Modeling three-phase separation using MFIX

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CanmetENERGY
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Devon, Alberta, Canada, T9G 1A8

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GENERAL INFORMATION

Natural Resources Canada is a department of the Canadian Federal Government mandated to promote the sustainable development of Canada's land, energy, mineral and forest resources.

Main mandate of CanmetENERGY is:
Development of sustainable technology for Oil Sands exploration through R&D

OIL SAND LOCATION

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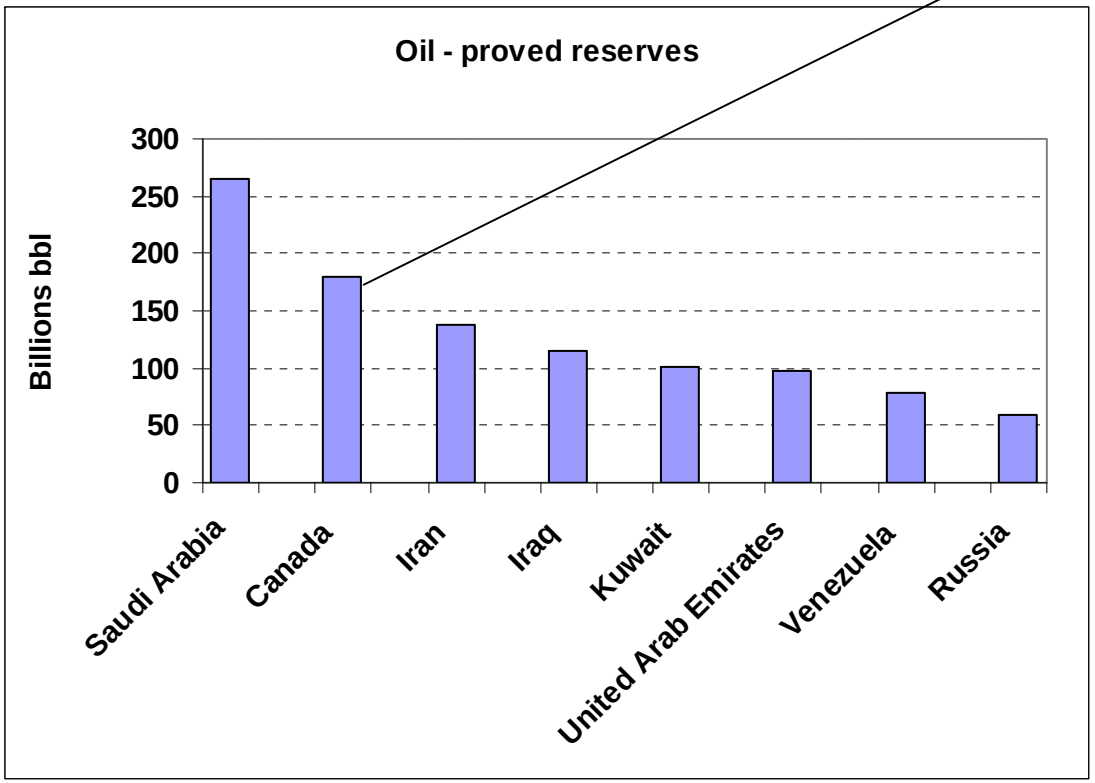
WORLD OIL RESERVES

Mainly in oil sands (~12% bitumen)



