Enhanced shear microfiltration

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DISTINCTIVE – 1st Annual Meeting 2015
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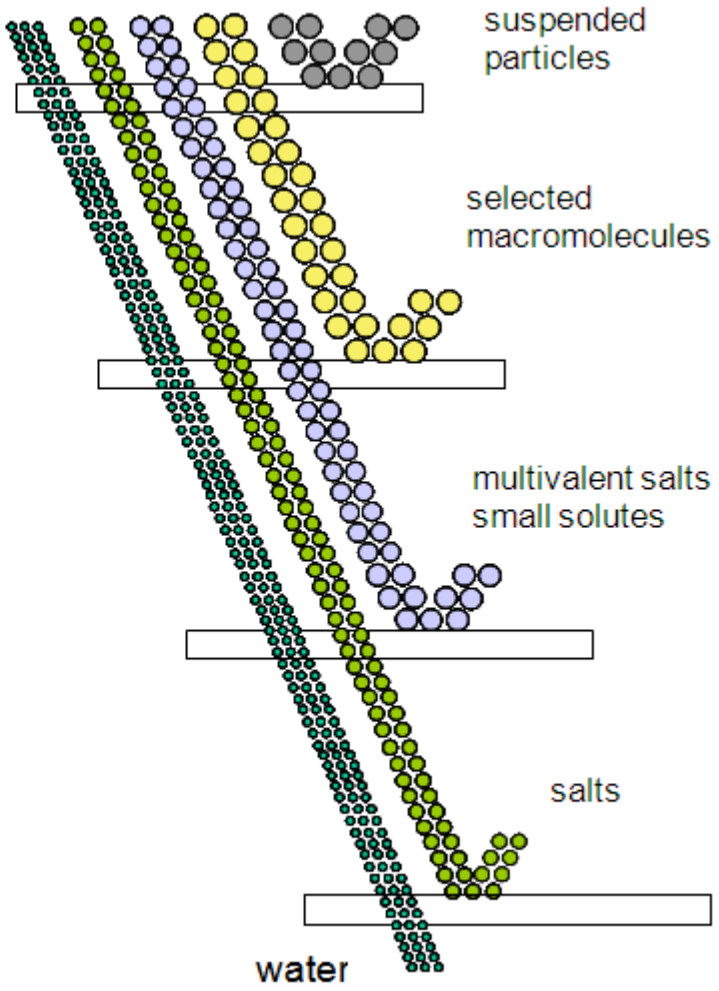
Microfiltration

MF	0.1 - 3 bar 0.1 - 5 µm
UF	2 - 10 bar 20 nm - 0.1 µm
NF	5 - 30 bar » 1 nm
RO	10 - 100 bar 0.1 - 1 nm (close)



(Emis, 2015), retrieved from http://emis.vito.be/sites/emis.vito.be/files/data_sheets/migrated/Microfiltration.png accessed Apr/2015

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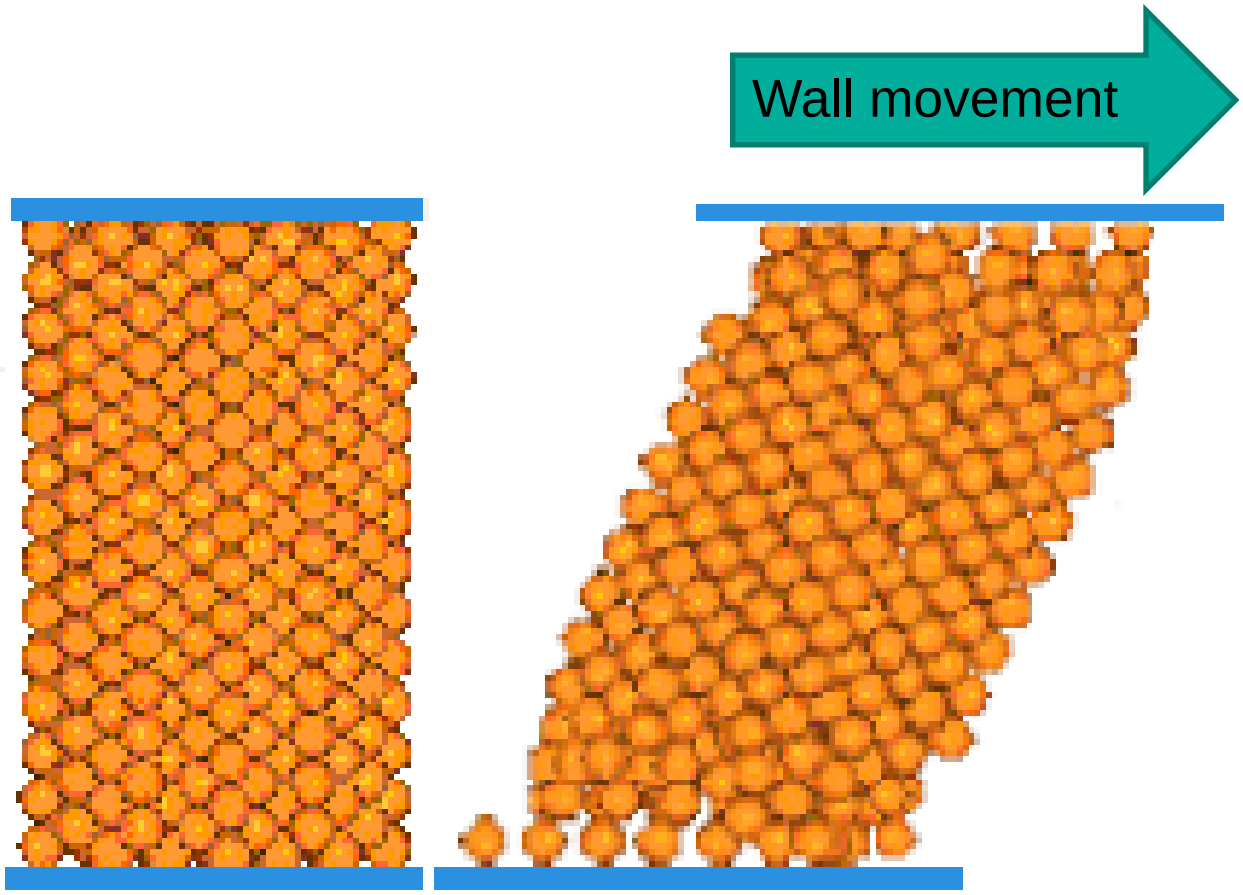
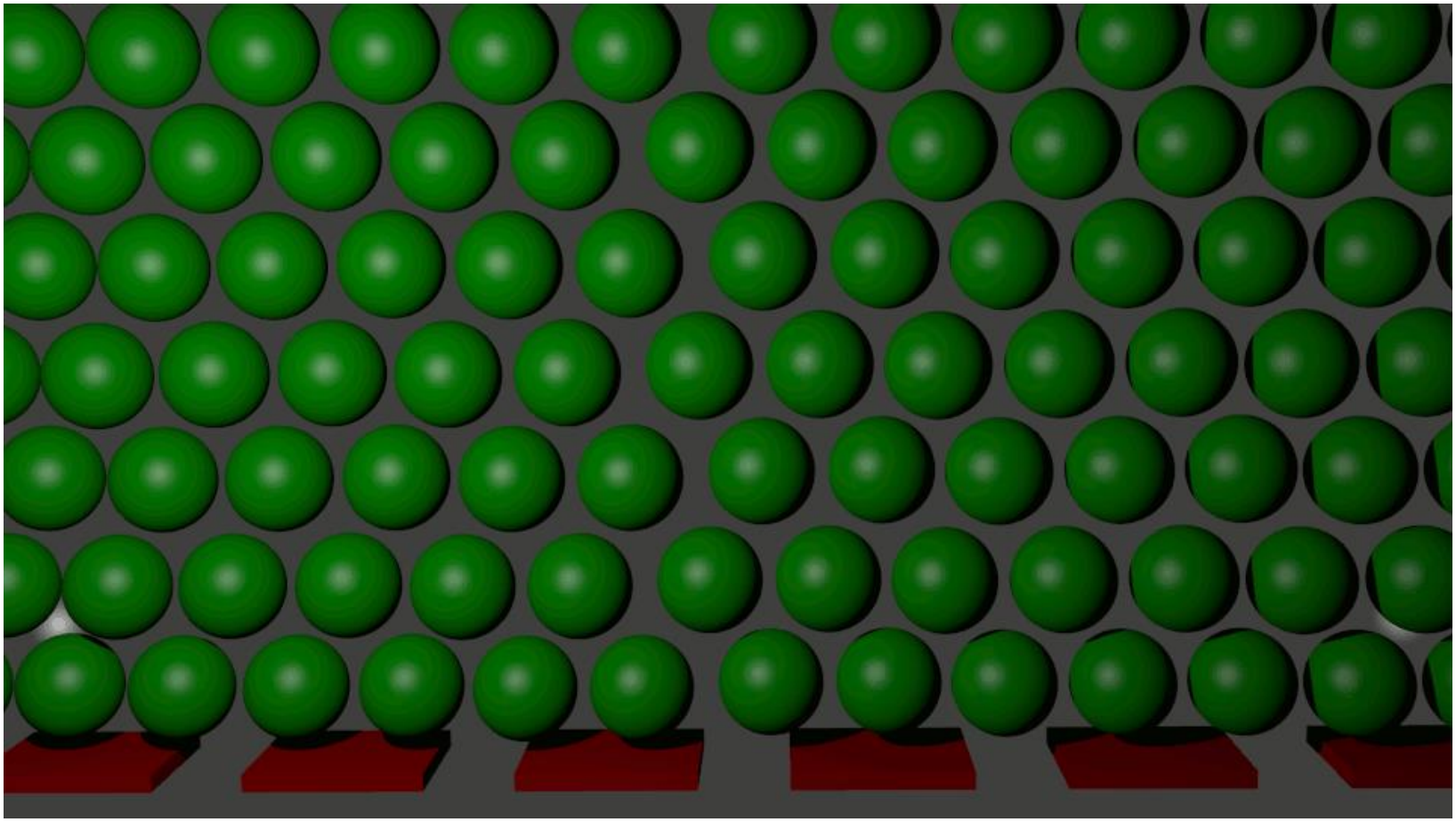
What is shear?



