
IMPORTANCE OF RHEOLOGICAL PROPERTIES WHEN DRYING SLUDGE IN A FIXED BED

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Experimental set-up

■ Batch convective dryer

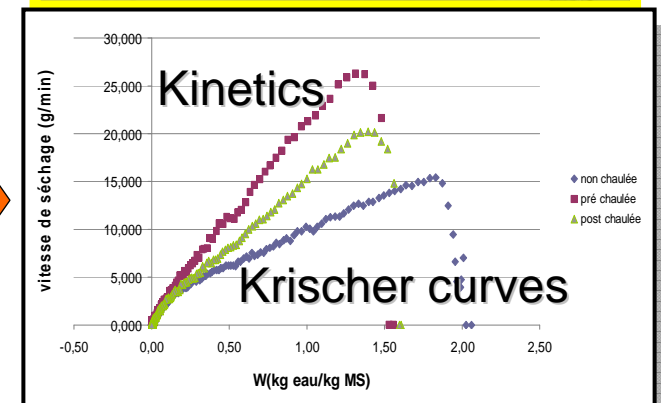
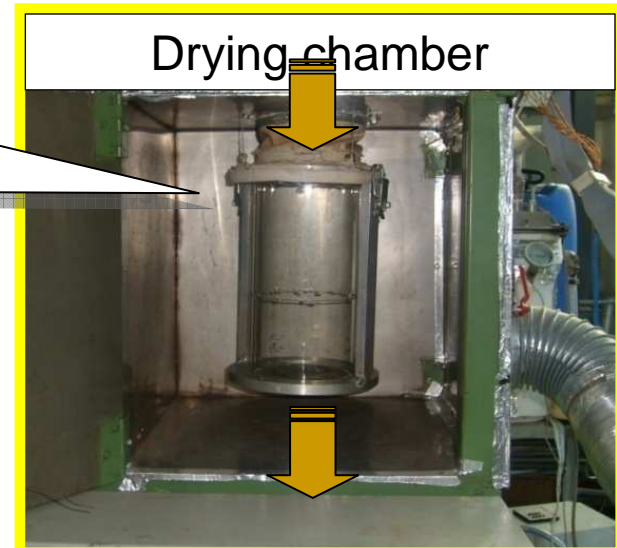
Fixed bed:

- Mass: **1 – 1.5** kg
- (extrudates) - Volume: **0.002** m³
- Diameter: **0.16** m
- Height: **0.10** m

Specific evaporation capacity :
up to **200** kg water/m²h

Operating conditions:

- Temperature: **105 °C**
- Superficial velocity: **1.1** m/s
- Humidity (ambient): **~ 0.007** kg/kg