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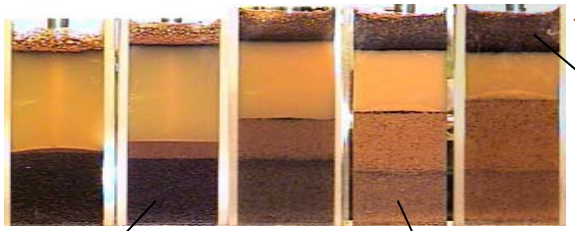
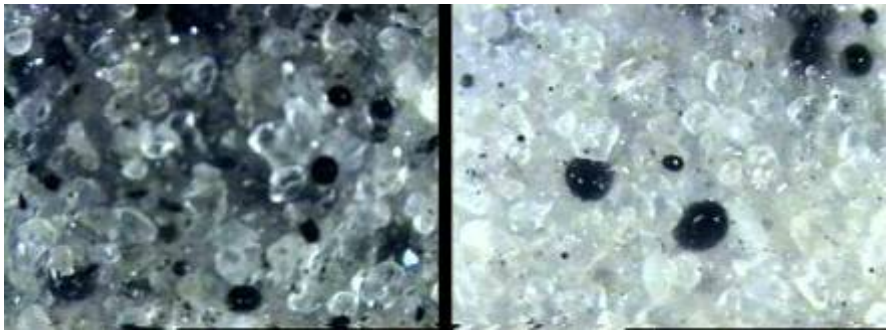
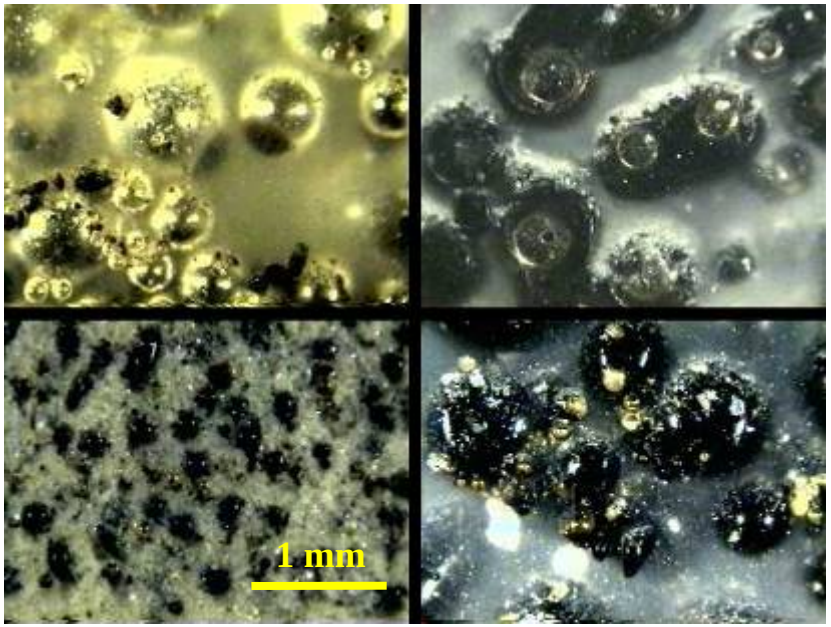
BITUMEN EXTRACTION

Bitumen Froth
~60% bitumen
~30% water
~10% minerals

Time







We are interested in separation of various phases under dynamic conditions – in a settler

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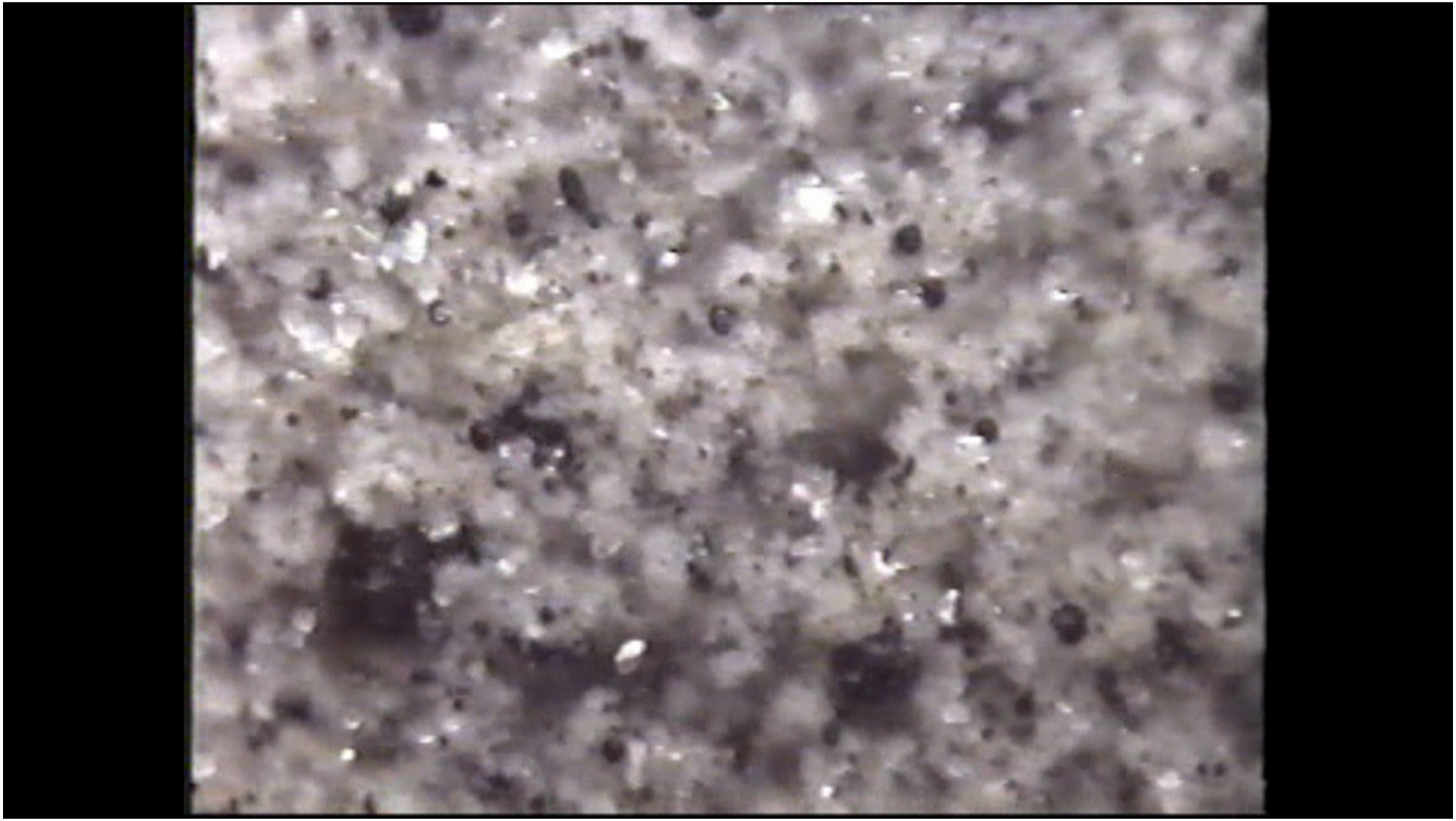

