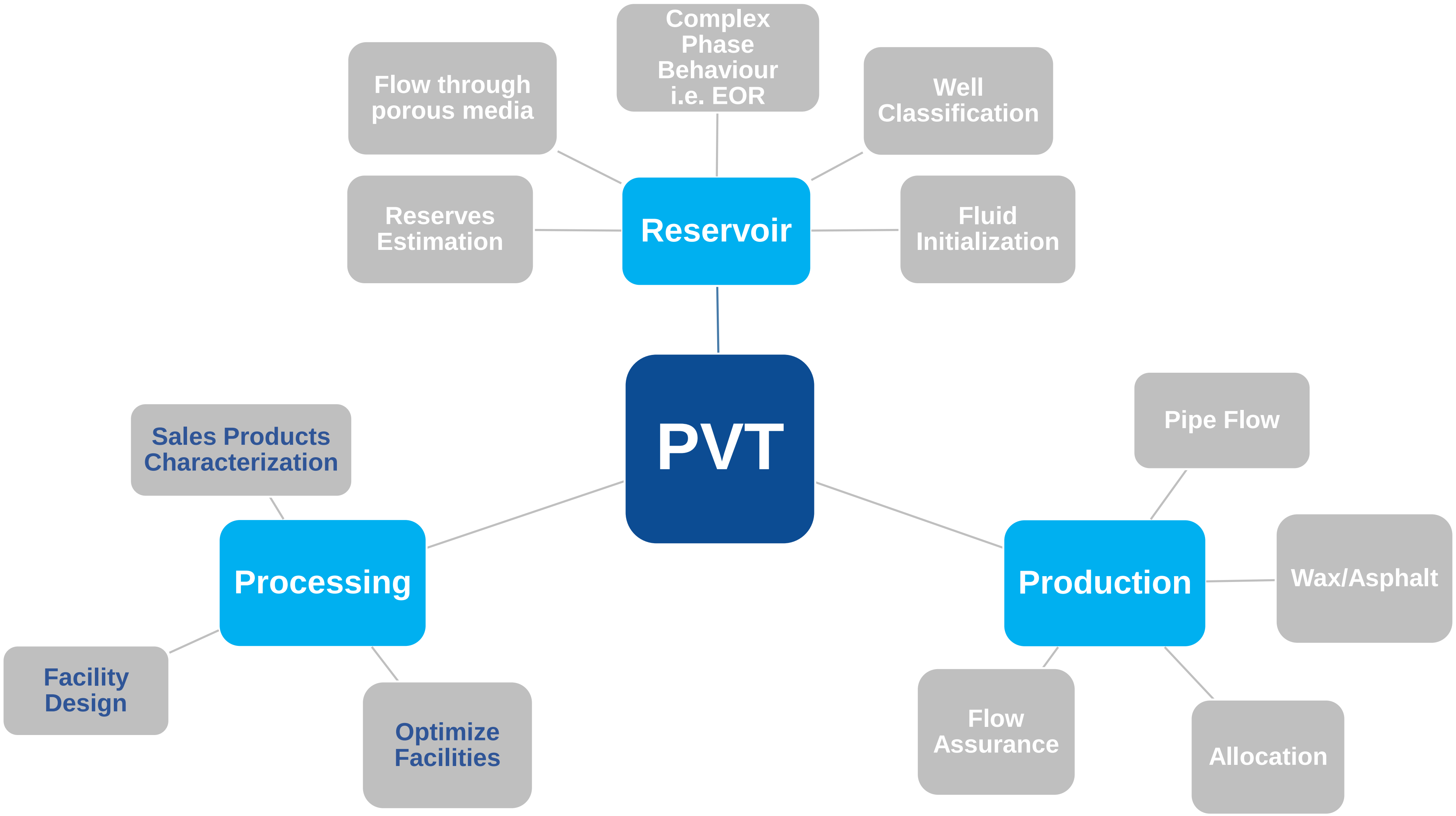
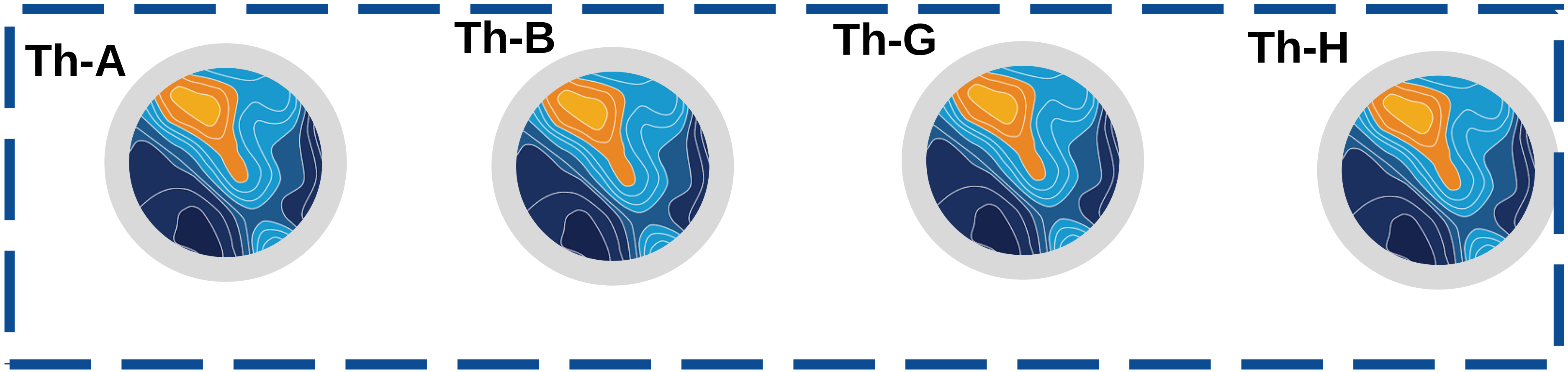
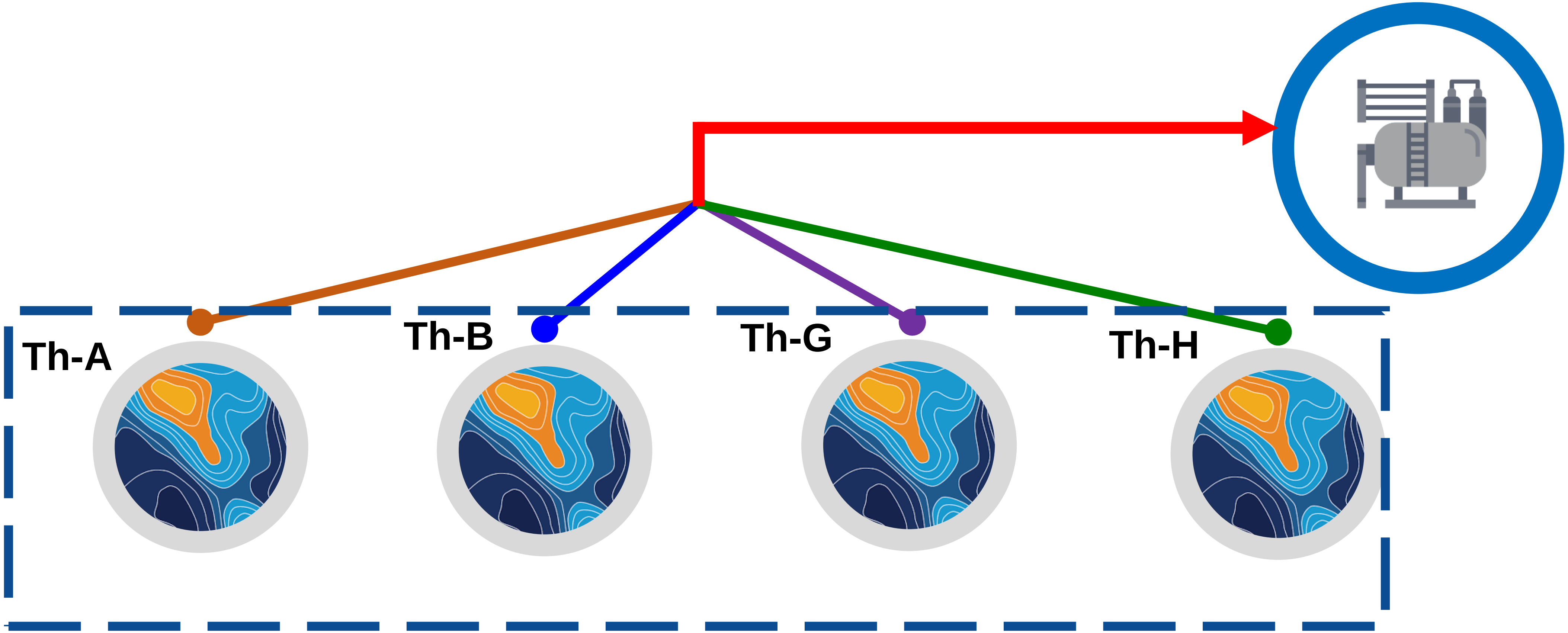