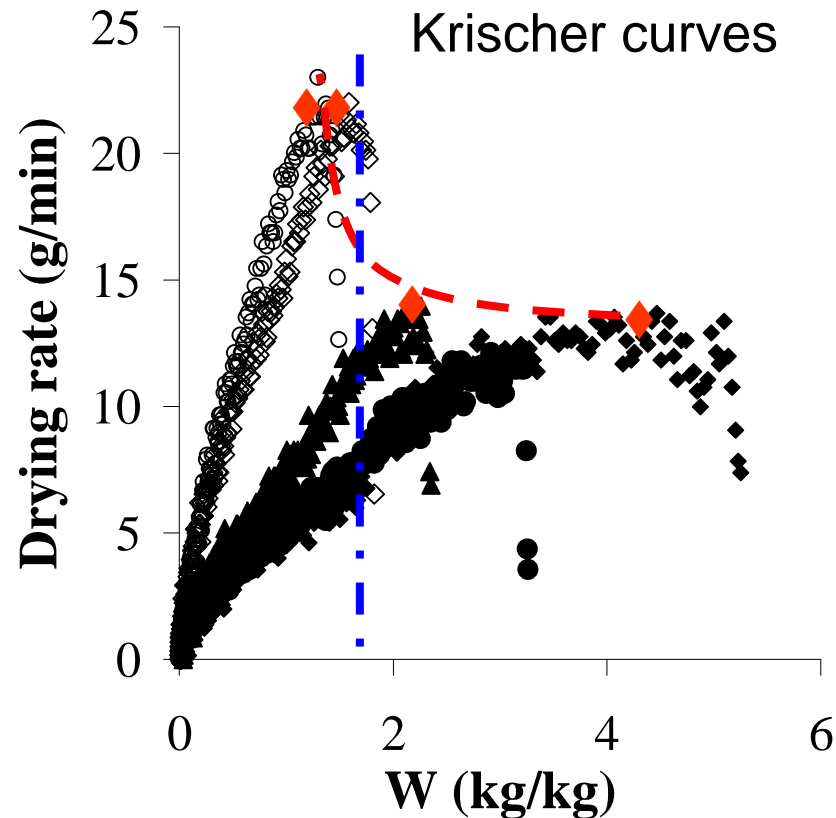


Different types of sludge

WWTP	Type of sludge	Sampling location	DS (%)	VS (%)
A	Stabilised by anaerobic digestion	After mechanical dewatering	~ 16 ($W_{in} \sim 5$ kg/kg)	~ 45
B	Stabilised by anaerobic digestion	After mechanical dewatering	~ 32 ($W_{in} \sim 2$ kg/kg)	~ 41
C	Not stabilised	After mechanical dewatering	22 ($W_{in} \sim 5$ kg/kg)	~ 61