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Problem Definition

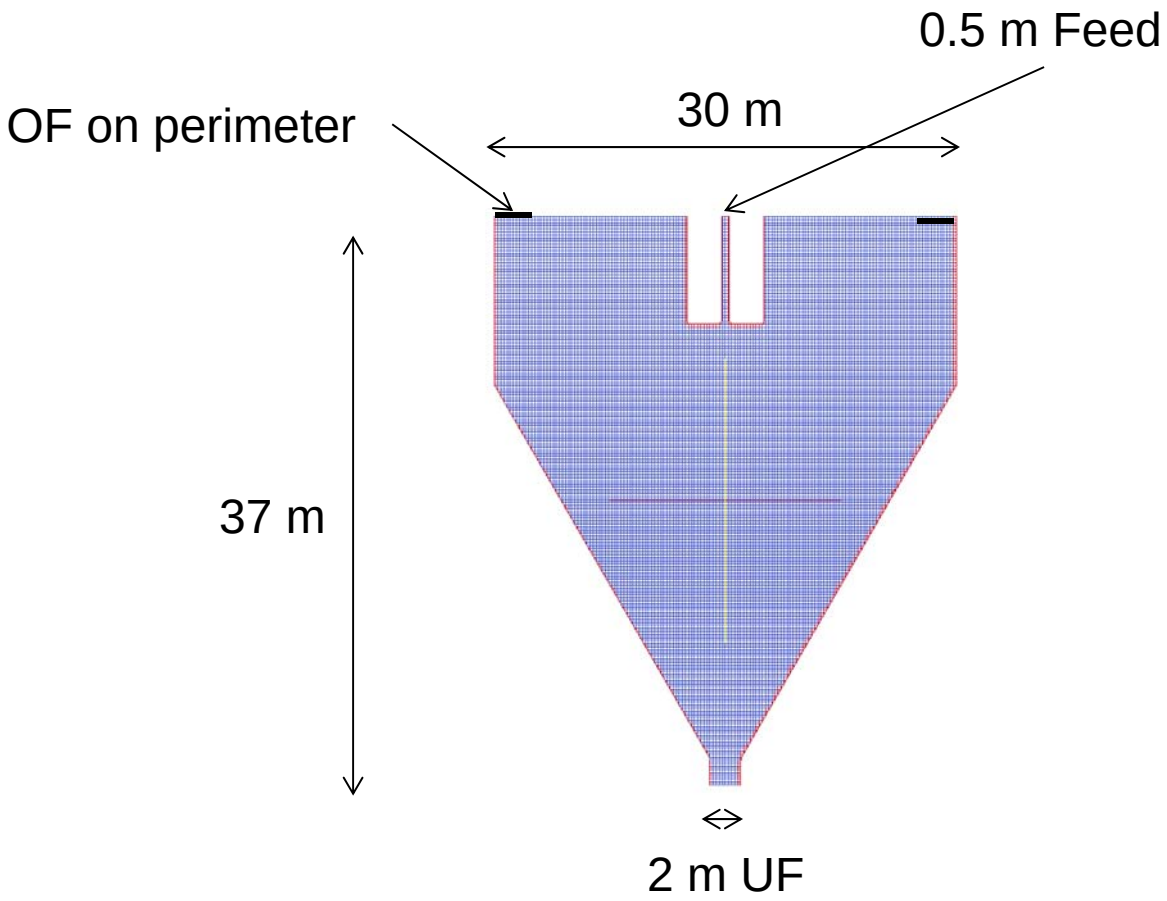
What we want to know:

