

DRAINAGE OF A FRICTIONAL FLUID IN A CONFINED GEOMETRY



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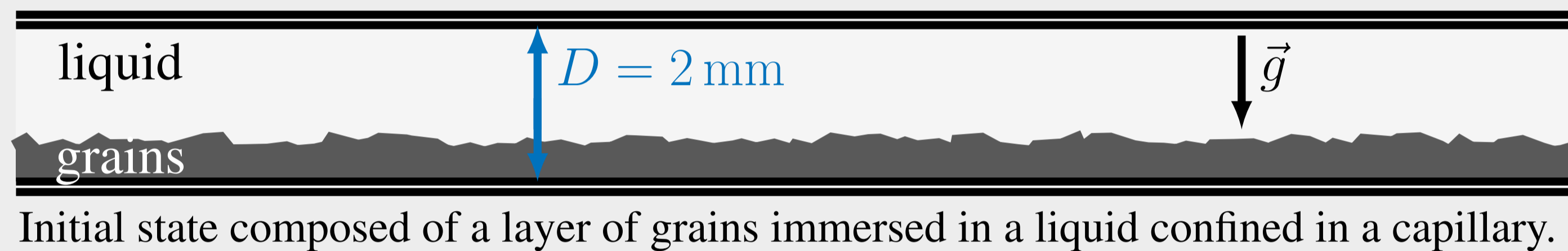
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You can find the videos on poster.louisonthorens.com

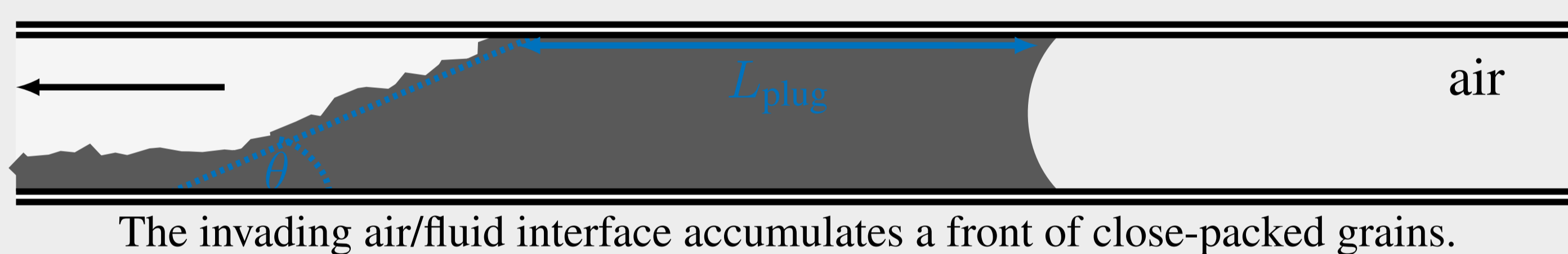
1. CONTEXT

A mixture of glass beads (few hundred microns size) in a Newtonian liquid is slowly drained out at a constant rate (thanks to a syringe pump) from a capillary tube (2 mm diameter), with one side open to the air.



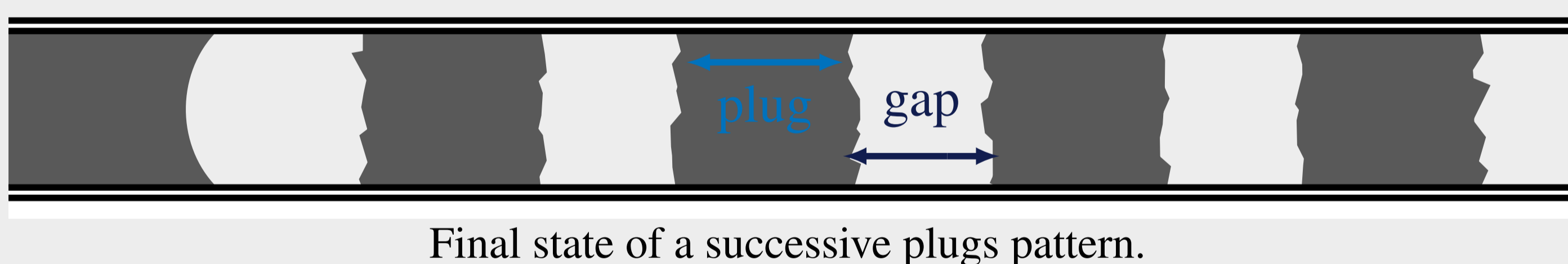
Bulldozing process

The advancing air-liquid meniscus may push and accumulate particles ahead.