(COSY, 2015), retrieved from
http://www.lce.hut.fi/publications/annualrep/node21.html
accessed Apr/2015

What is enhanced shear?



Oscillating membrane wall

(COSY, 2015), retrieved from
http://www.lce.hut.fi/publications/annualrep/node21.html
accessed Apr/2015

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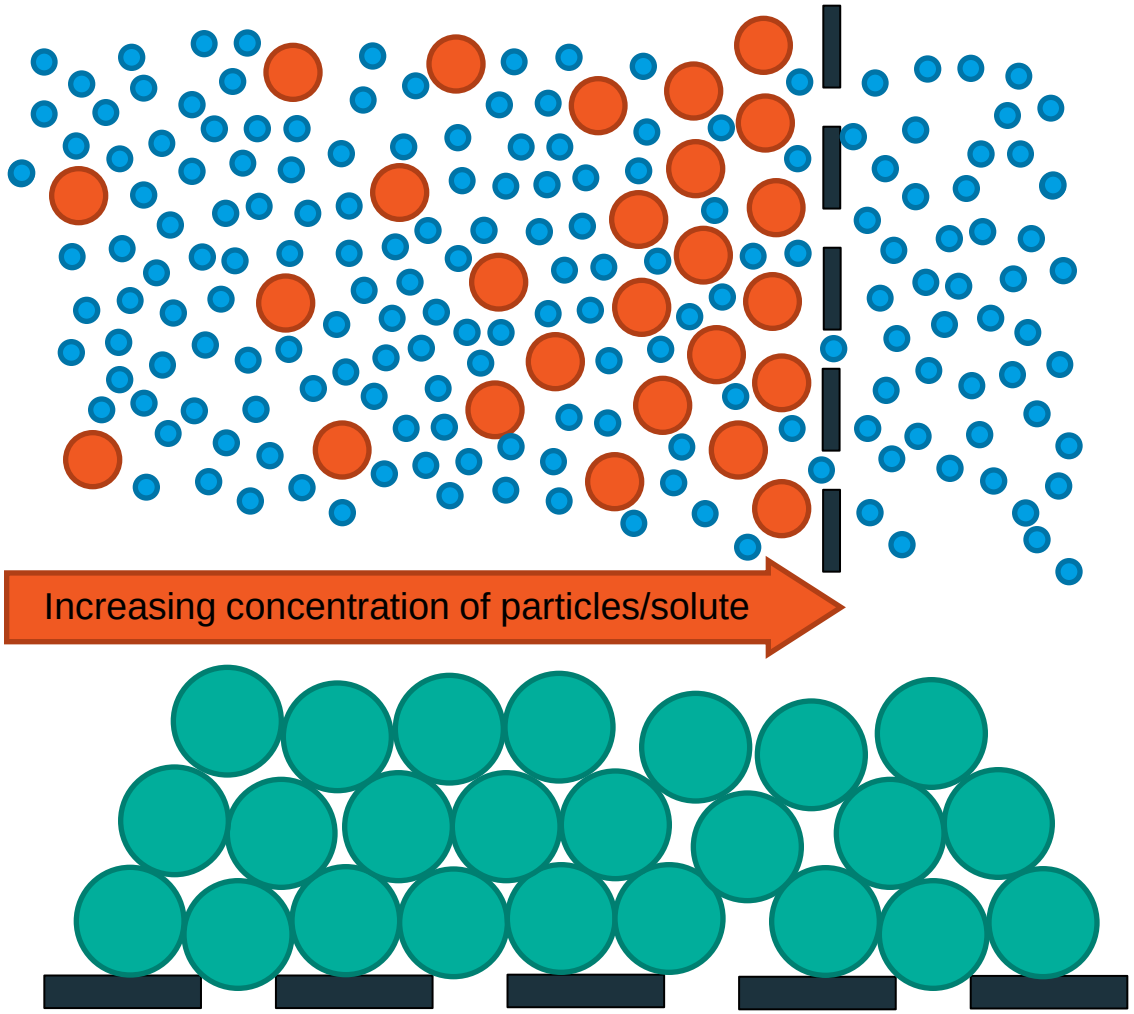
Filter cake/concentration polarization