1. Flow pattern in the settler (separation vessel)
2. Maximum feed rate, which will give good separation

In Future:

1. Impact of vessel geometry (e.g. feed well) on the separation
2. Impact of interactions between dispersed particles on composition
3. Flow properties of various streams (under flow, over flow)

Example:

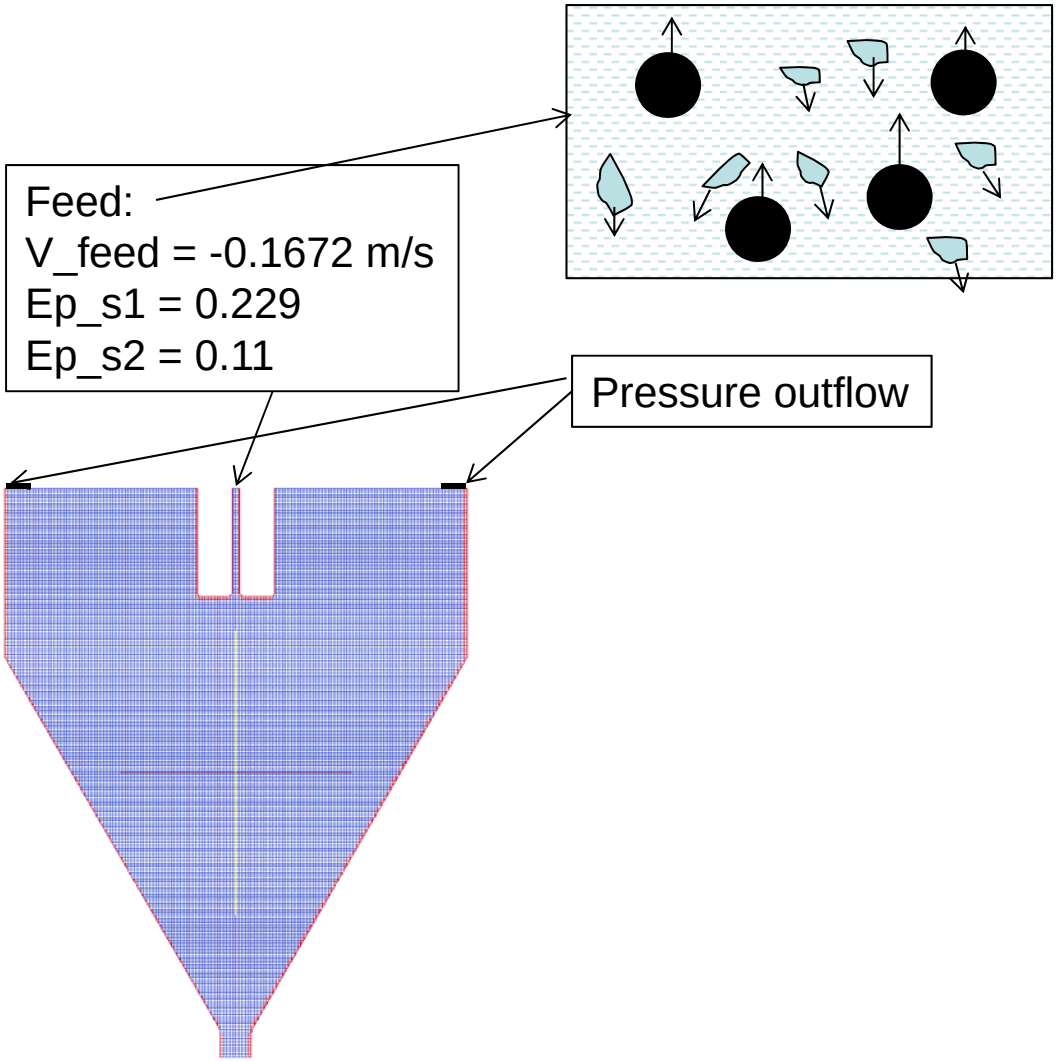


Grid:
IMAX = 150
JMAX = 185
NO_K = .TRUE.