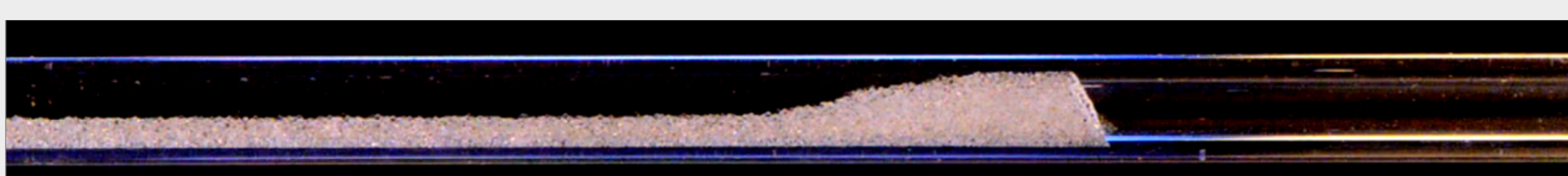


Clogging → plug formation

The stress against the capillary walls exerted by the granular medium competes with the pore pressure at which air percolates through the granular assembly.



This process repeats periodically leading to the formation of a plug trail along the tube.



Typical example of dynamic plug formation - [Video available online](#)

To visualize the percolation of air (in black) through the granular medium, we used a liquid matching the refractive index of glass.

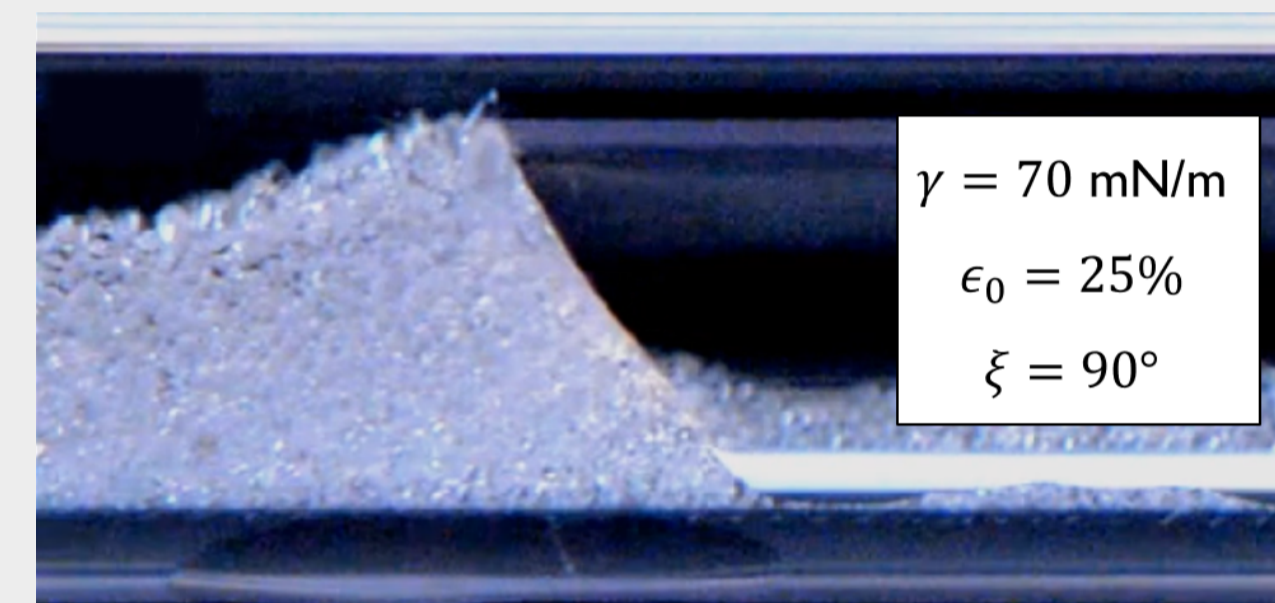


Index matching experiment - [Video available online](#)