Filter cake on a cylindrical filter



Filter cake diagram

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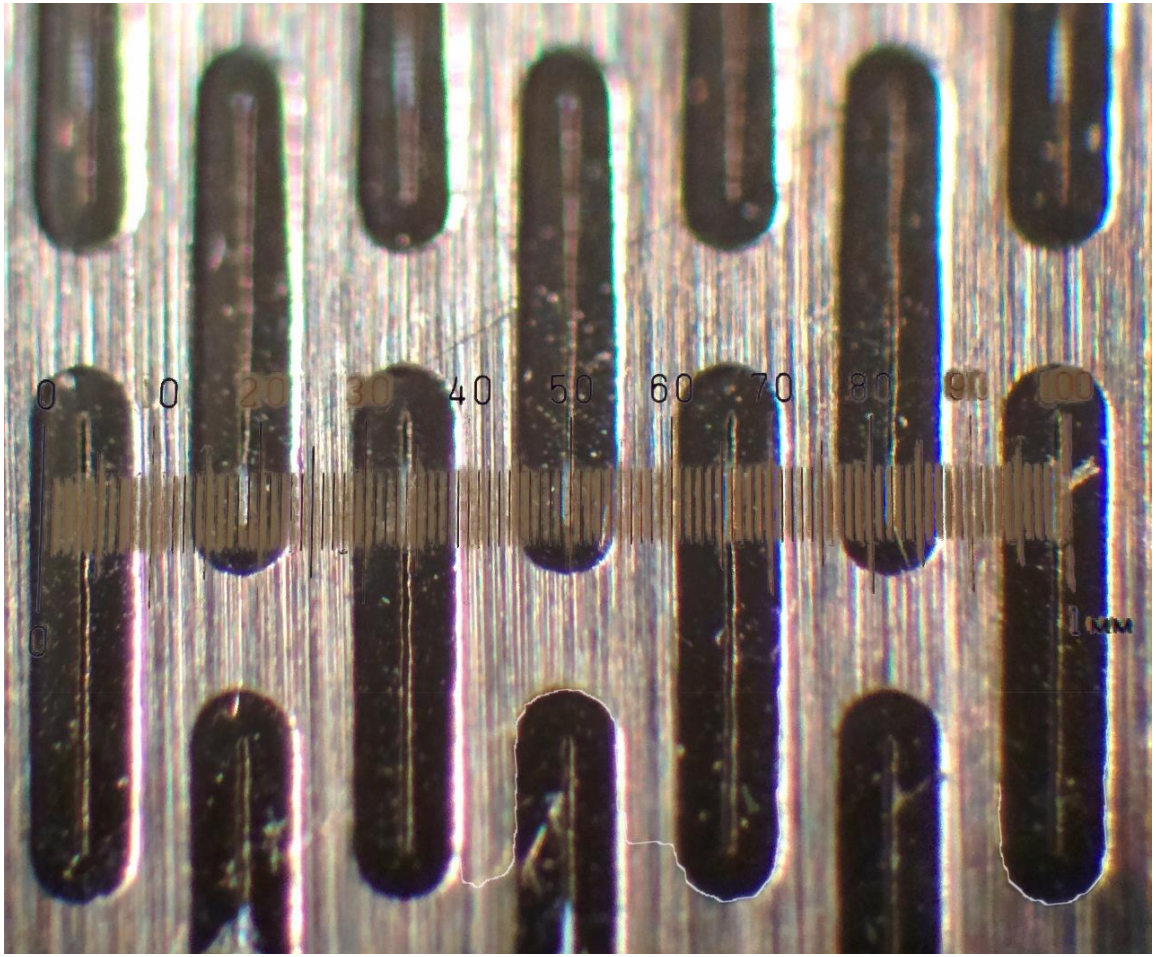
Slotted microfilter



Slotted microfilter under an optical microscope

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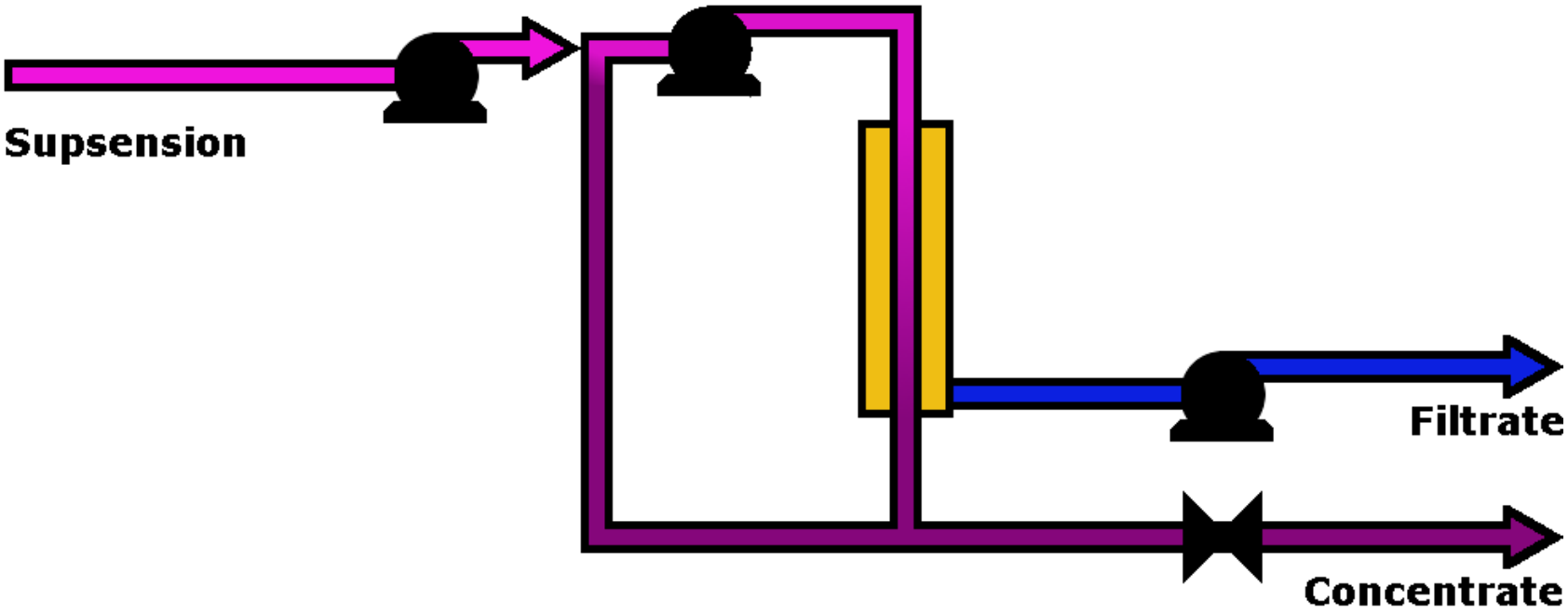
Cross flow filtration



Typical arrangement for micro and ultrafiltration

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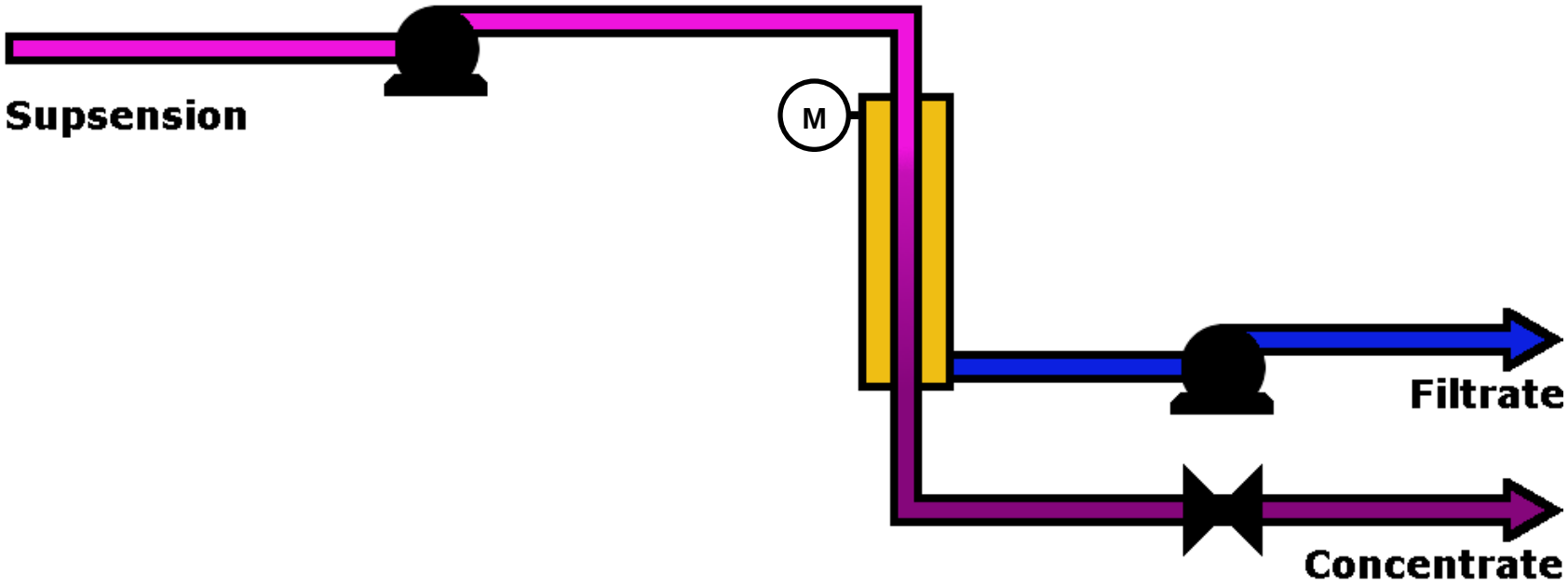
Ideal system