Influence of backmixing : sludge A

■ Influence of the recycling ratio



Reference : raw sludge

◆: 1 kg fresh material

Mixed sludge

●: 1 kg fresh material + 0.1 kg DS

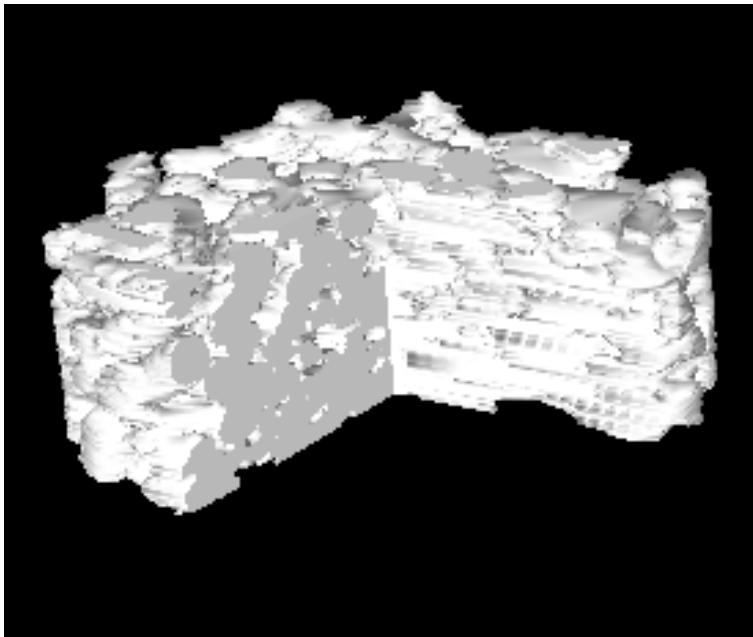
▲: 1 kg fresh material + 0.2 kg DS

◇: 1 kg fresh material + 0.3 kg DS

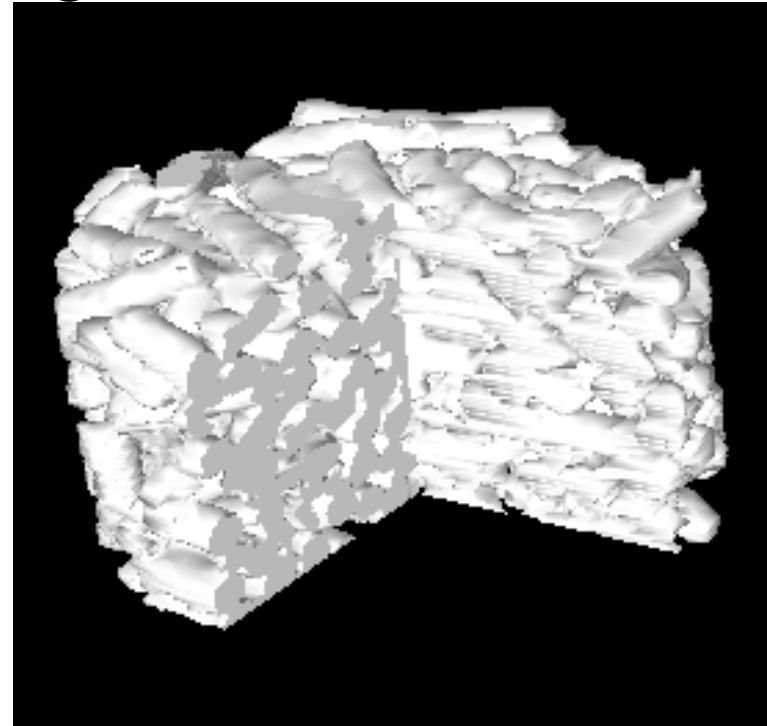