2. BULLDOZING MECHANISM

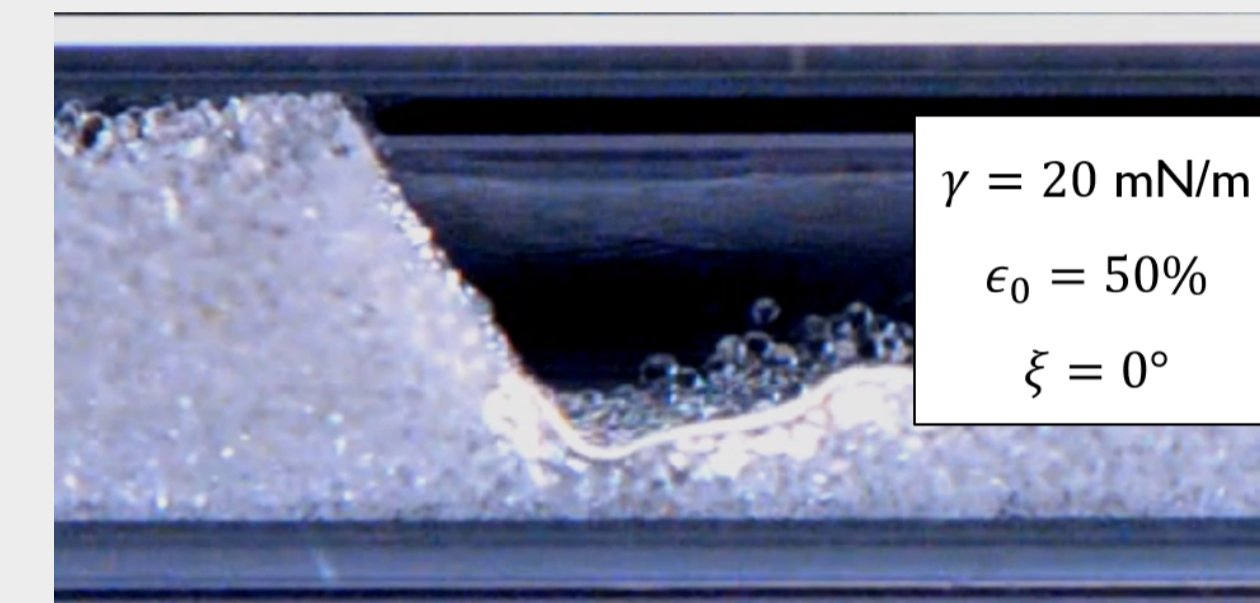
The bulldozing mechanism and the plug formation depend on surface tension γ , contact angle ξ and filling fraction ϵ_0 :