Single pass filtration with enhanced shear membrane

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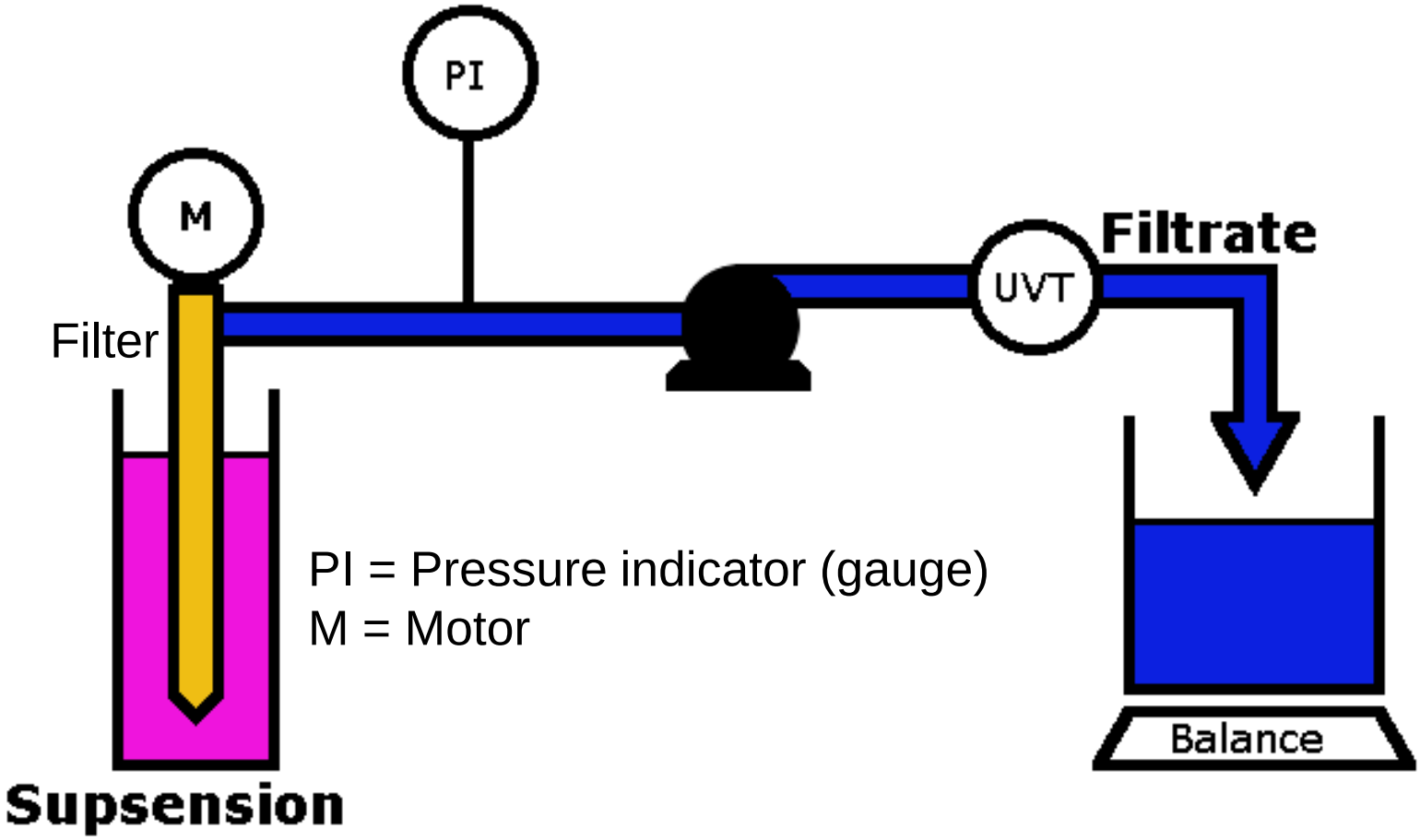
Experimental system



Simple experimental setup

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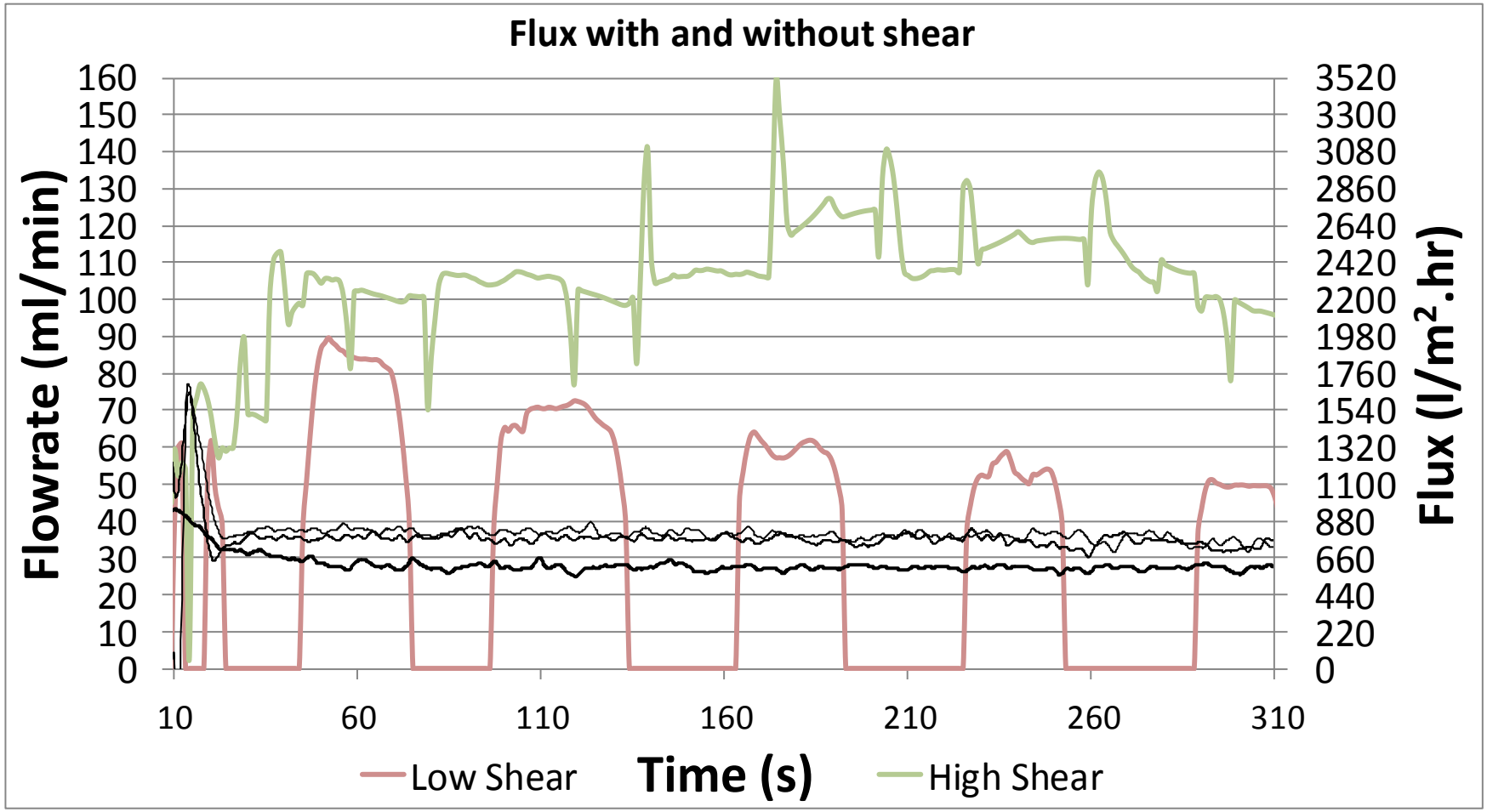
Flux rates