Problem Explanation



Multi Billion bbl Oil Field in Middle East

Problem Explanation



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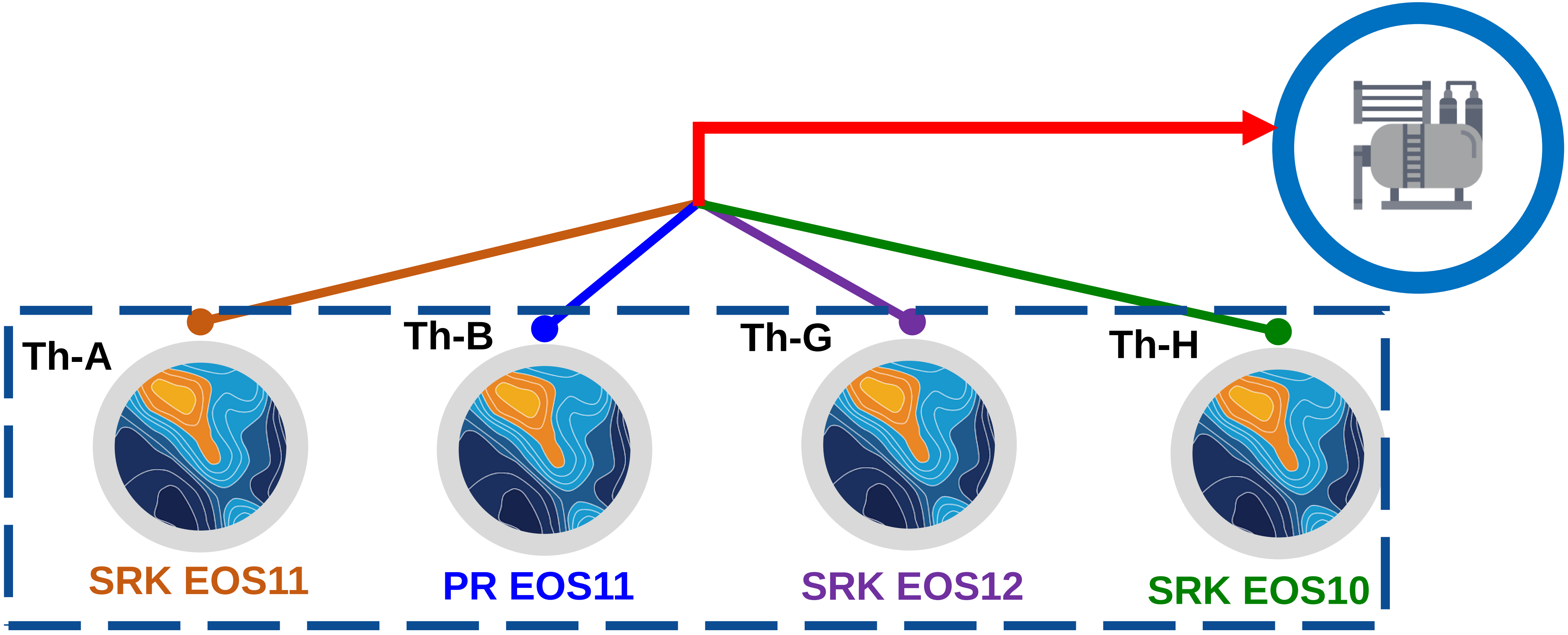

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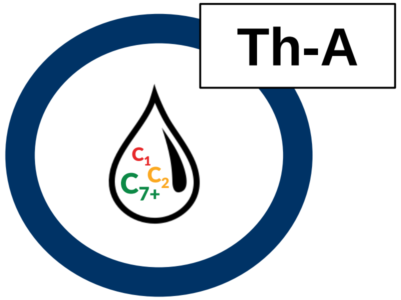
Samples



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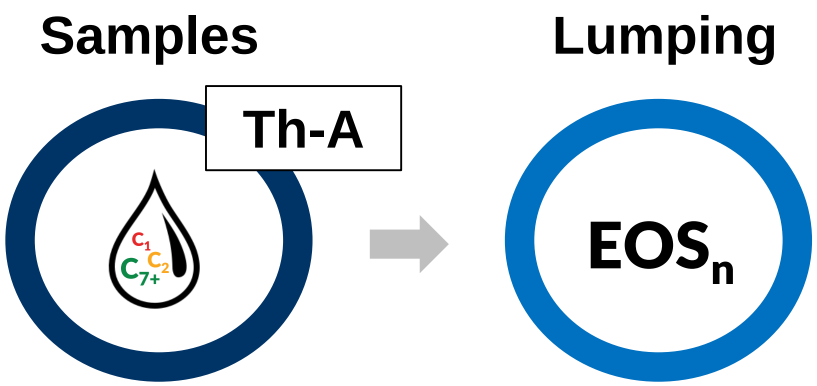

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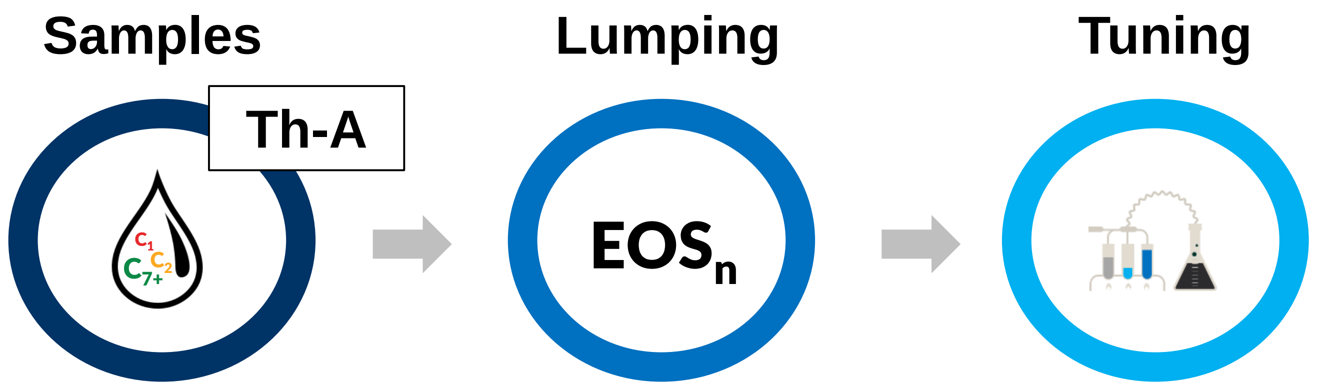

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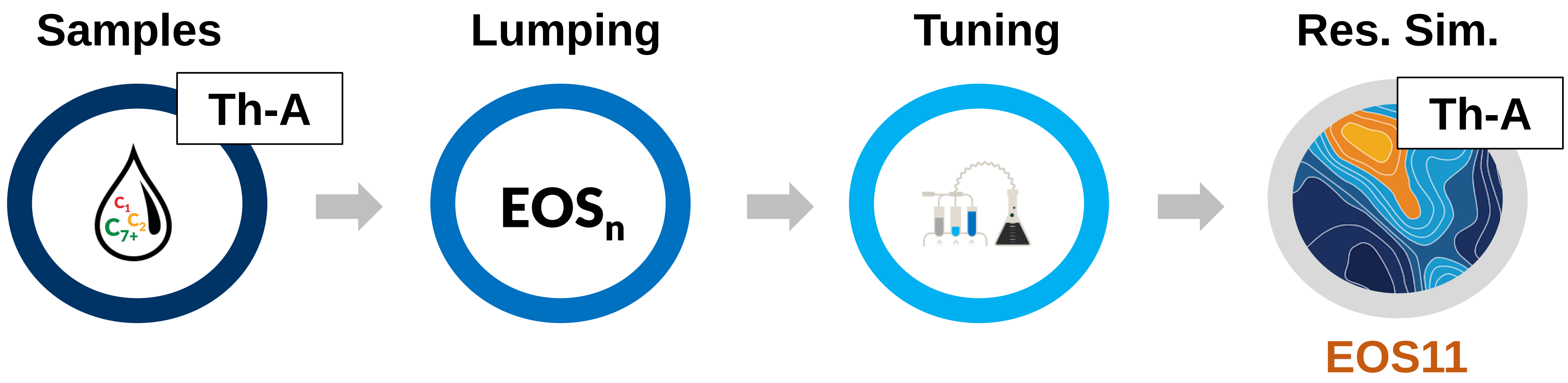

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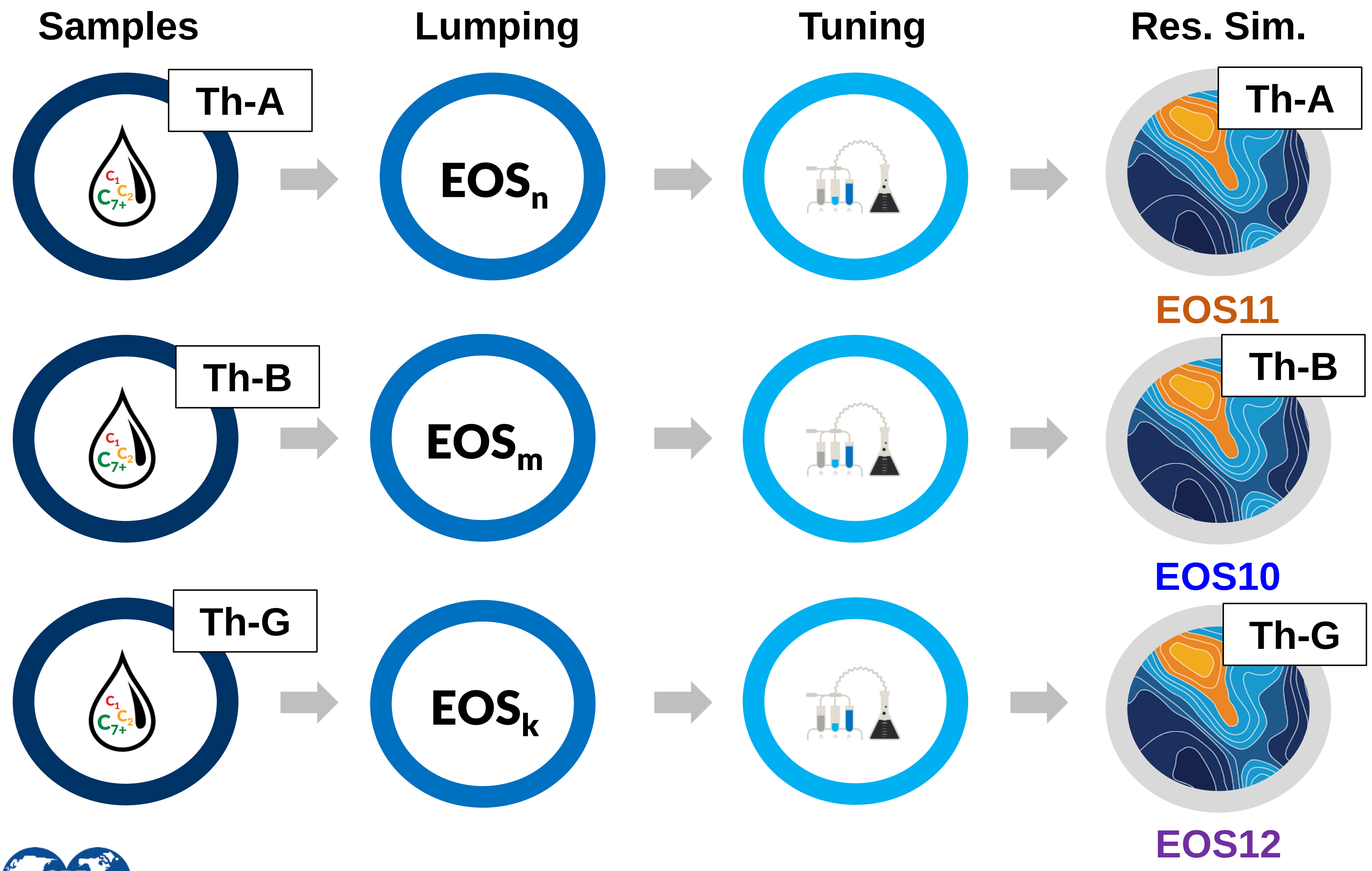