surface tension (γ) · wettability

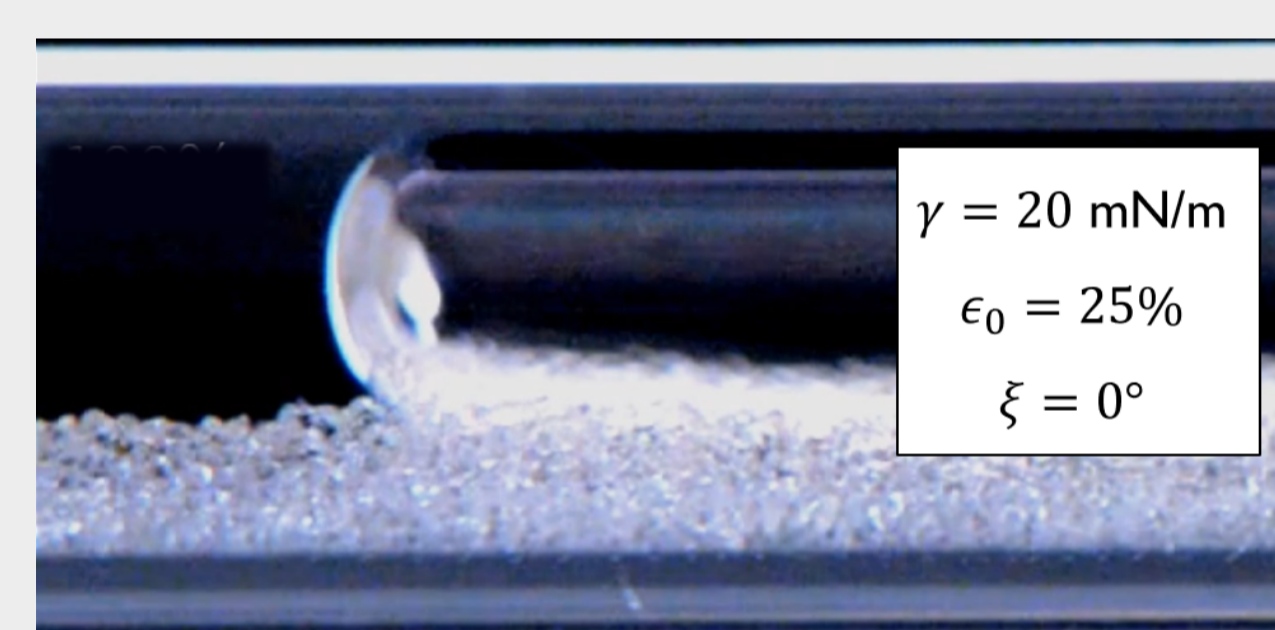


bulldozing & plug

filling fraction (ϵ_0)