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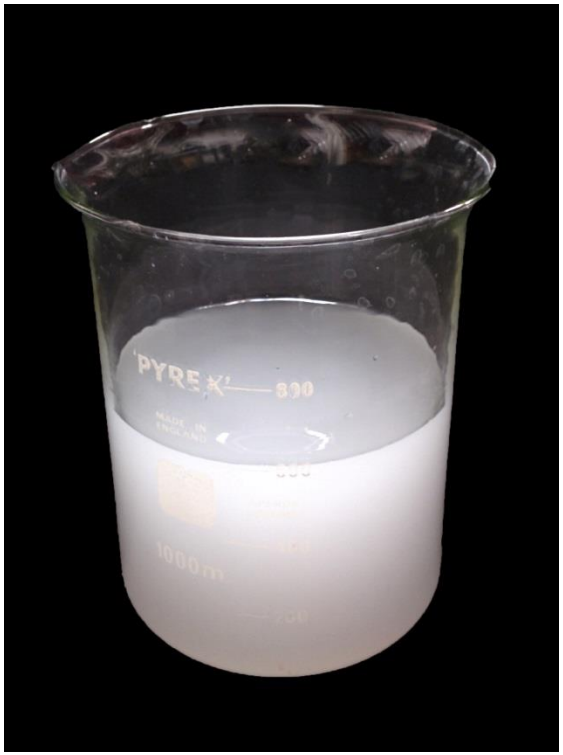
Filtrate at high shear



Filtrate with high shear

Filtrate without shear

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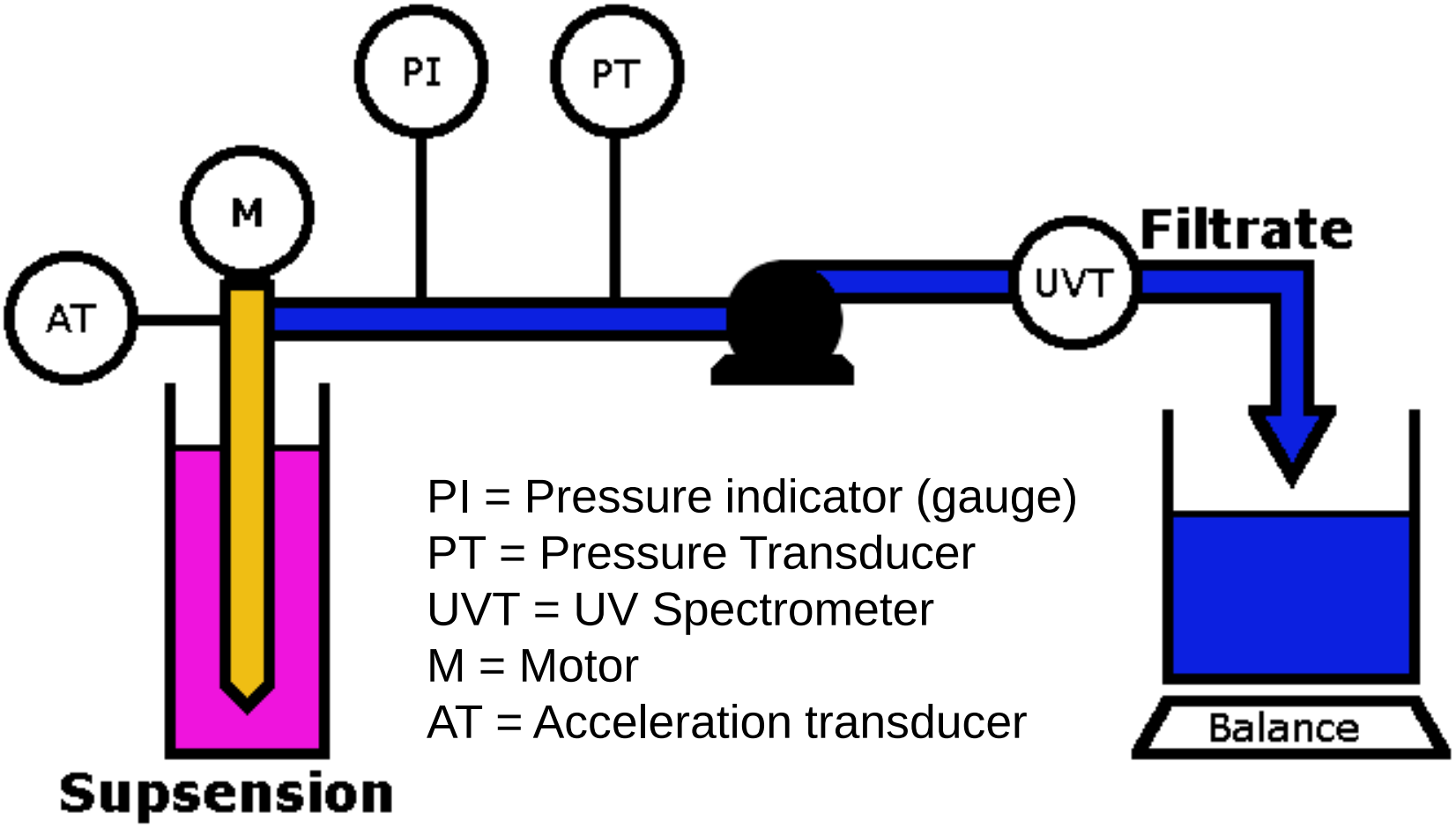
New experimental system



PI = Pressure indicator (gauge)
PT = Pressure Transducer
UVT = UV Spectrometer
M = Motor
AT = Acceleration transducer

More thorough experimental setup

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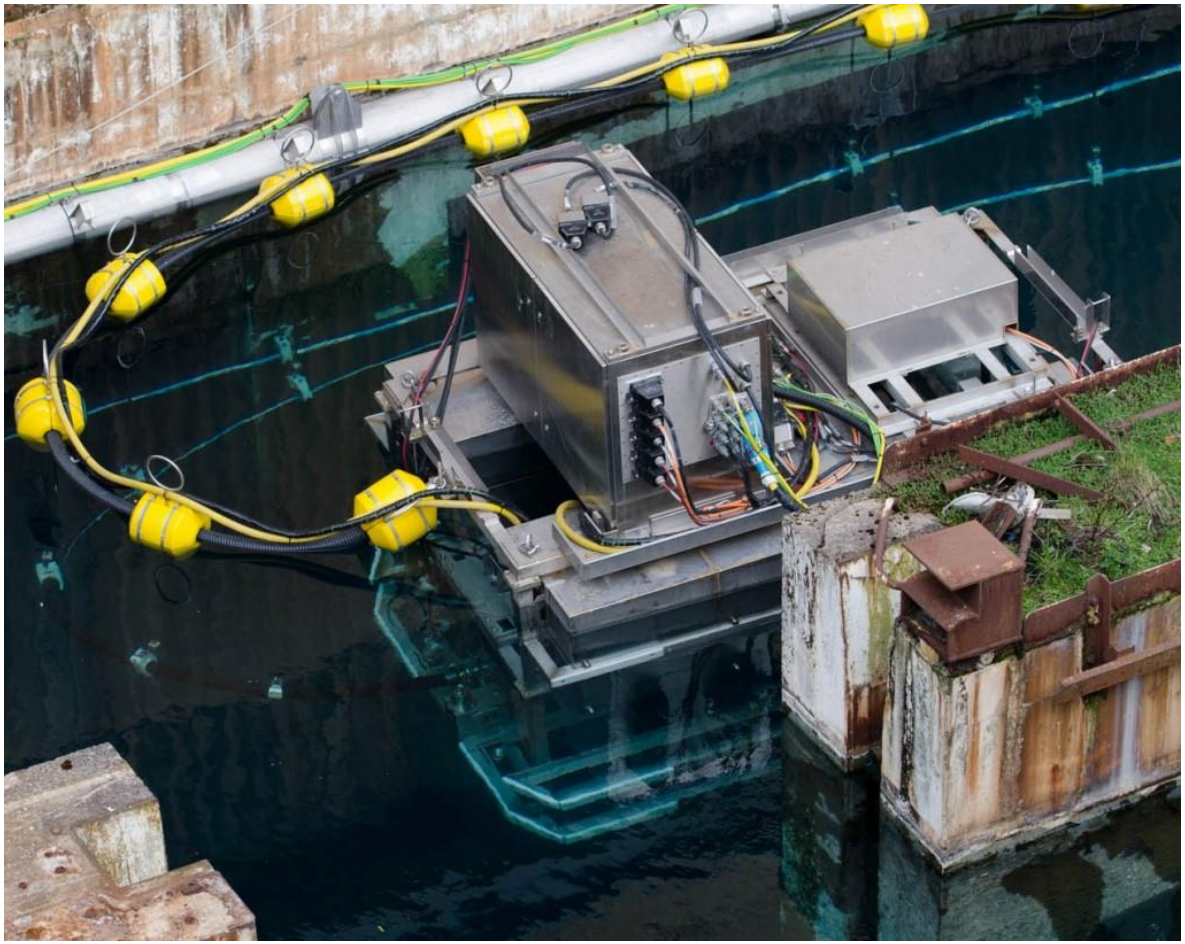
How is this relevant to DISTINCTIVE?