Gas-phase:
MU_g0 = 0.0018 Pa s
Rho_g0 = 1000kg/m^3

Solids-phase:
Rho_s1 = 2600kg/m^3
Rho_s2 = 600kg/m^3
D_p01 = 300e-6 m
D_p02 = 0.001m
e = 0.1 (restitution)
Phi = 30.0
EP_star = 0.43

Example:



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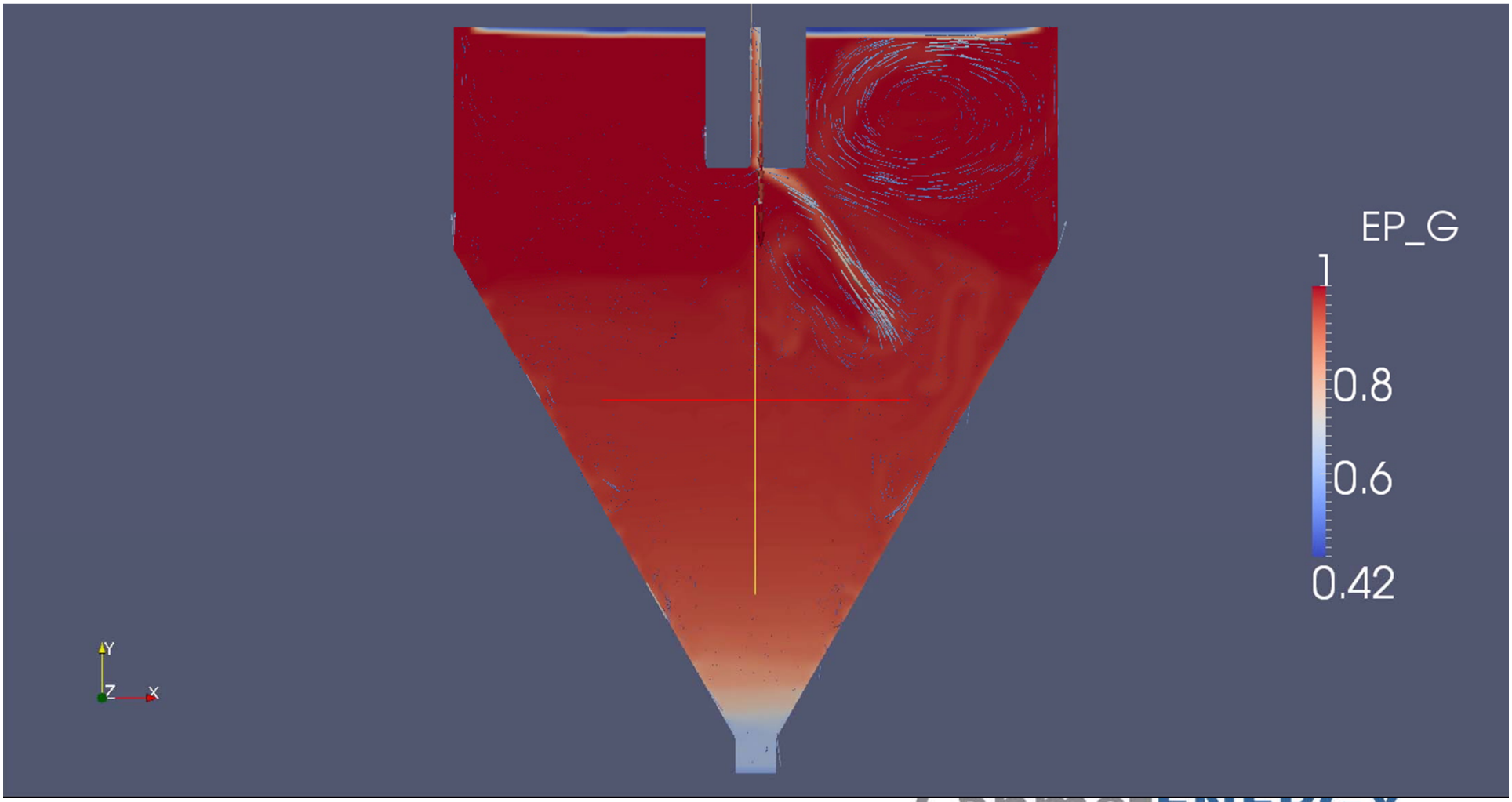
Results: Flow and Settling



