Ferro filter - Overview

Objective: Investigate / design the possibility of a microplastic filter using ferrofluid adhesion

Tasks:

- Characterize microplastic suspension
  - Concentration, size distribution
- Characterize homemade ferrofluid
  - Determine $\underbrace{\chi, \tau}_{\text{ferrofluid}}$, $\underbrace{\rho, \nu, \gamma}_{\text{oil}}$
- Design, execute and simulate experiment (called de Lava)
  - Validate simulation
  - Preliminary insight into the performance of the process
- Design and simulate vortex filter
  - Compare performance efficiency Vs other methods
  - Pros and cons
  - Scalability, applications

Simulations

Update

found a "simple" 2-phase model:

water + ferrofluid

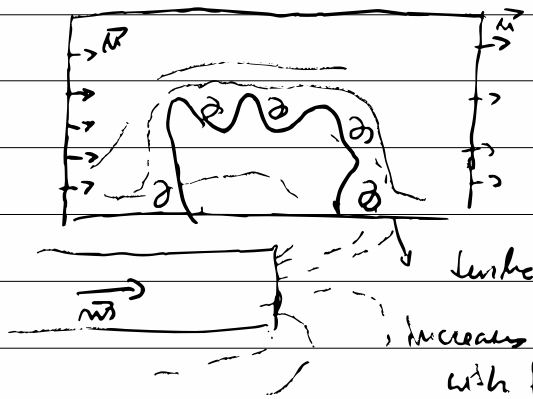
(might need 3-phase model: + air)

Very steep to solve PDE

(finite elements, weak formulation)

To DO

1st "big" simulation → can have many variations



- 3D
- multiple blobs
- flow
- blob size
- turbulence
- field strength

increase surface area with ferrofluid, but reduce flow

experimental parameters: $\chi, \tau, \rho, \nu, \gamma$

Two phase model

$$\partial_t \theta + \vec{\nabla} \cdot (\vec{u}\,\theta) + \gamma\, \Delta \psi = 0 \qquad (A)$$

$$-\varepsilon \Delta \theta + \tfrac{1}{\varepsilon} f(\theta) + \psi = 0 \qquad (B)$$

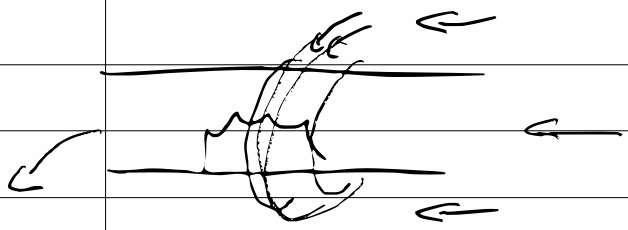
$$\partial_t \vec{m} + (\vec{u} \cdot \vec{\nabla})\vec{m} = -\tfrac{1}{\tau}(\vec{m} - \chi_\theta \vec{h}) \qquad (C)$$

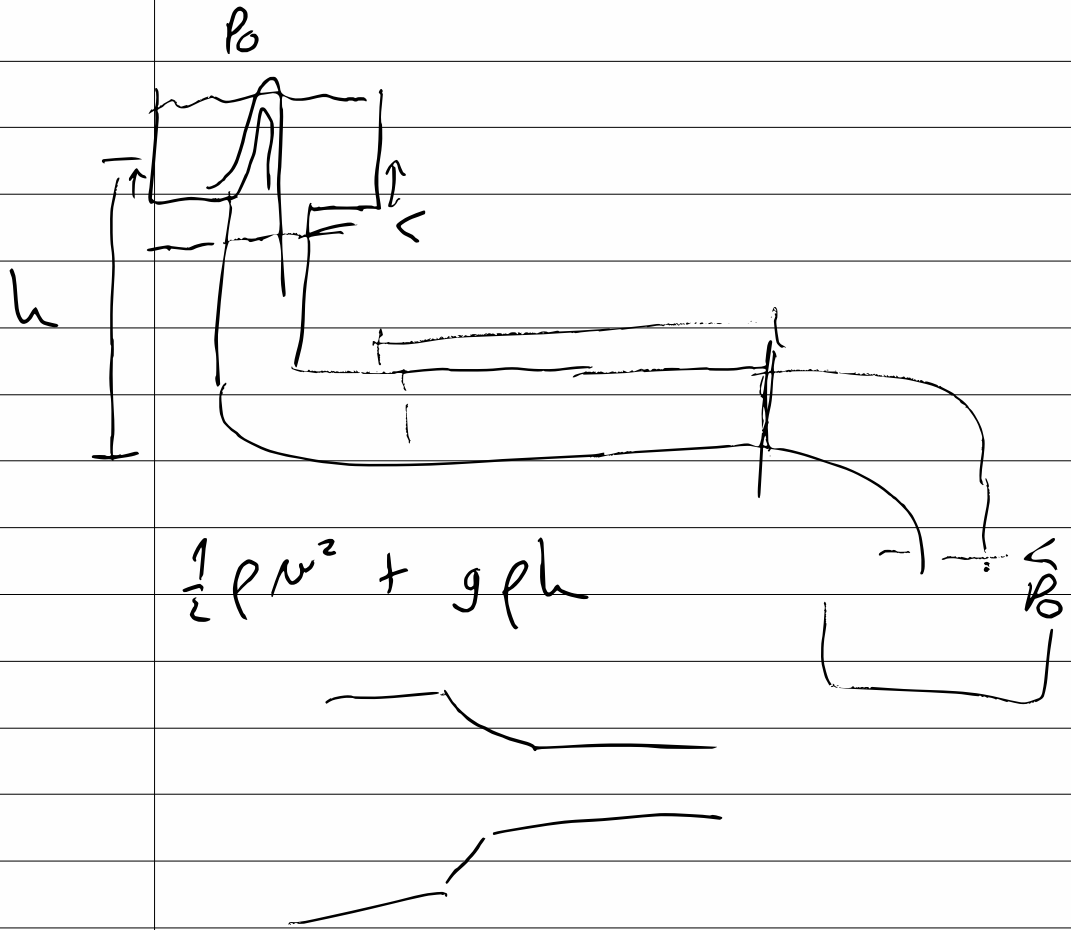
$$-\Delta \psi = \vec{\nabla} \cdot (\vec{m} - \vec{h_a}) \qquad (D)$$

$$\partial_t \vec{u} + (\vec{u} \cdot \vec{\nabla})\vec{u} - \vec{\nabla} \cdot (\nu_\theta\ \hat{T}(\vec{u})) + \vec{\nabla} p \qquad (E)$$

$$= \mu_0 (\vec{m} \cdot \vec{\nabla})\vec{h} + \lambda/\varepsilon\, \theta \nabla \psi$$

$$\vec{\nabla} \cdot \vec{u} = 0 \qquad (F)$$




p_0
h
$\frac{1}{2}\rho v^2 + g\rho h$
p_0