(Sellafield, 2015), retrieved from http://www.sellafieldsites.com/2015/03/sludge-removal-marks-significant-step-in-sellafield-clean-up/ accessed Apr/2015

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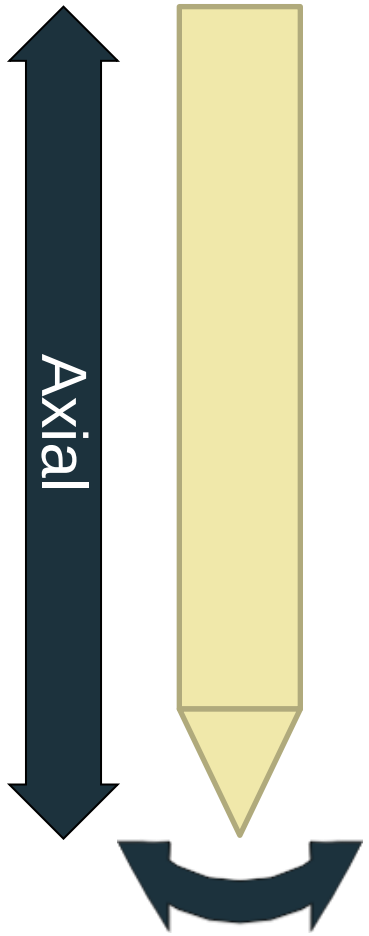
Key research questions

- Is this enhancement attributed directly to shear?
- What are the specific advantages of oscillating, or pulsed flow?
- What are the key parameters for optimisation (e.g. flux, power efficiency, particle retention)?
- How can the filters be scaled up (i.e. sized)?
- How do filter coatings effect filtration?
- What are the potential problems of using this technology?
- What is the effect of frequency and amplitude on flux (apart from shear)?
- How easy would a filter be to clean?
- Does the localised shear damage the suspension, creating a more difficult to filter suspension?



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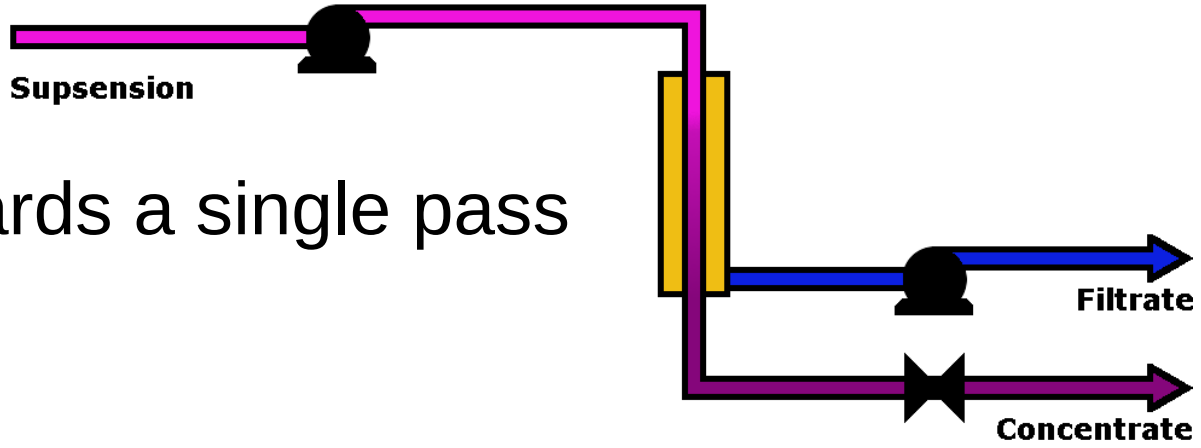
Conclusions

- This area of study has definite potential
- Project is in early stages, little data collected so far
- Working towards a single pass filtration system



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Acknowledgements

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Links – for answers

- V-Sep
- Shear Enhanced Systems
- Turbulence Promoters
- The Filter
- Concentration Polarization Vs Cake
- Particle size determination
- References