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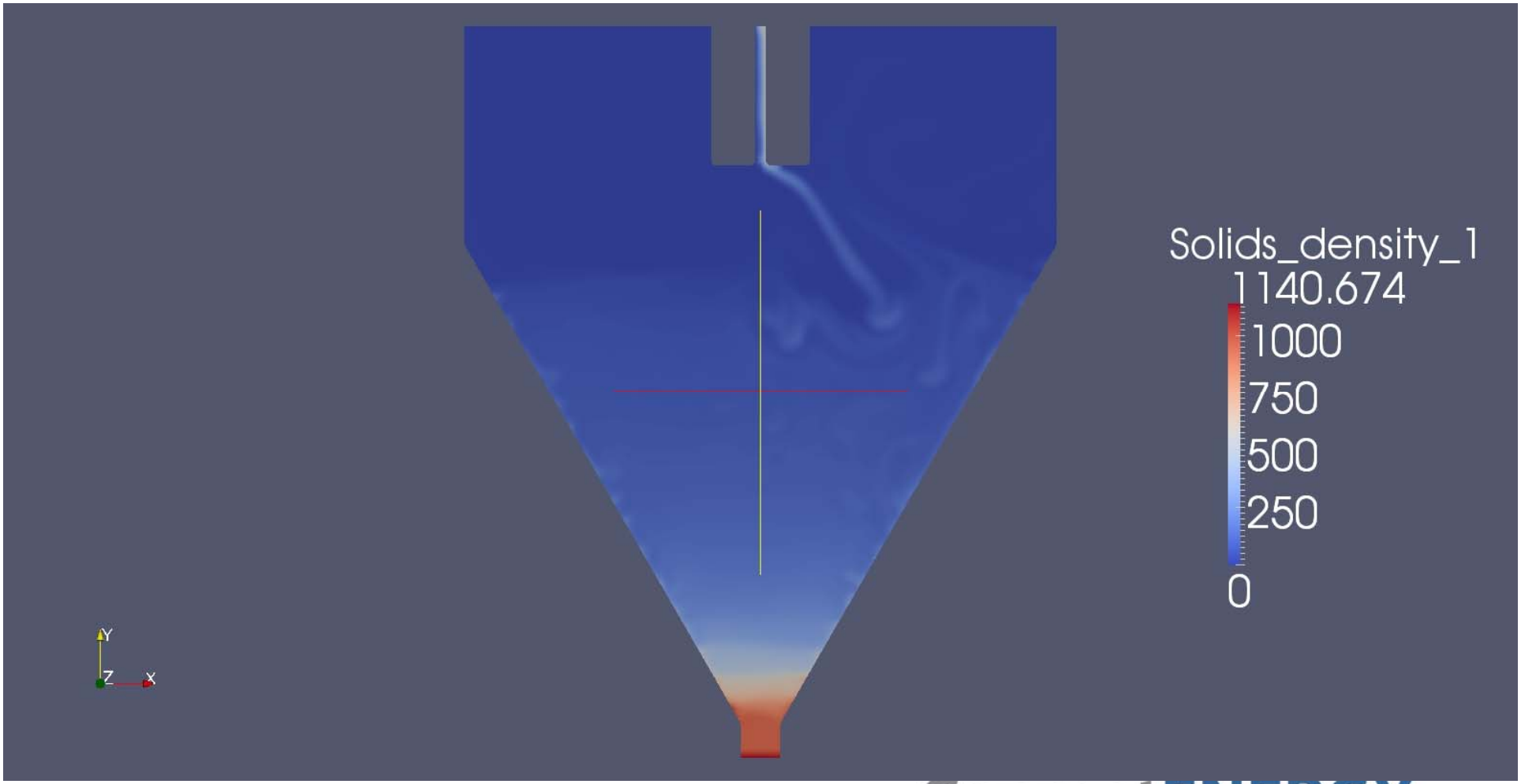
Results: Sand separation