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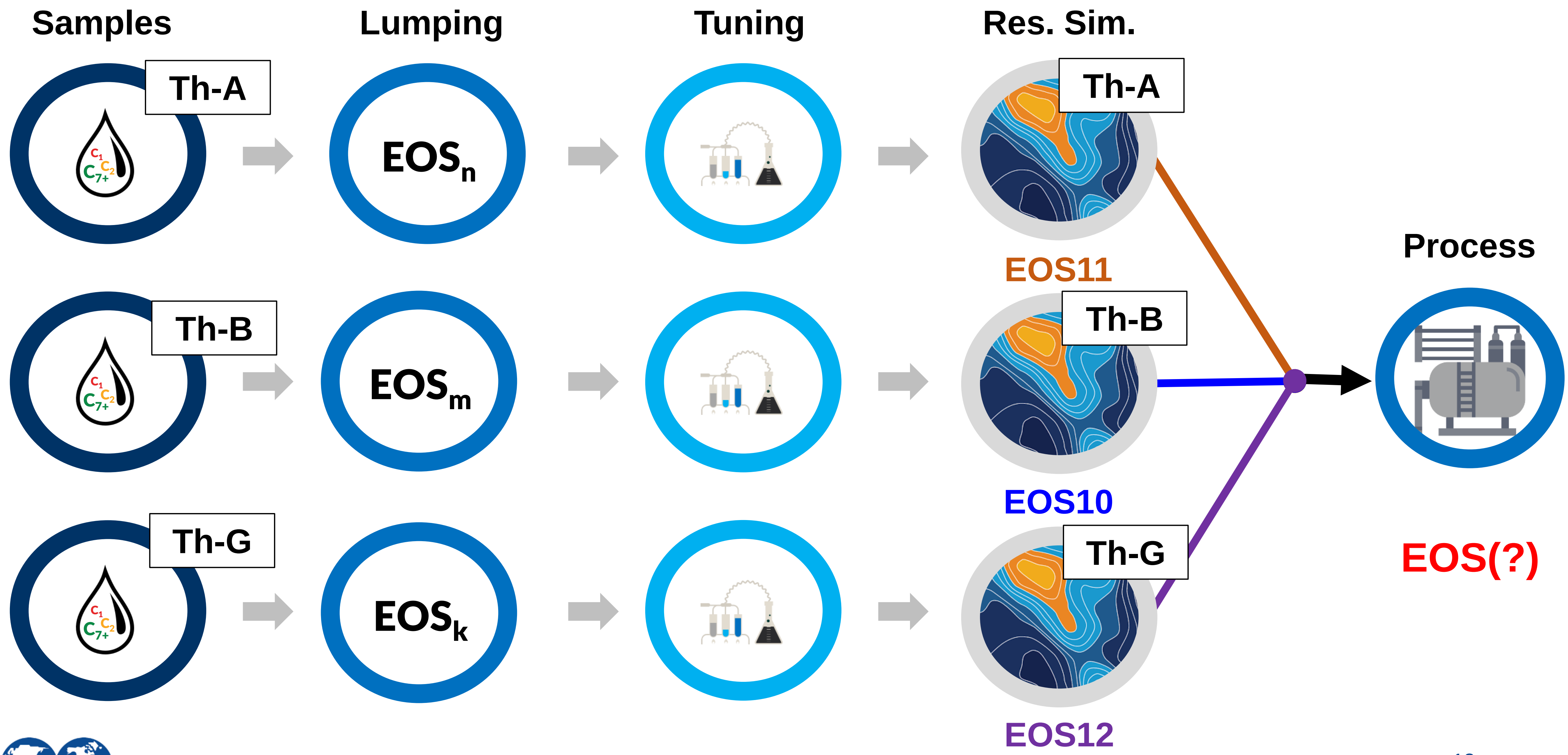

Technical Solution

- **Operator Requirement**

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  - A PVT model with as good or better quality as current PVT models

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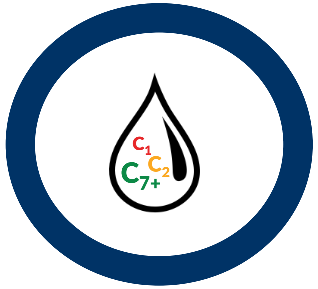
ALL
Samples (80+)



ALL
Reservoirs

Technical Solution

- **Operator Requirement**
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One Common Detailed EOS | **Tuning** | **ALL Samples (80+)**