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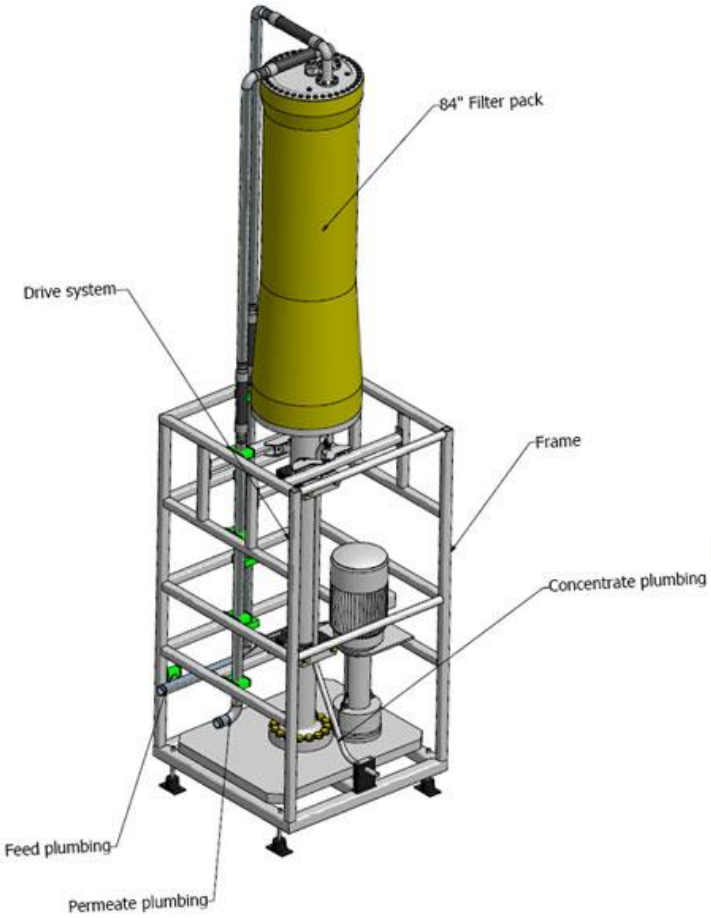
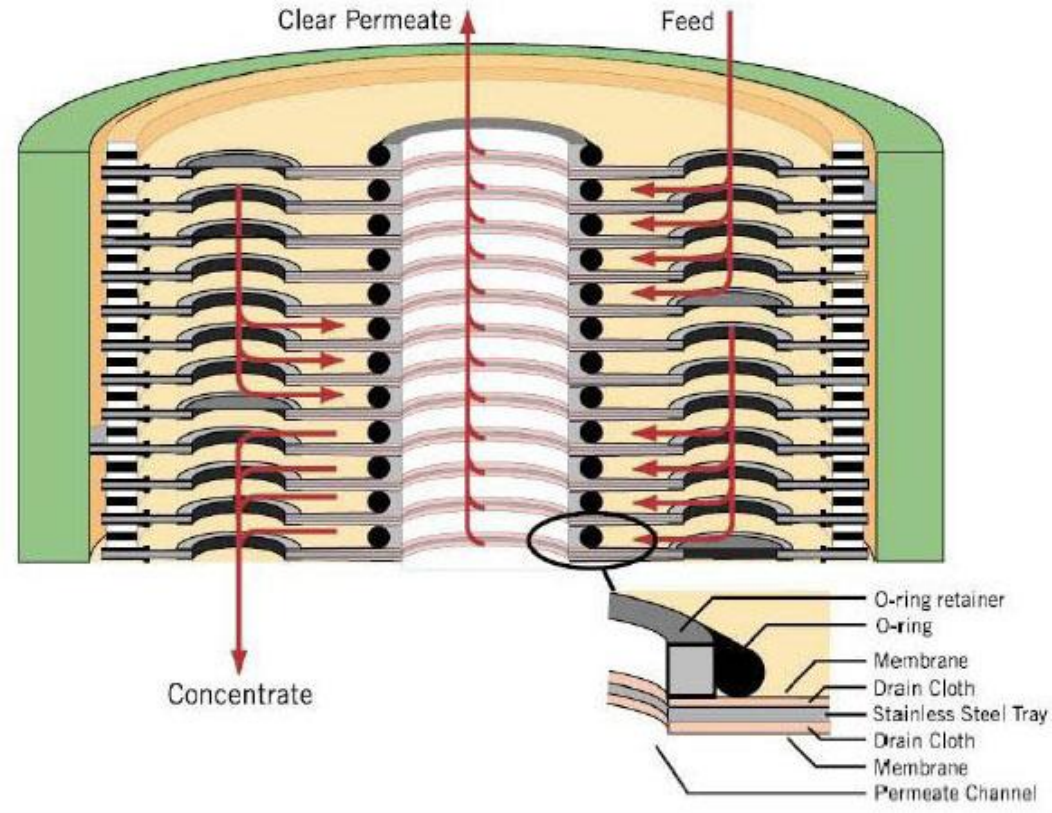
V-SEP





(VSEP, 2015), retrieved from http://www.vsep.com/index.html accessed Apr/2015

Other shear enhanced systems

- Rotary membranes
- Rotary discs near static membranes
- Vibratory discs (e.g. VSep)
- Oscillatory hollow fibres (tangential movement)
- Membranes with turbulence promoters
- Oscillatory axial, tangential, azimuthal
- Pulsed flow
- Oscillatory flow
- Particle fluidisation
- Gas sparging

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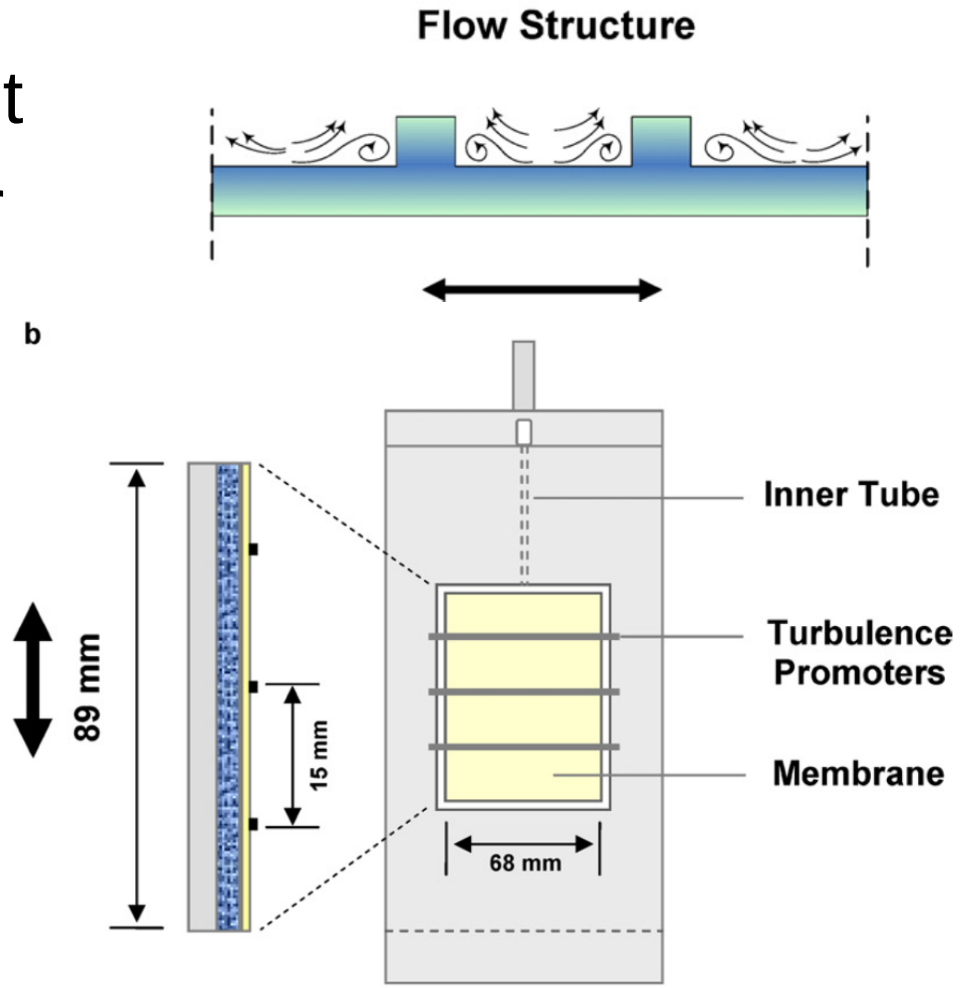
Turbulence promoters

- Reported enhancement rates of 8x at much lower shear than systems with similar enhancements

- Lower amplitude and Higher frequency led to higher enhancement



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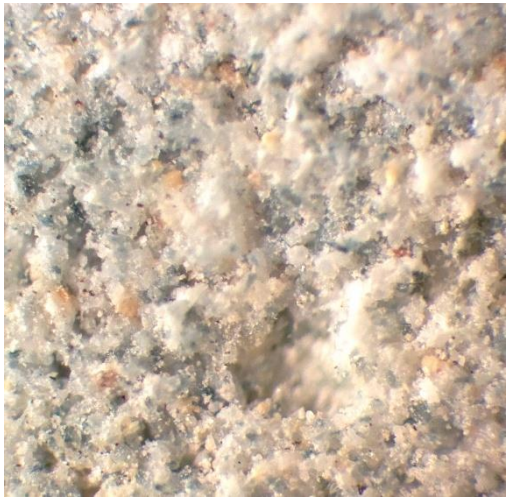
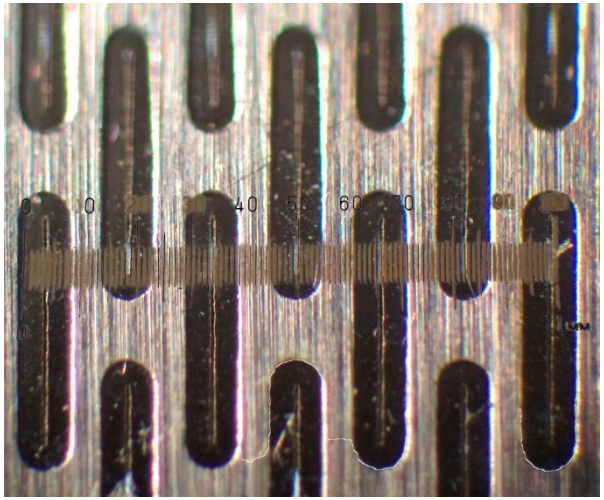
The Filter