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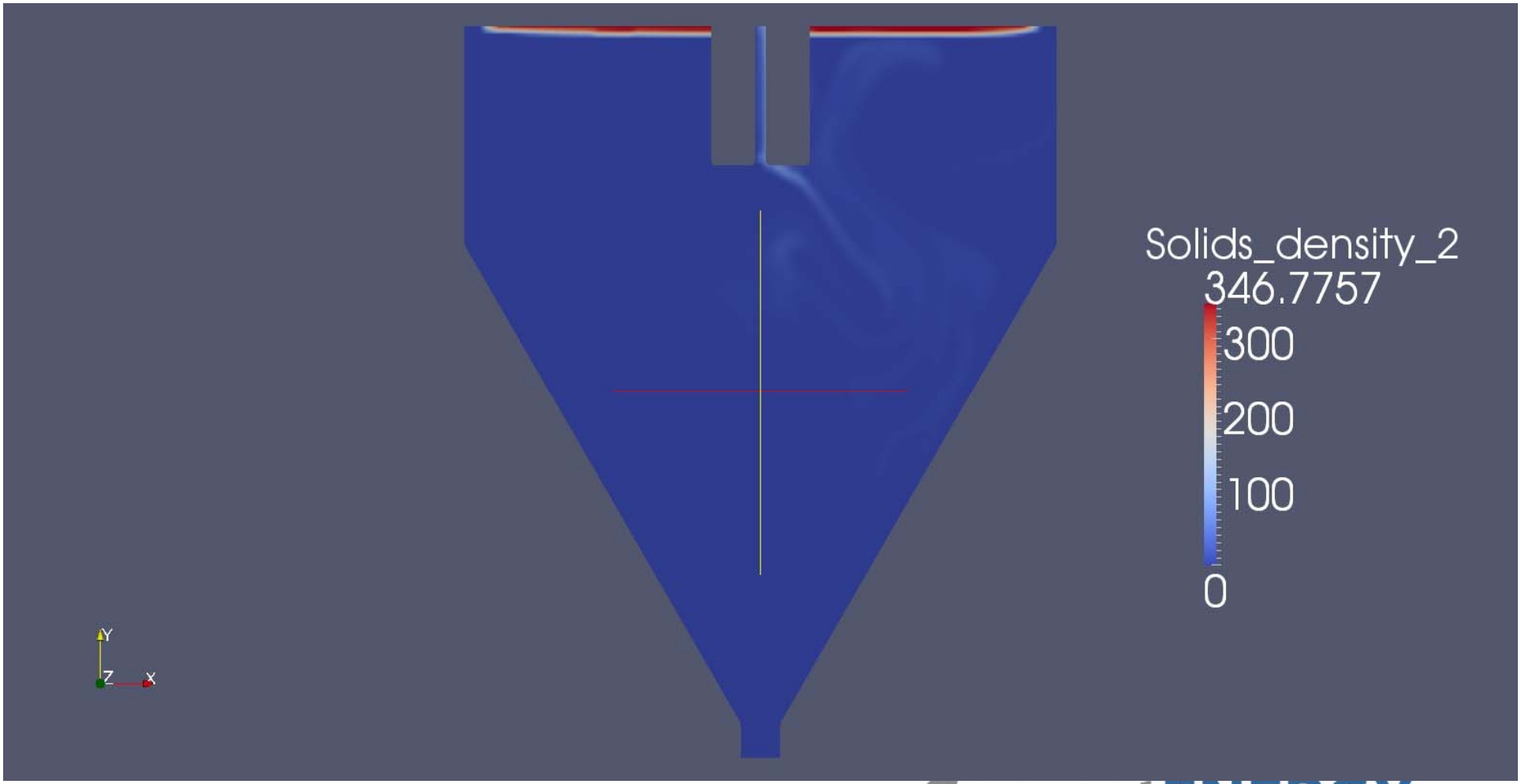
Results: Bitumen separation