ALL Reservoirs

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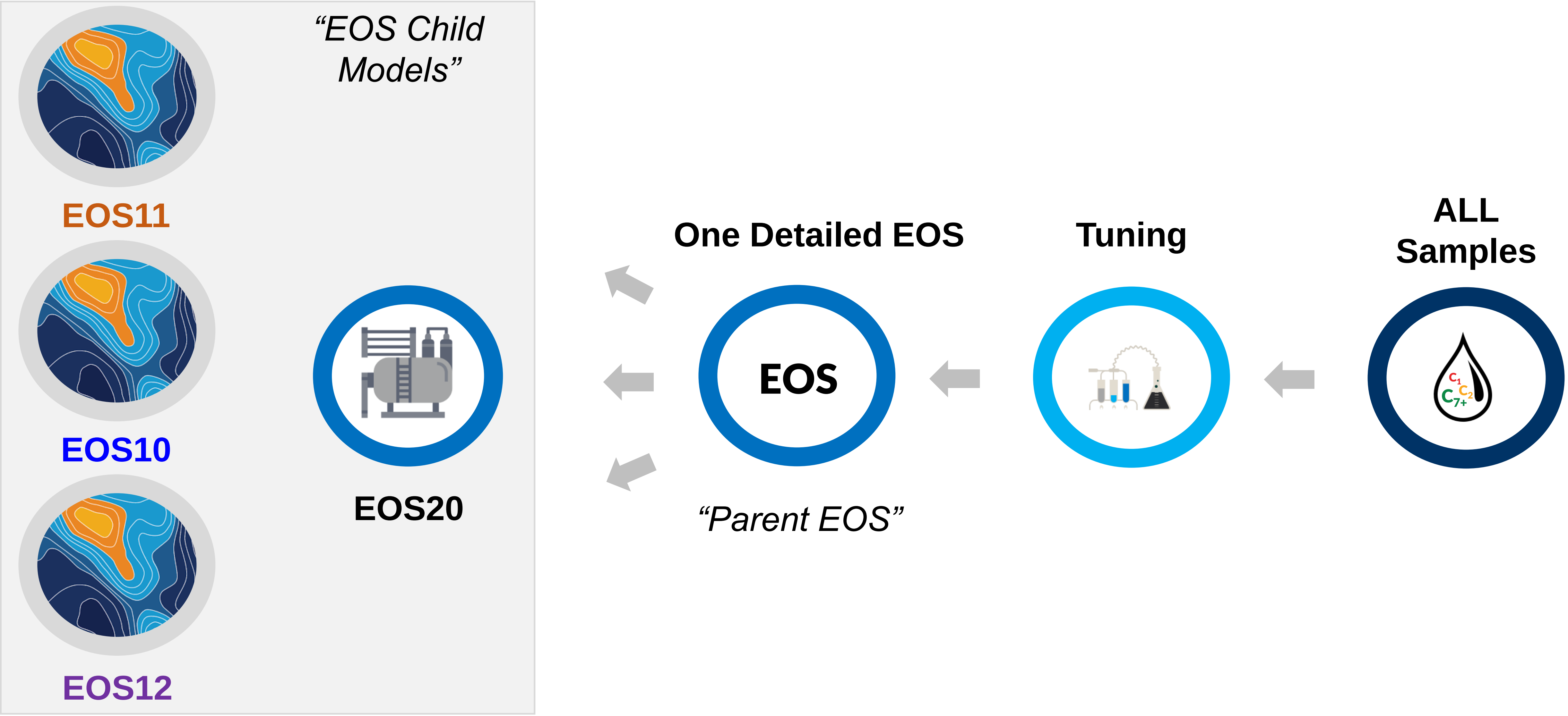
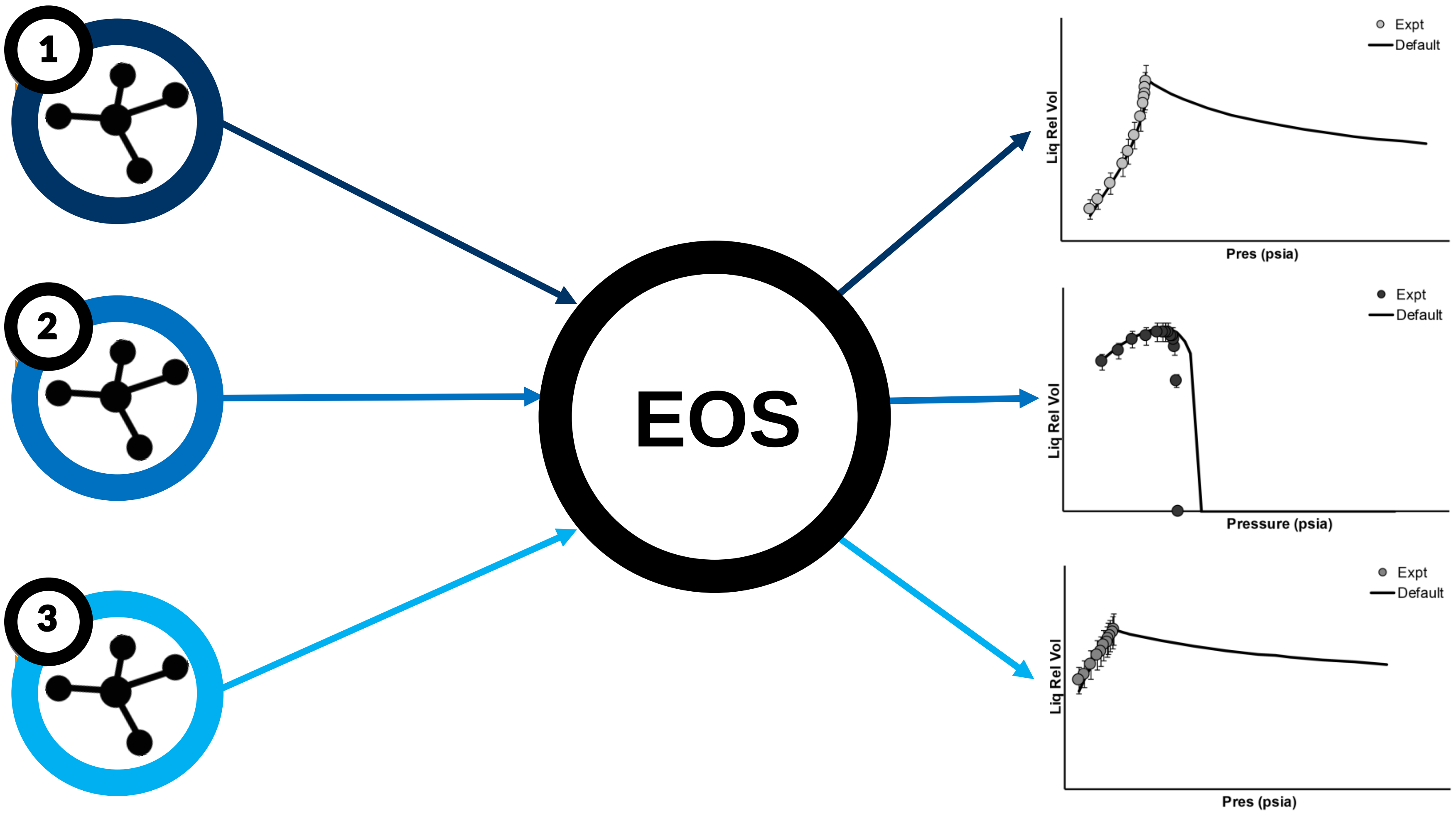
One Common Detailed EOS | **Tuning** | **ALL Samples (80+)**

"Parent EOS" | **ALL Reservoirs**

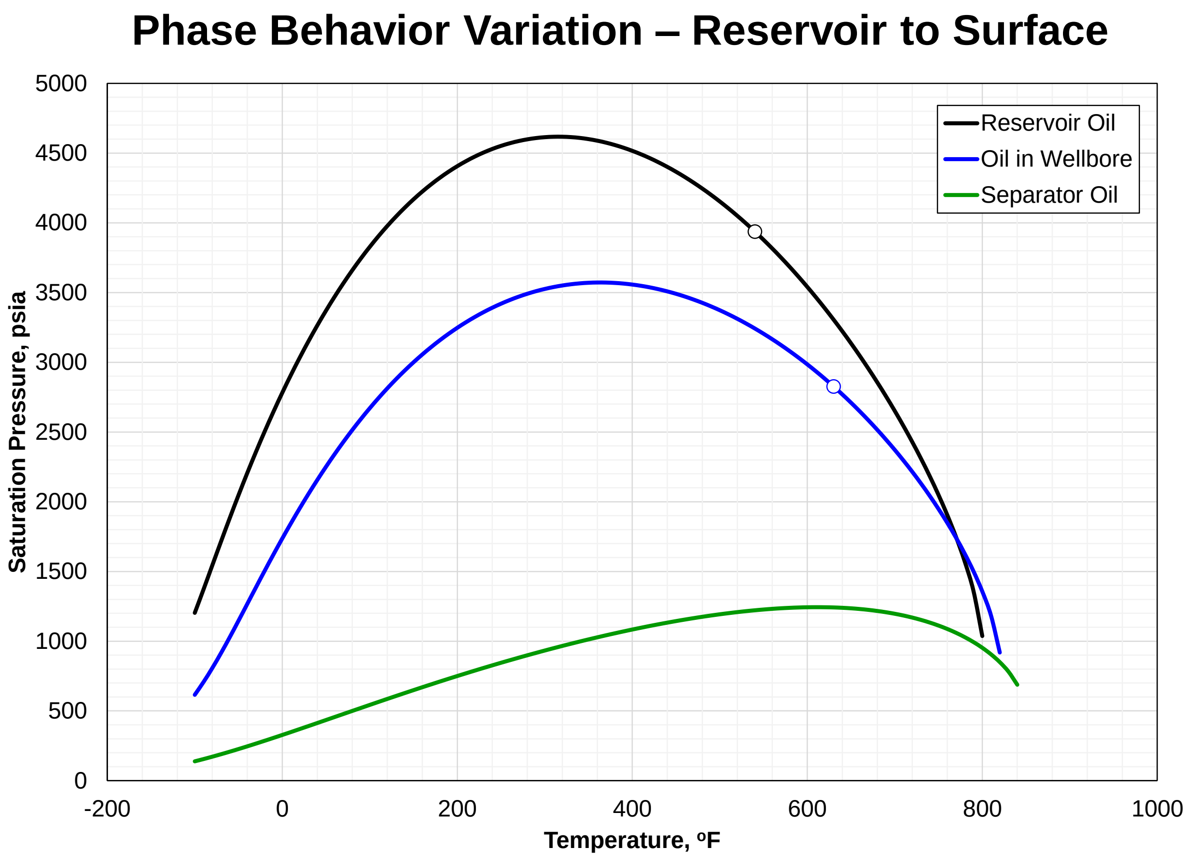
Technical Solution



Common EOS Model



Common EOS Model – Considerations



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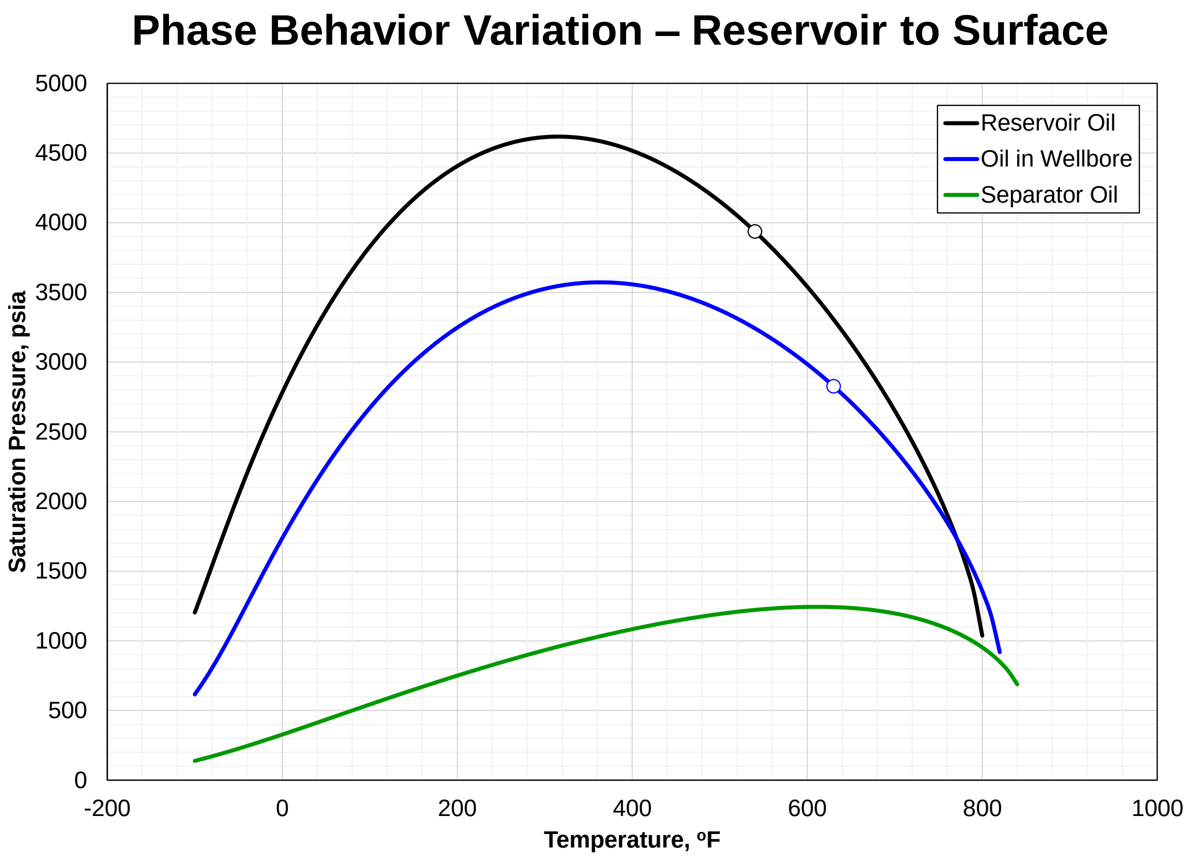