bulldozing & plug



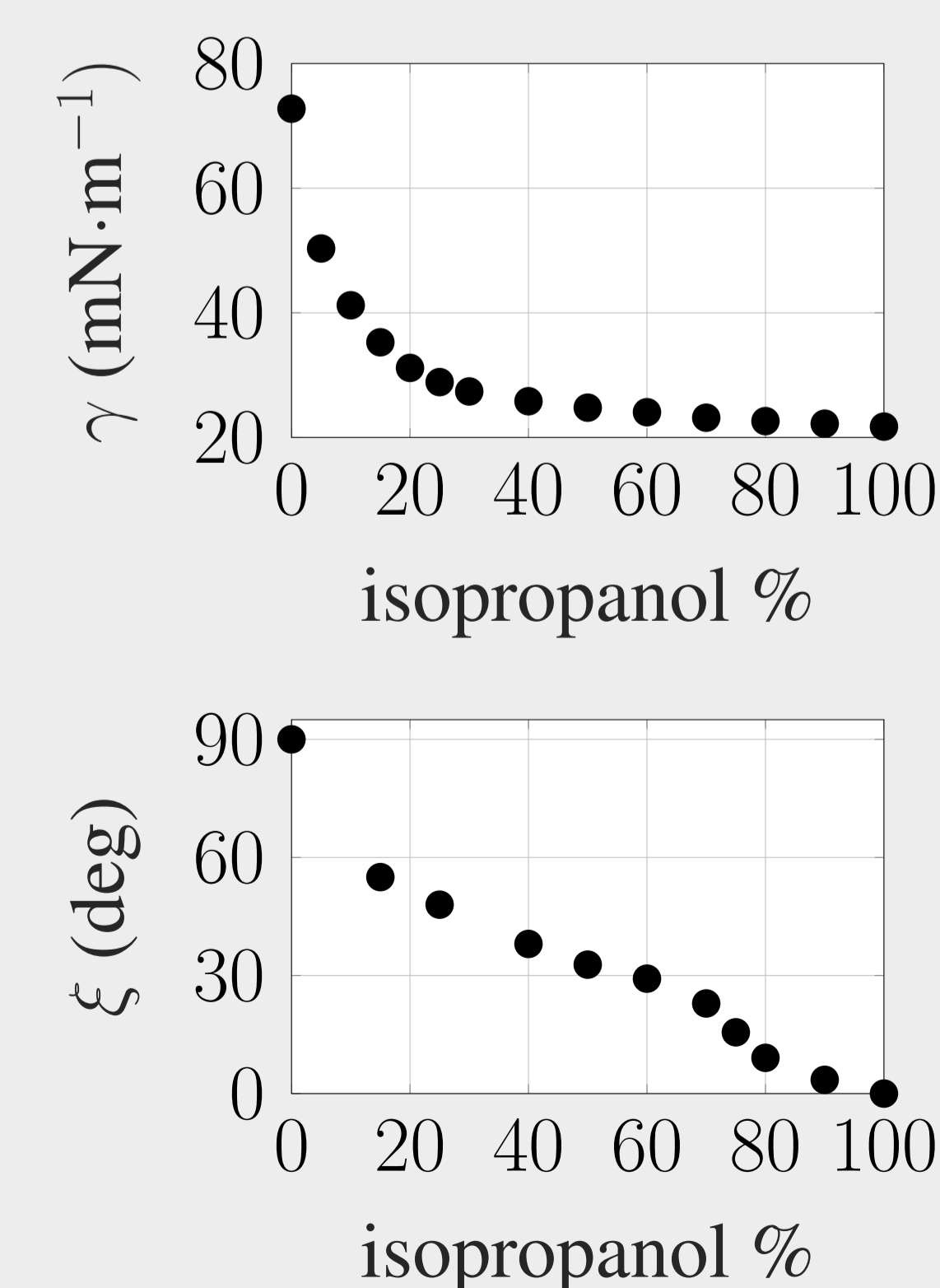
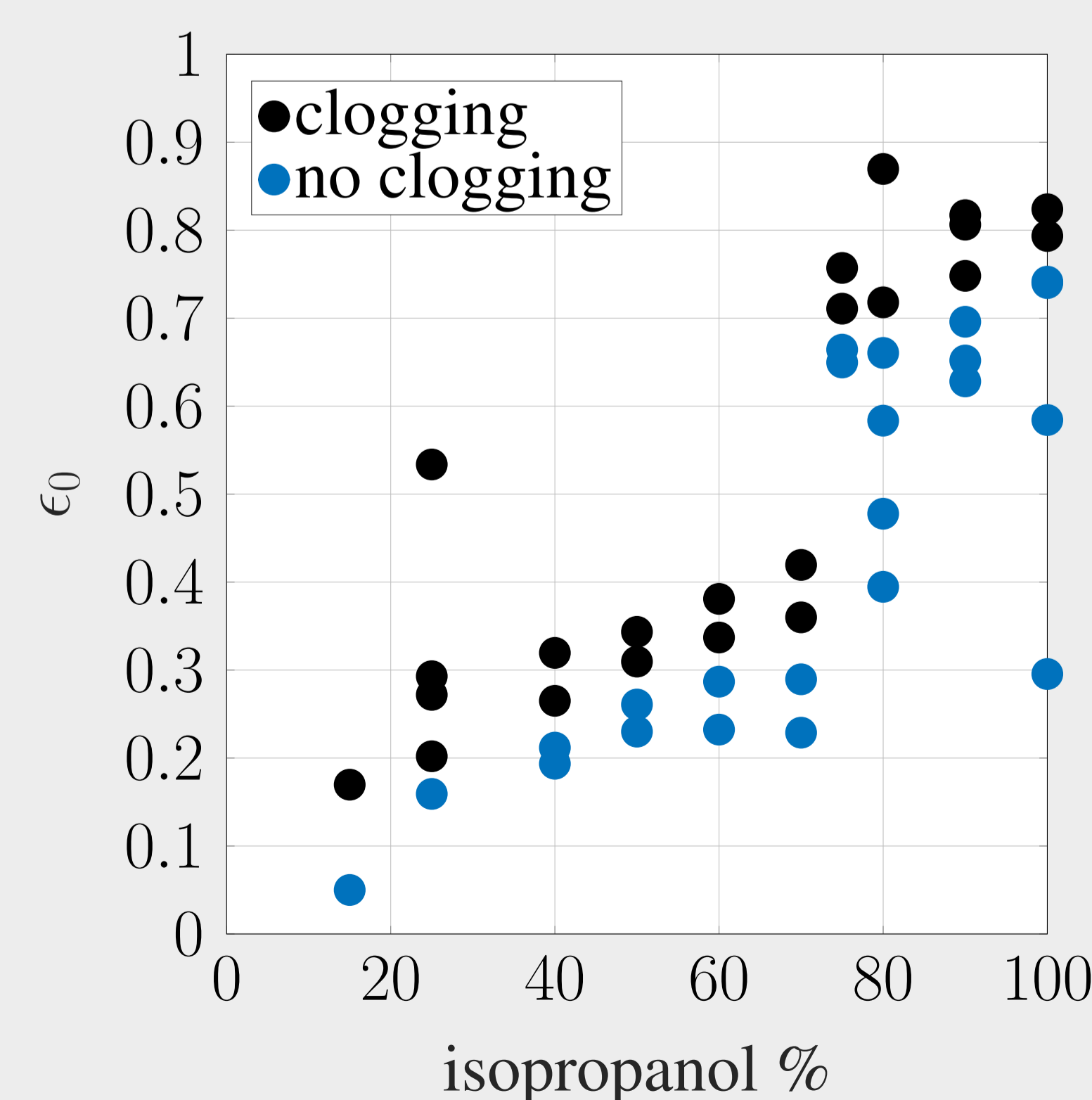
no bulldozing