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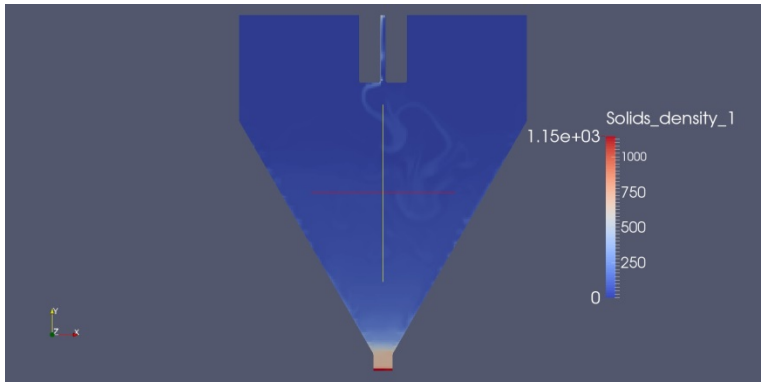
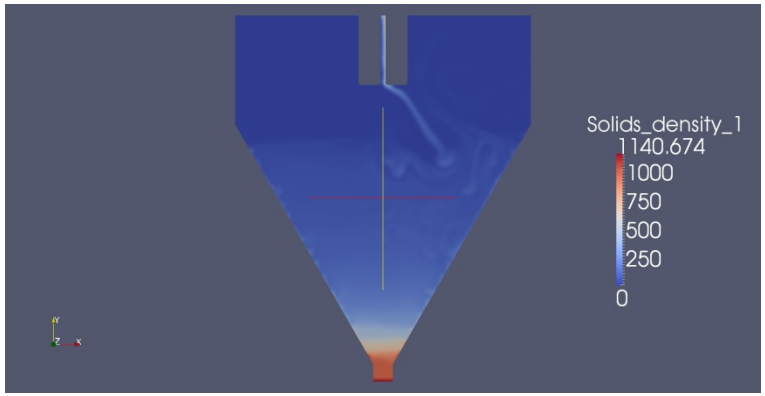
Results: Sand separation



5 m/h



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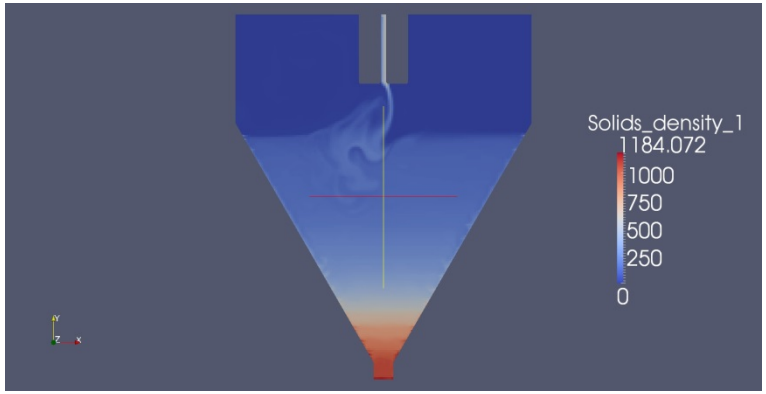
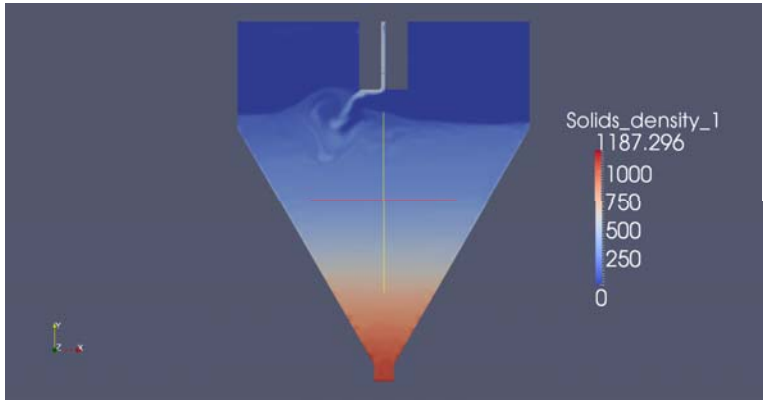


20 m/h



30 m/h

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Summary and Questions

1. Some difficulties with geometry and grid construction – calculations converged only for some combinations of IMAX and JMAX

2. Realistic flow and concentration patterns observed …

3. Except – is the feed jet swinging real?

4. Maximum load appears to be consistent with industrial observations

5. Frictional and drag models were developed mainly based on observations of fluidized beds. Are they applicable for fluid (water) suspensions?

6. Development of Constitutive Models for Settlement, Consolidation and Flow of Granular Materials in liquids – collaboration with Stuart Savage and Mohamed Sayed

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Thank you