- **Use all available PVT samples (30-100)**

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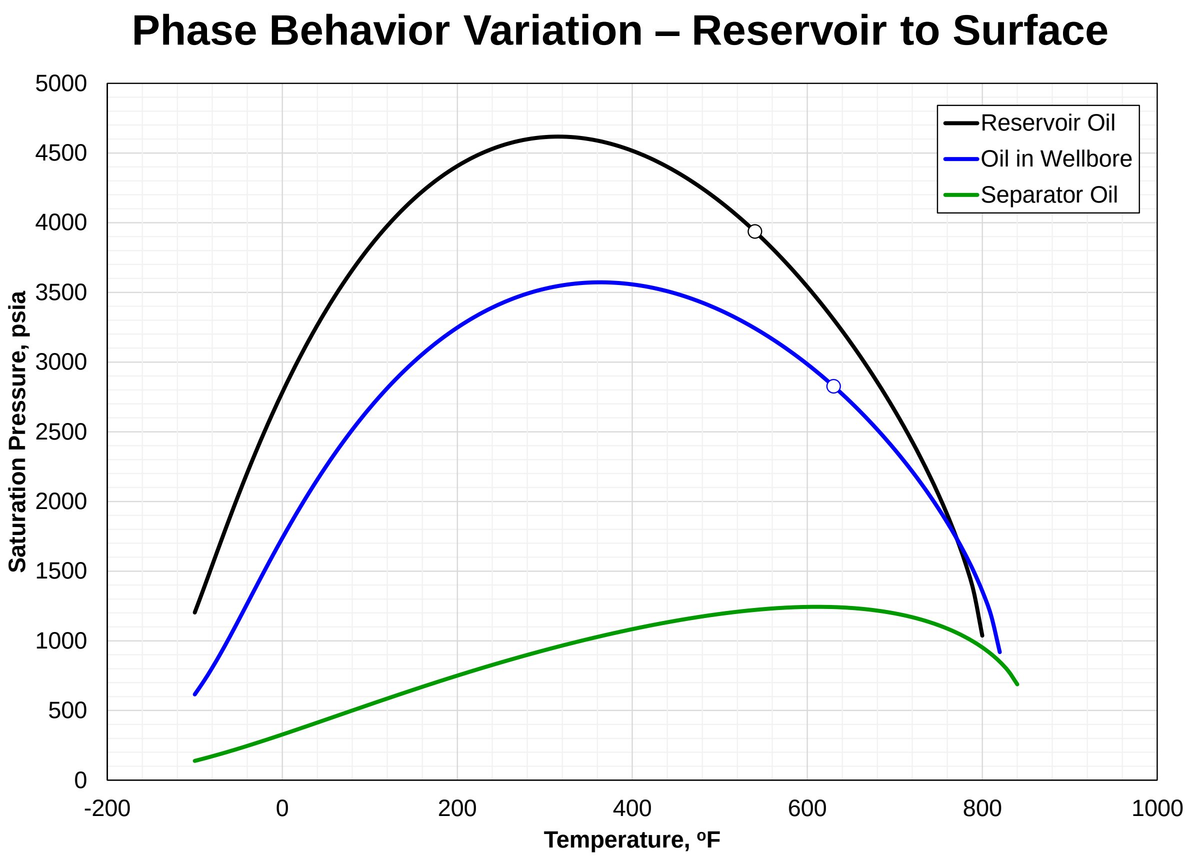

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- **Wider the composition range, better the EOS model**

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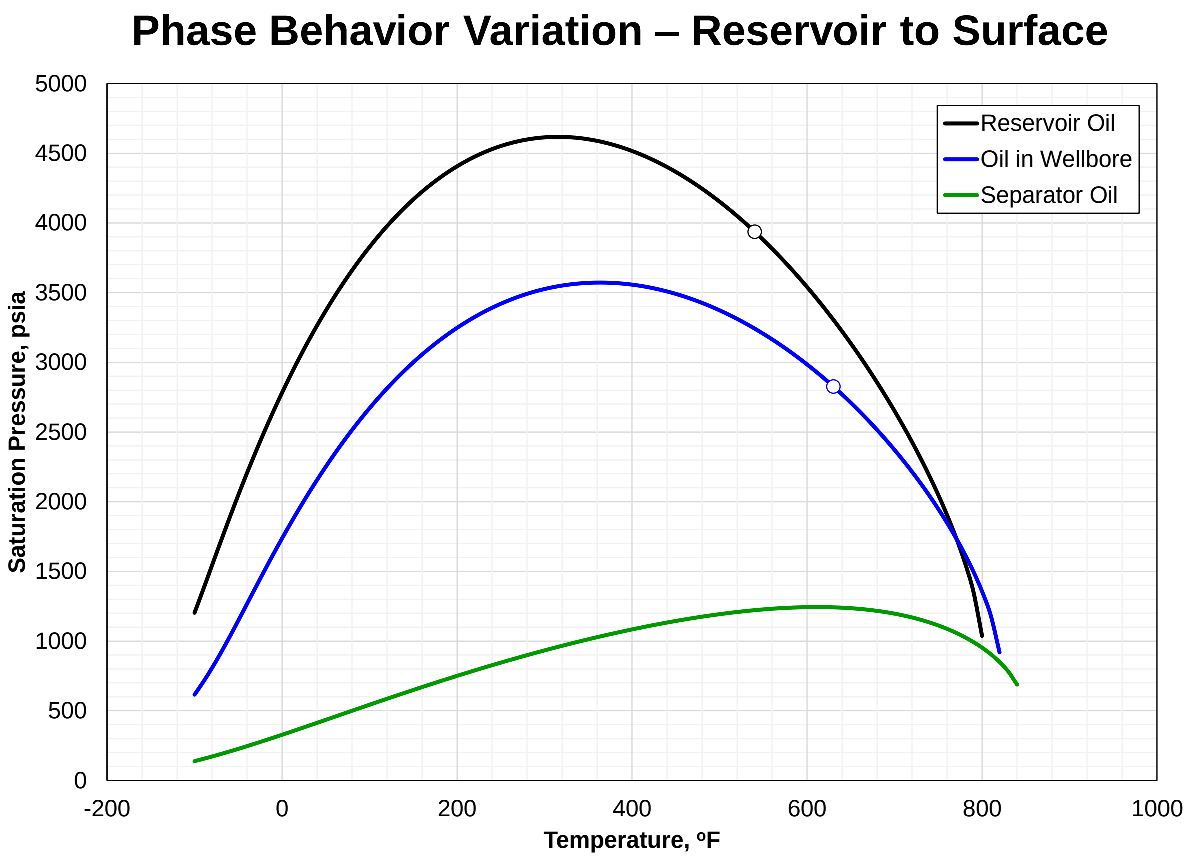

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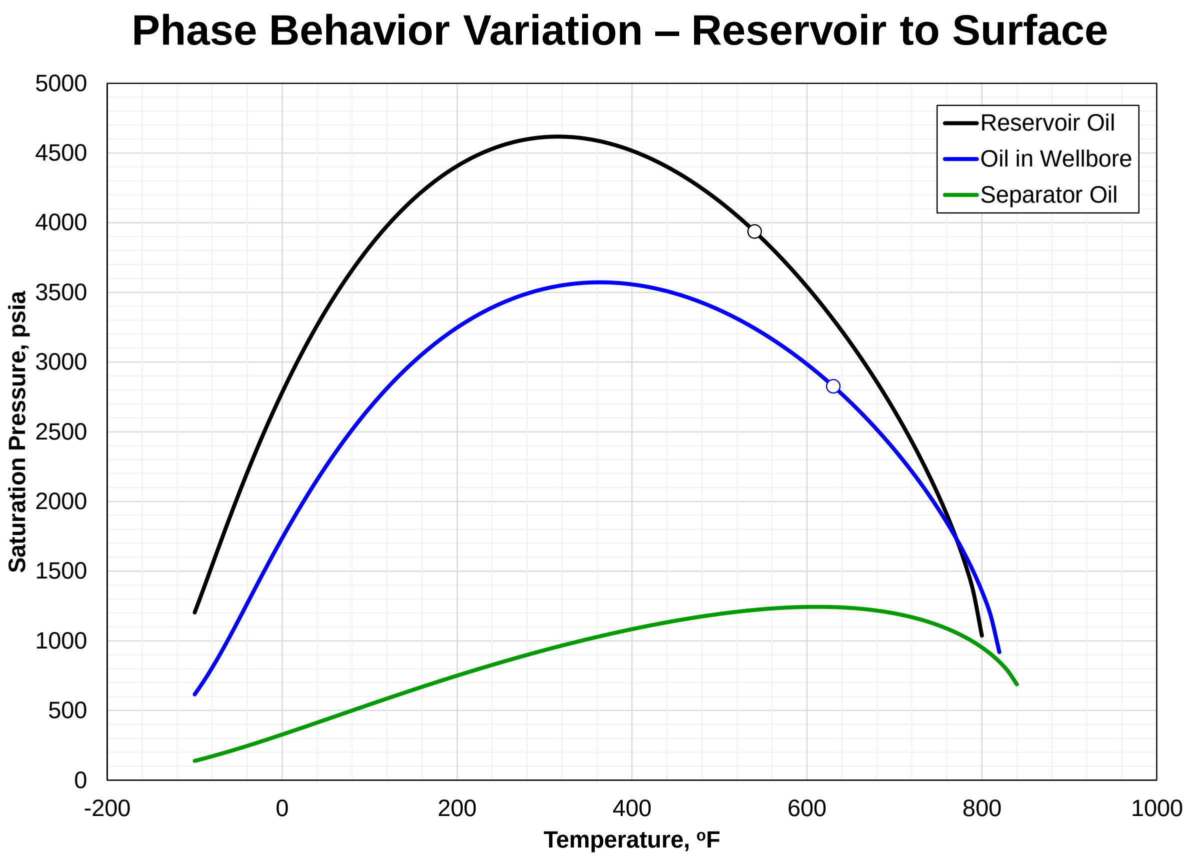