Depth filter



Surface filter

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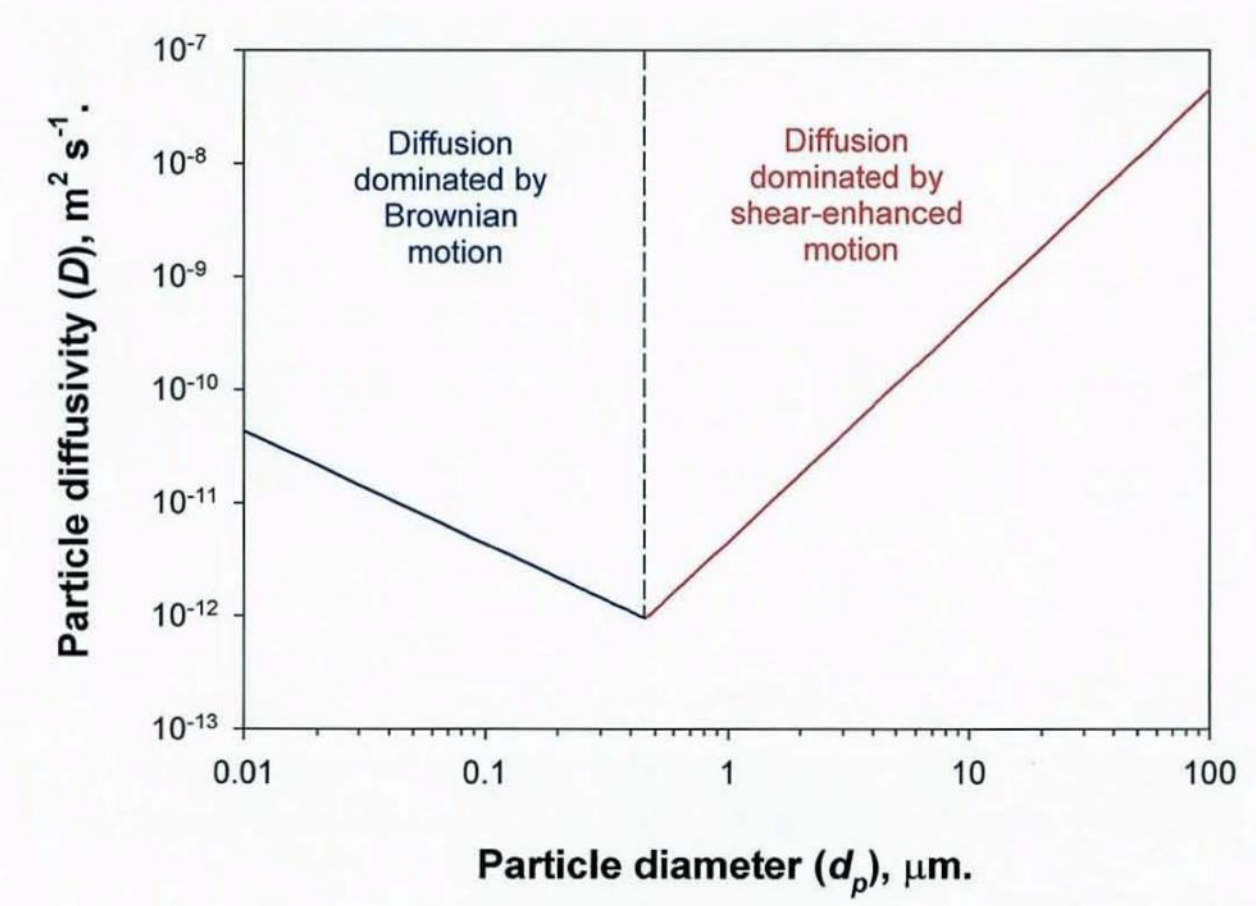
Concentration polarization vs. cake



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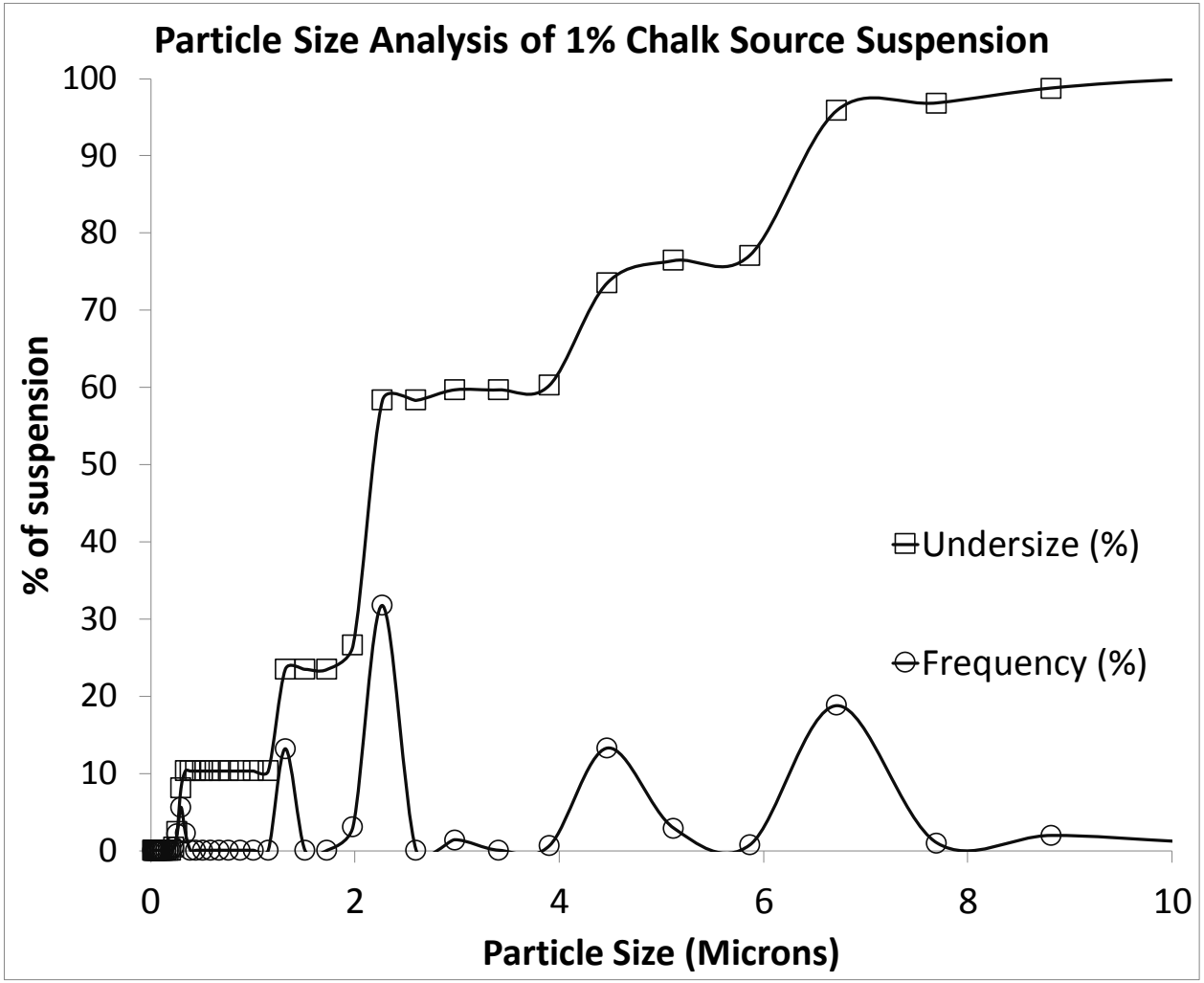
Particle size determination



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