bulldozing & no plug

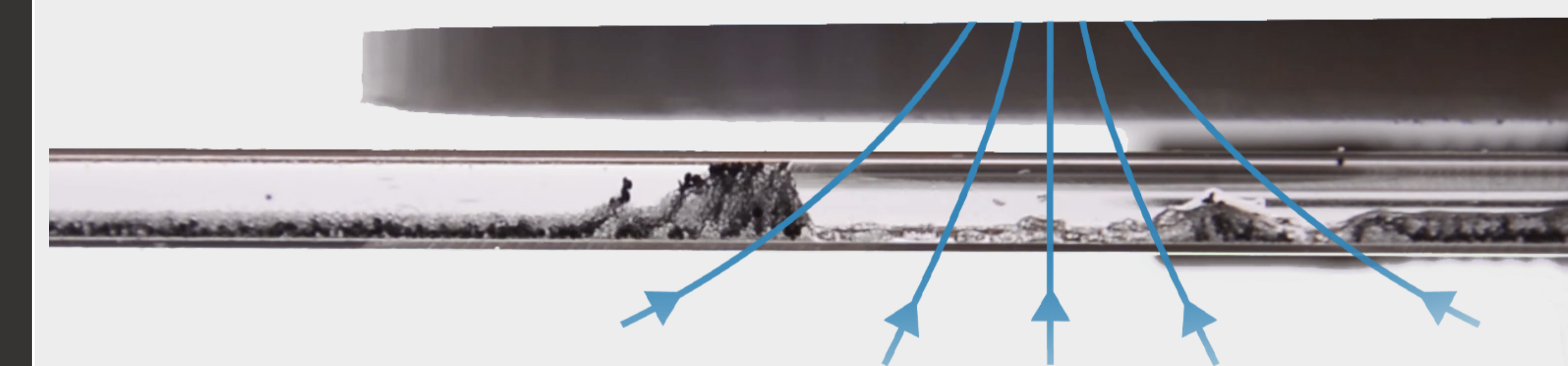
Water-isopropanol mixture - [Video available online](#)

Phase diagram for the plug formation



3. MAGNETIC FORCING

To control the onset of the bulldozing and the plug formation we propose to add ferromagnetic particles and a magnetic field \vec{B}



First plug formation with ferromagnetic particles - [Video available online](#)

We observe that once the first plug is formed, the bulldozing mechanism starts and the plug formation will repeat.



no triggering



triggering

4. CONCLUSION

We identify the experimental conditions (surface tension, wettability, amount of particles) leading to the bulldozing mechanism and unstable plug formation.

Using ferromagnetic grains, we could force the bulldozing process and study the impact of "magnetic Janssen effect" [3] on the final plug pattern.

REFERENCES

[1] **Frictional fluid dynamics and plug formation in multiphase millifluidic flow**
G. Dumazer, B. Sandnes, M. Ayaz, K. J. Måløy, and E. G. Flekkøy
Phys. Rev. Letters 117, 2016

[2] **Capillary bulldozing of sedimented granular material confined in a millifluidic tube**
G. Dumazer, B. Sandnes, K. J. Måløy, and E. G. Flekkøy
Phys. Rev. Fluids 5, 2020

[3] **Magnetic Janssen Effect**
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