- Use all available PVT samples (30-100)
- Wider the composition range, better the EOS model
- Detailed component slate
- **Use all types of PVT data**
  - Depletion
  - EOR
  - Crude Distillation

PVT Models Family

Common Detailed EOS Model

N2	C-C5	C8-SCN	C11	C21	C31
CO2	C6-SCN	C8*	C12	C22	C32
H2S	C6*	E-Benzene	C13	C23	C33
C1	MC-C5	m-xylene	C14	C24	C34
C2	C-C6	o-xylene	C15	C25	C35
C3	Benzene	C9-SCN	C16	C26	C36p
I-C4	C7-SCN	C9*	C17	C27	
N-C4	C7*	124TM-BEN	C18	C28	
I-C5	MC-C6	C10-SCN	C19	C29	
N-C5	Toluene	C10*	C20	C30	

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Parent

PVT Models Family

Parent

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I-C4	C7-SCN	C9*	C17	C27	
N-C4	C7*	124TM-BEN	C18	C28	
I-C5	MC-C6	C10-SCN	C19	C29	
N-C5	Toluene	C10*	C20	C30	

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Child-1

SCN EOS Model

N2	C6	C14	C24	C34
CO2	C7	C15	C25	C35
H2S	C8	C16	C26	C36p
C1	C9	C17	C27	
C2	C10	C18	C28	
C3	C11	C19	C29	
I-C4	C12	C20	C30	
N-C4	C13	C21	C31	
I-C5	C14	C22	C32	
N-C5	C15	C23	C33	

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Child-2

Black Oil Tables

Child-3

Lumped 1

H2S
N2C1
C2CO2
C3
C4C6
C7C10
C11C18
C19C25
C25C35
C36p

10

Child-4

Lumped 2

H2S
N2C1
C2CO2
C3
C4
C5
C6C9
C10C20
C21C35
C36p

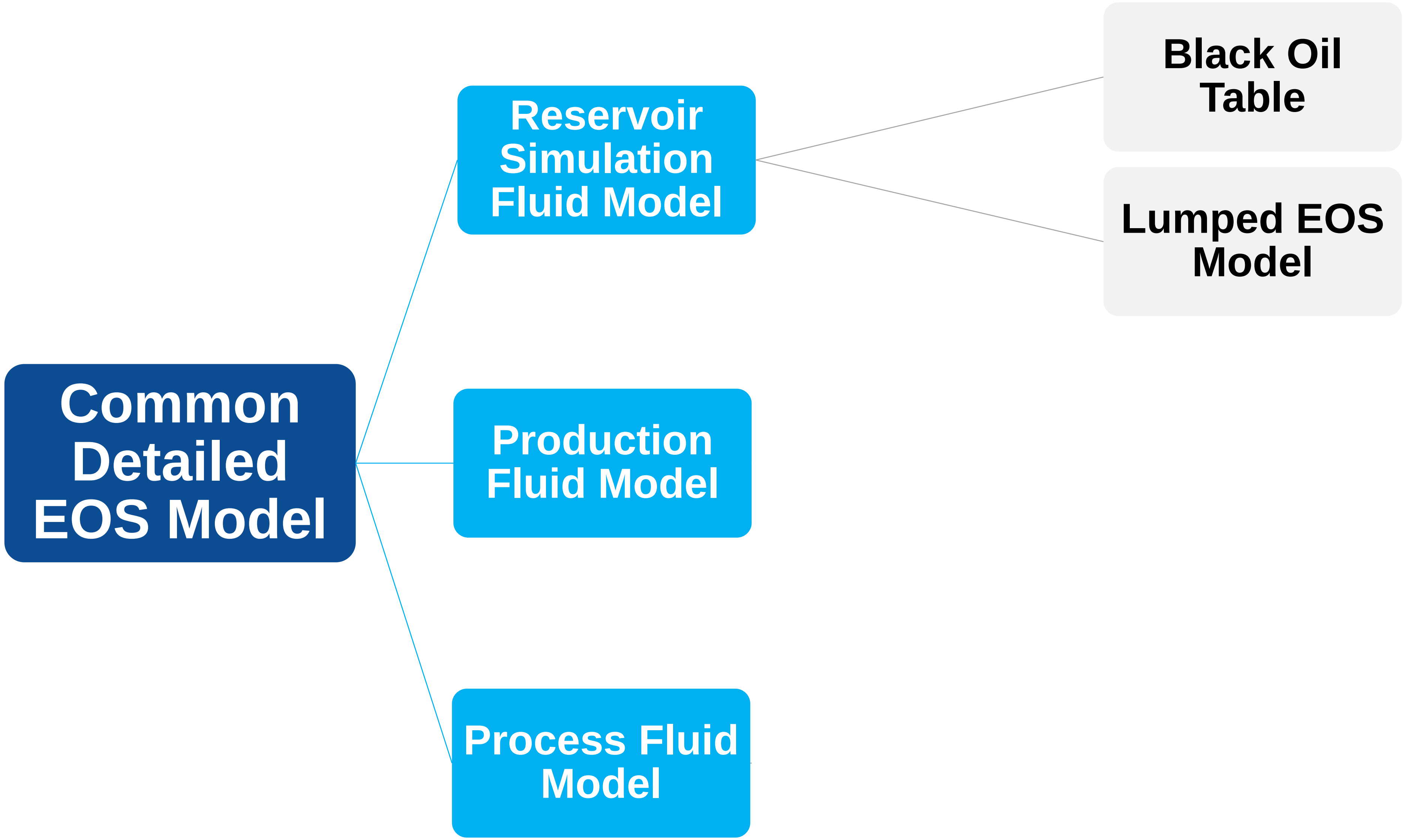
10

Integration of Different Parts of Value Chain

Common Detailed EOS Model

- Reservoir Simulation Fluid Model
- Production Fluid Model
- Process Fluid Model

Integration of Different Parts of Value Chain



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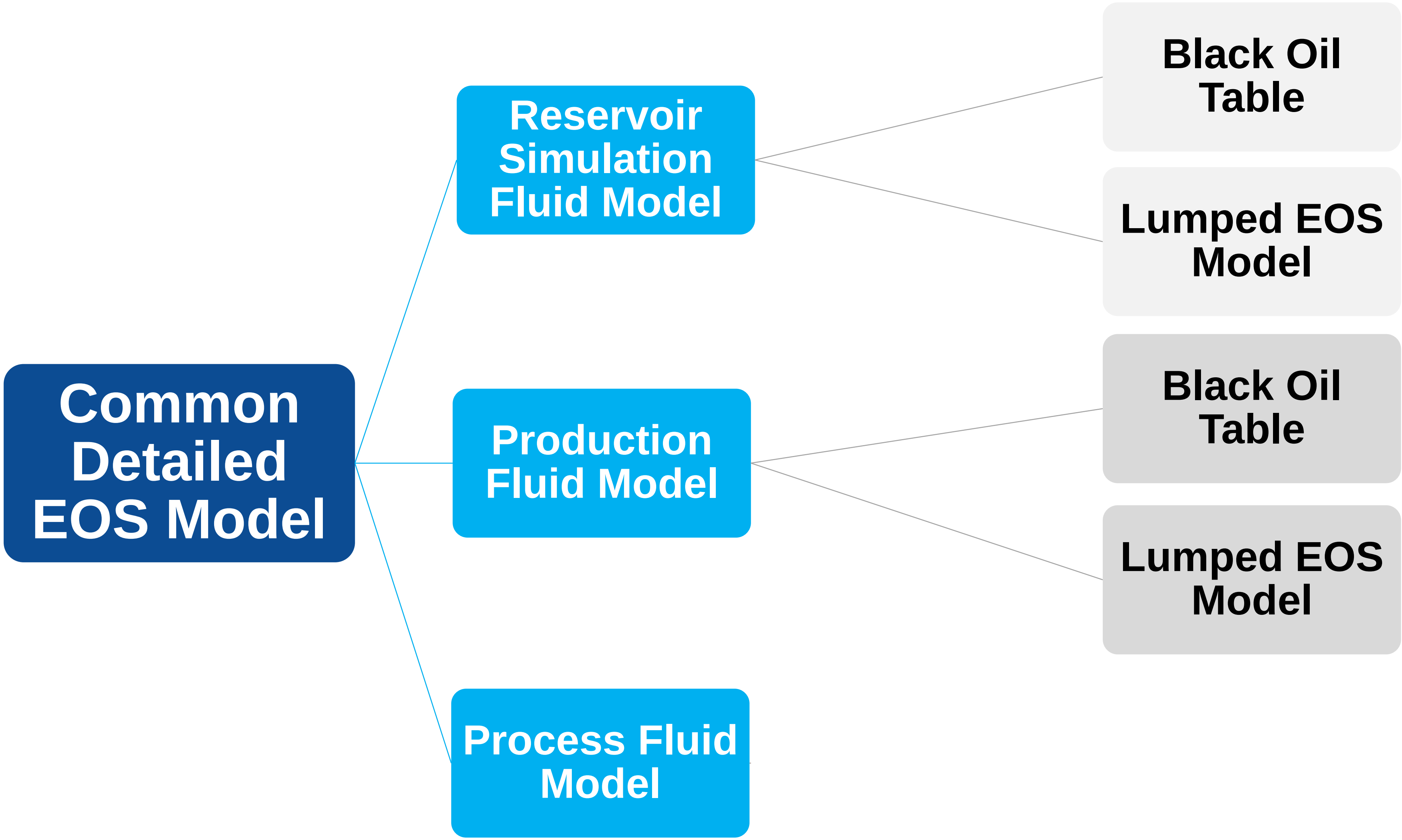
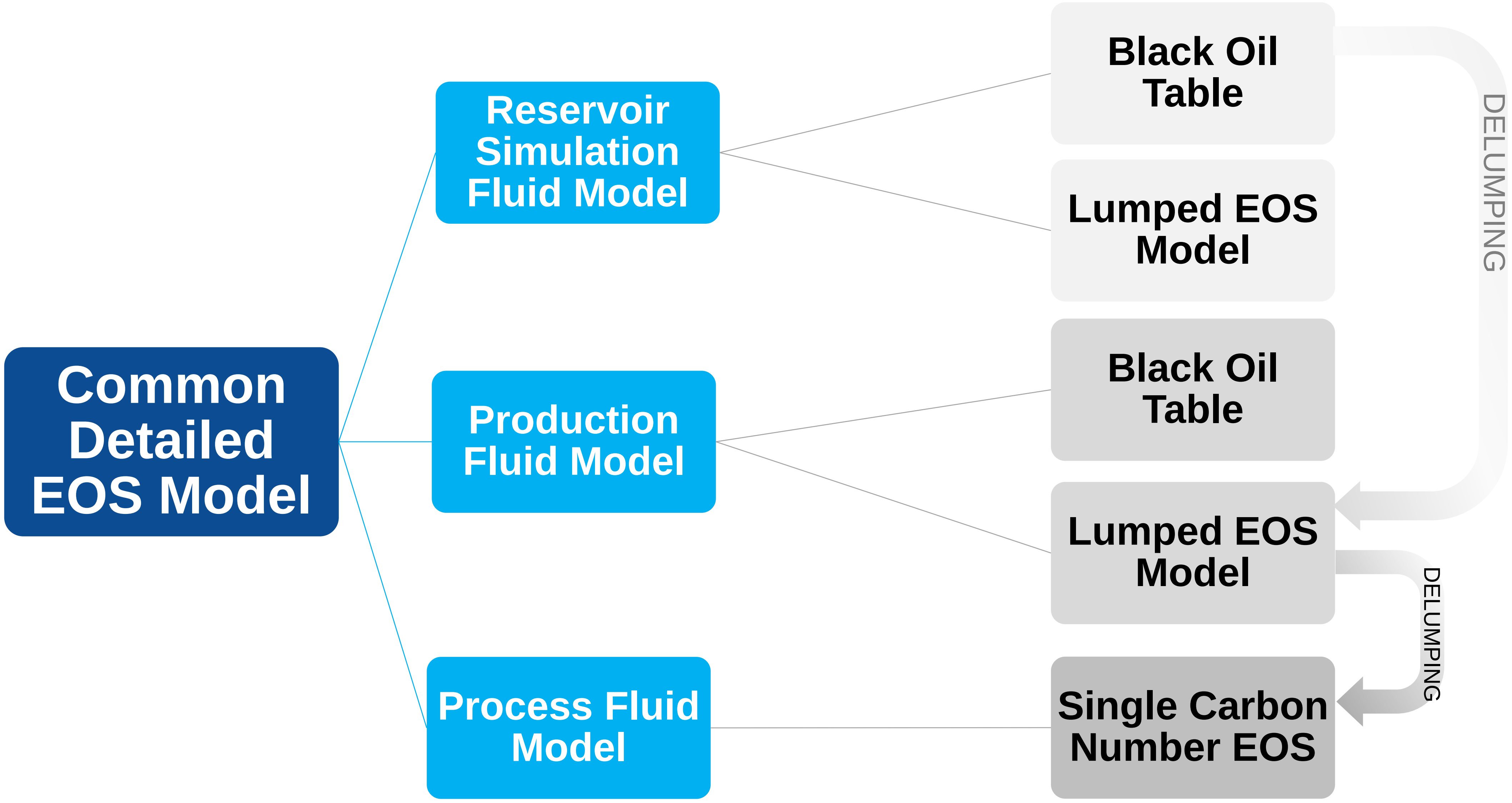


Integration of Different Parts of Value Chain

- **Common Detailed EOS Model**
  - **Reservoir Simulation Fluid Model**
    - Black Oil Table
    - Lumped EOS Model
  - **Production Fluid Model**
    - Black Oil Table
    - Lumped EOS Model
  - **Process Fluid Model**
    - Single Carbon Number EOS

Integration of Different Parts of Value Chain



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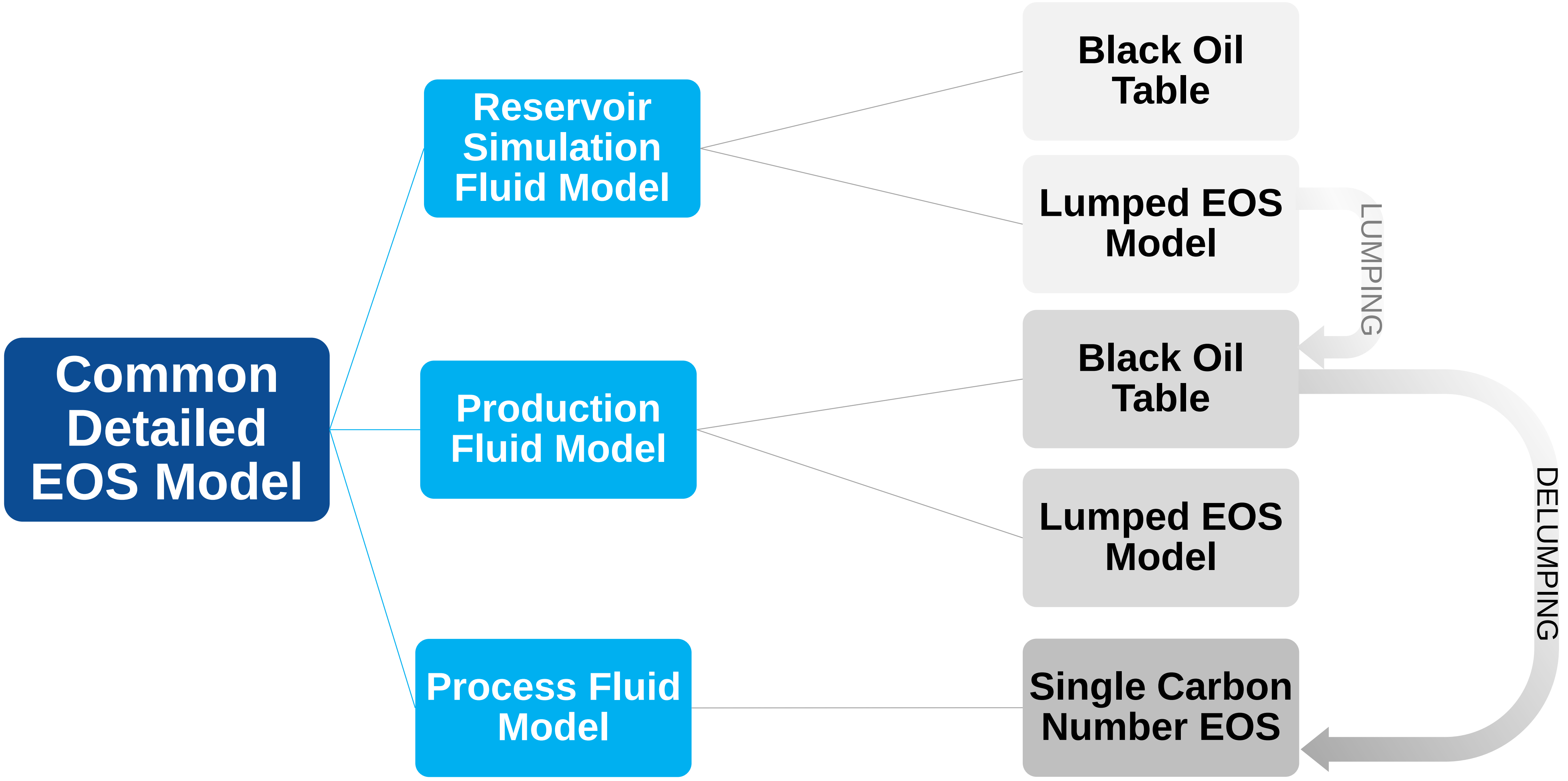
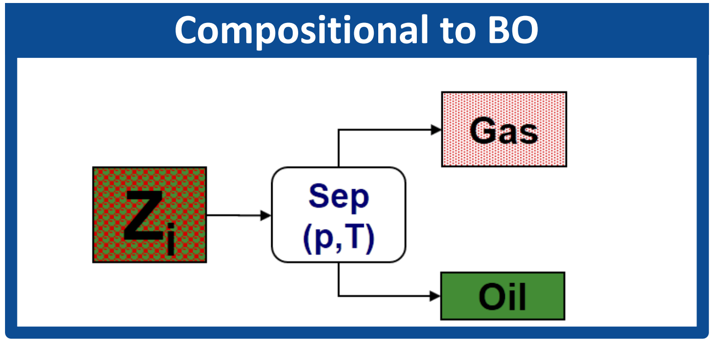
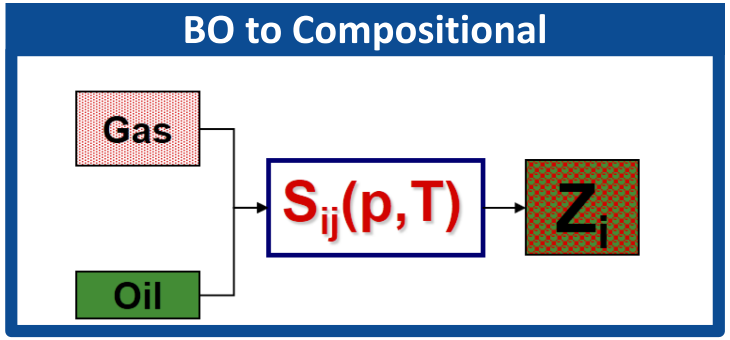


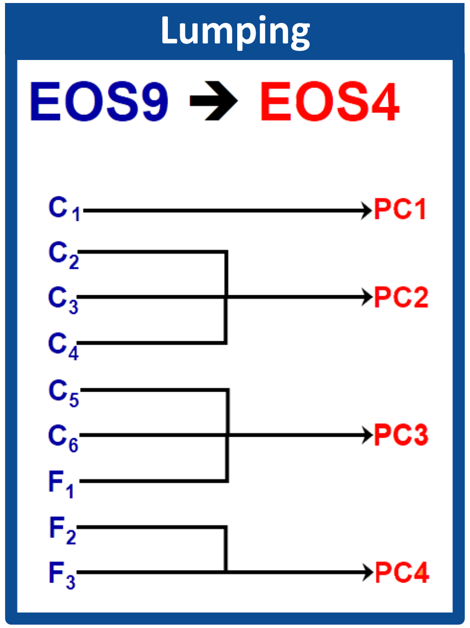
Consistent Lumping Delumping – References



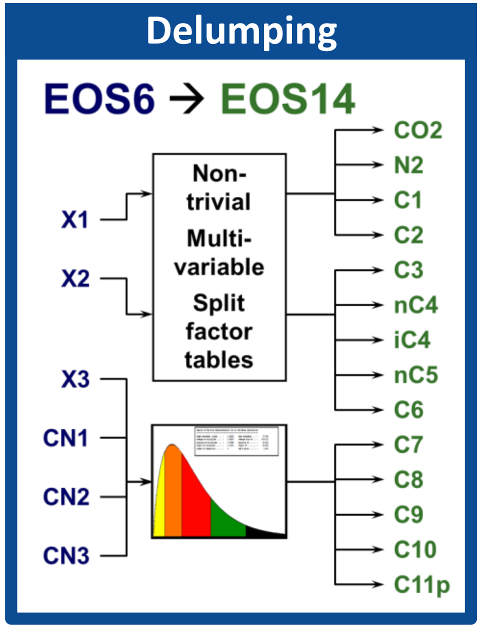
SPE 10067 “Evaluating constant Volume Depletion Data”



SPE 159400 “Dynamic Delumping of Reservoir Simulation”



SPE 170912 “Global Component Lumping for EOS Calculations”



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The fluid that flows from the reservoir is physically the same throughout the system, and should be described by the same fluid model throughout the entire production system, from reservoir to sales

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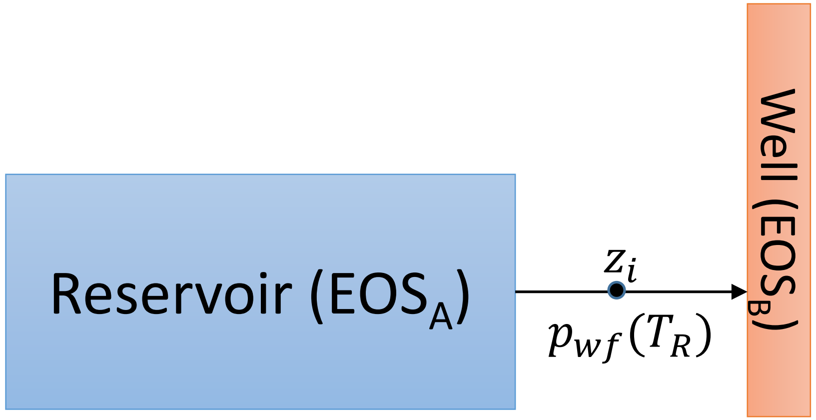

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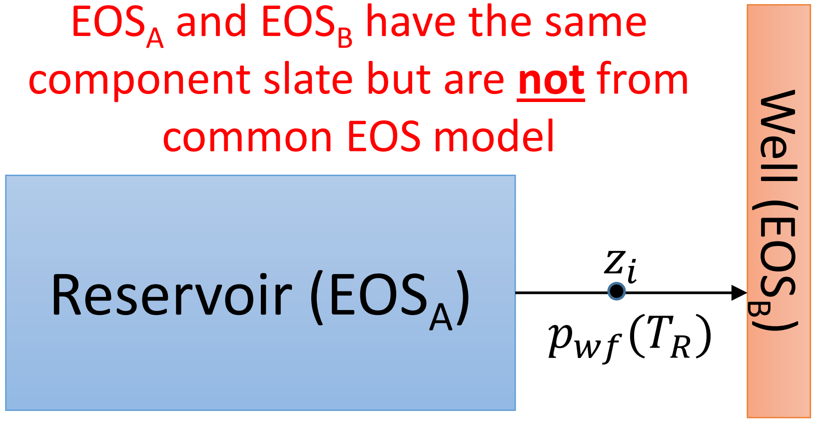

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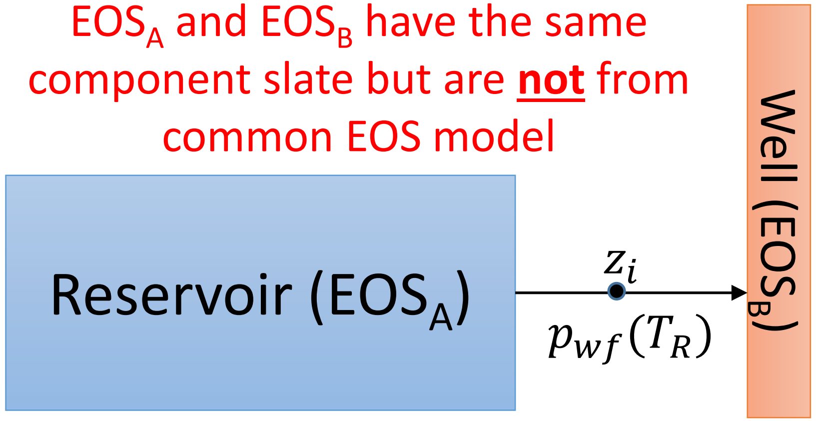

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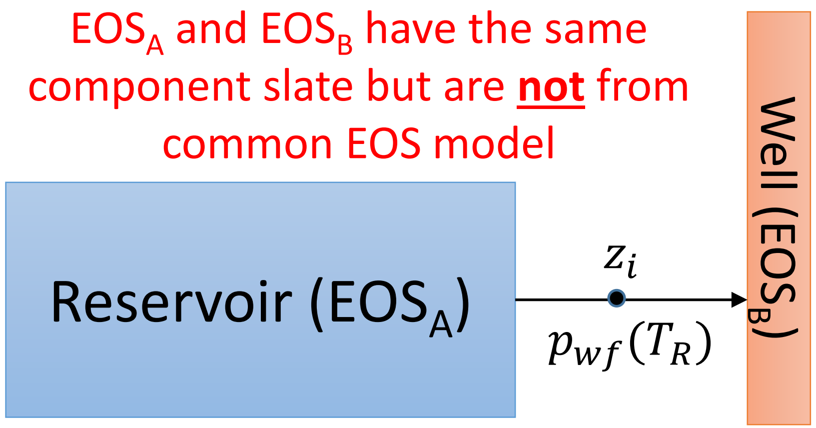

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Reservoir (EOS_A)

z_i

$p_{wf}(T_R)$

Well (EOS_B)

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PVT model inconsistencies can be a serious problem resulting in mass, molar, and volumetric material balance errors in key applications:

- Field Development & Design
- Short Term and Long Term Production Optimization
- Decision Support

Field Studies

Diluent Injection Optimization for an Offshore Heavy Oil Field in UK

SPE 183802, SPE 184119

Production Allocation for an Onshore Multi-Field Asset in South America

SPE 174843

Integration of Reservoir and Process Models for South Natuna Sea, Indonesia

IPA03-E-068

API Blending Optimization for a Multi-Field Asset in the Middle East

SPE 187471

Condensate Allocation Sutdy for Two Giant Gas Cap-Oil Fields in Middle East

Thank you

Questions?