○: 1 kg fresh material + 0.4 kg DS

Influence of backmixing: sludge A

- 3D X-ray tomographic images

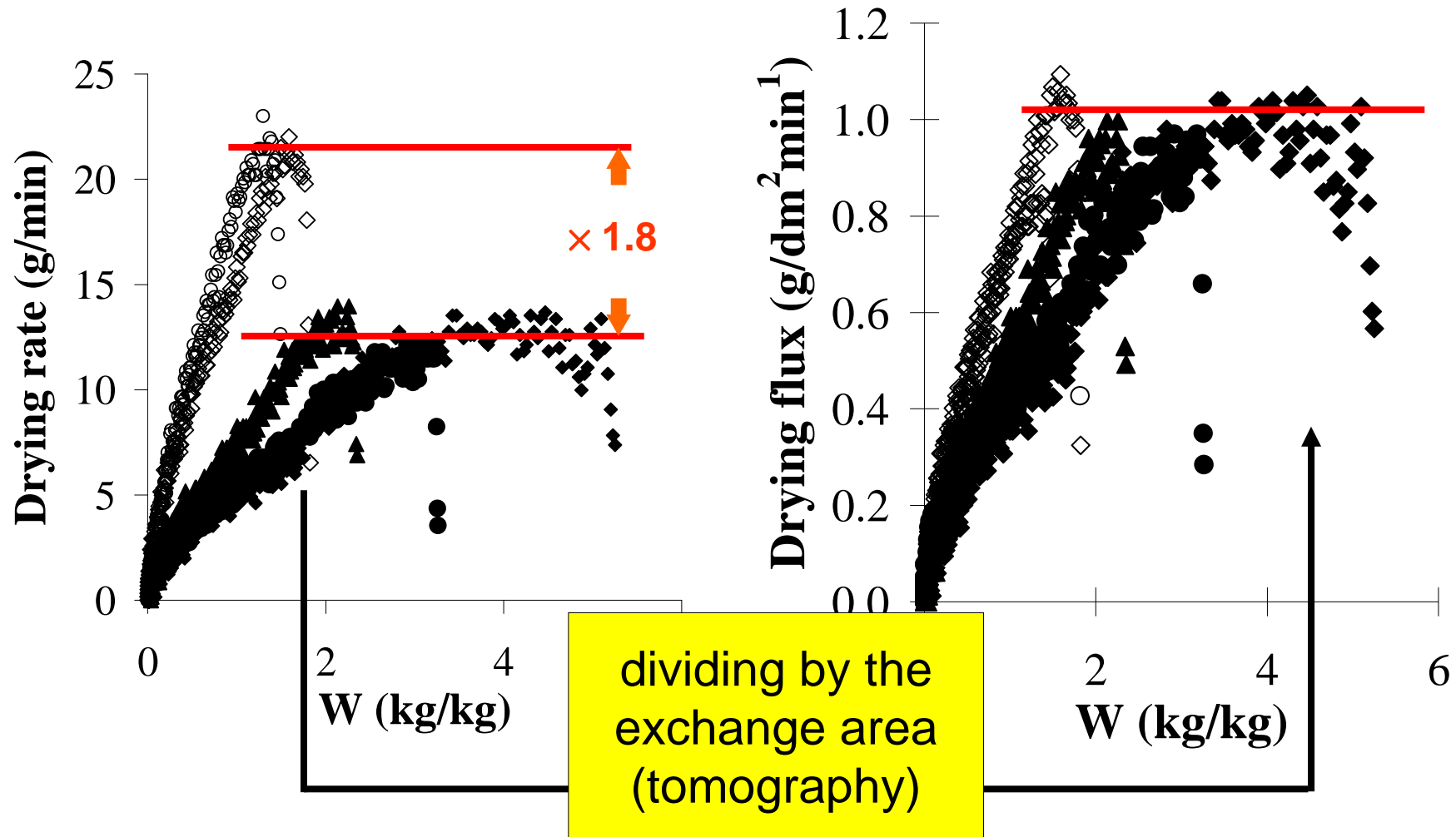


1000 g – 16% DS
No addition of dried sludge



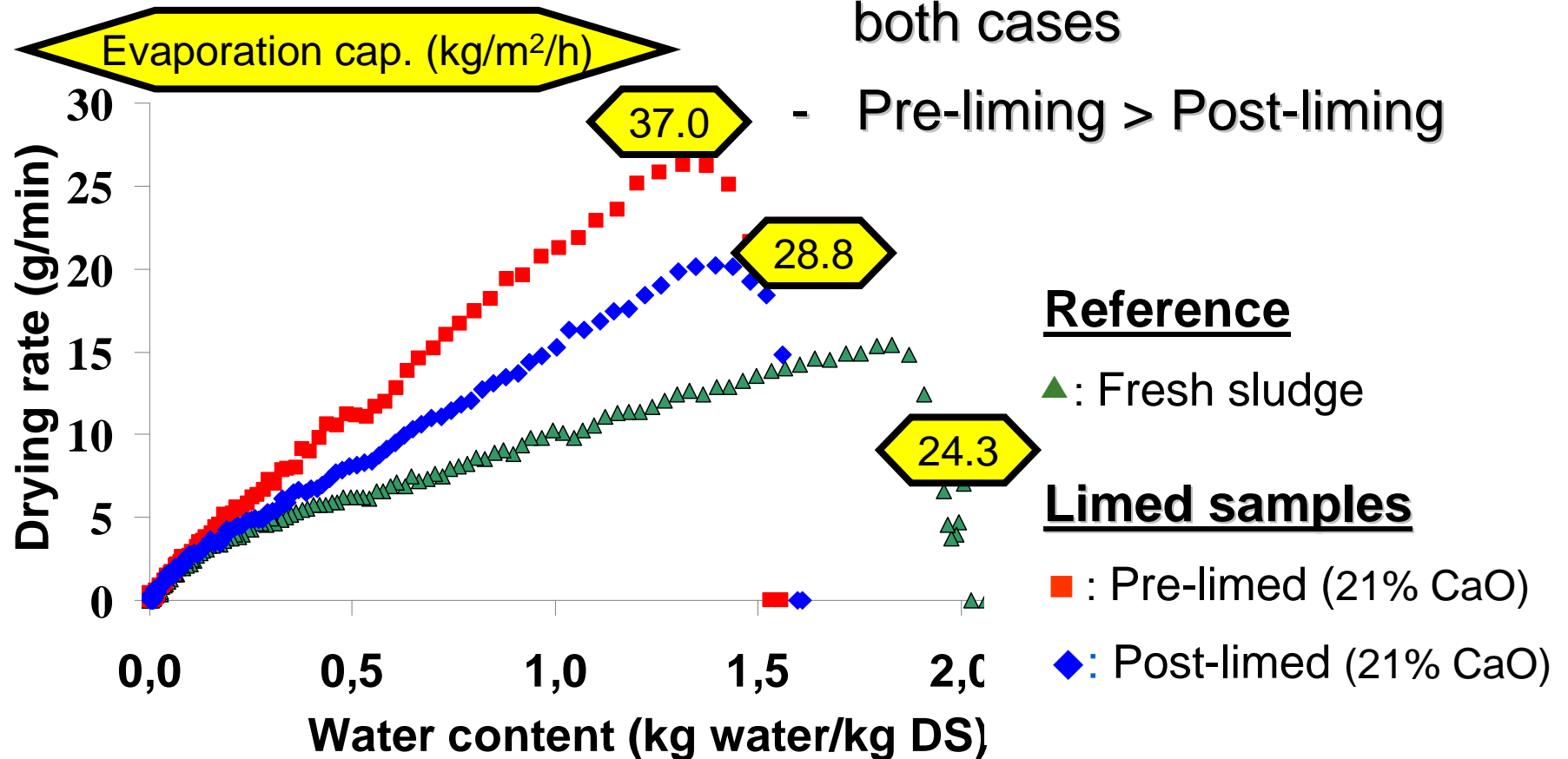
1400 g – 40% DS
Addition of 400 g dried sludge

Influence of backmixing: sludge A



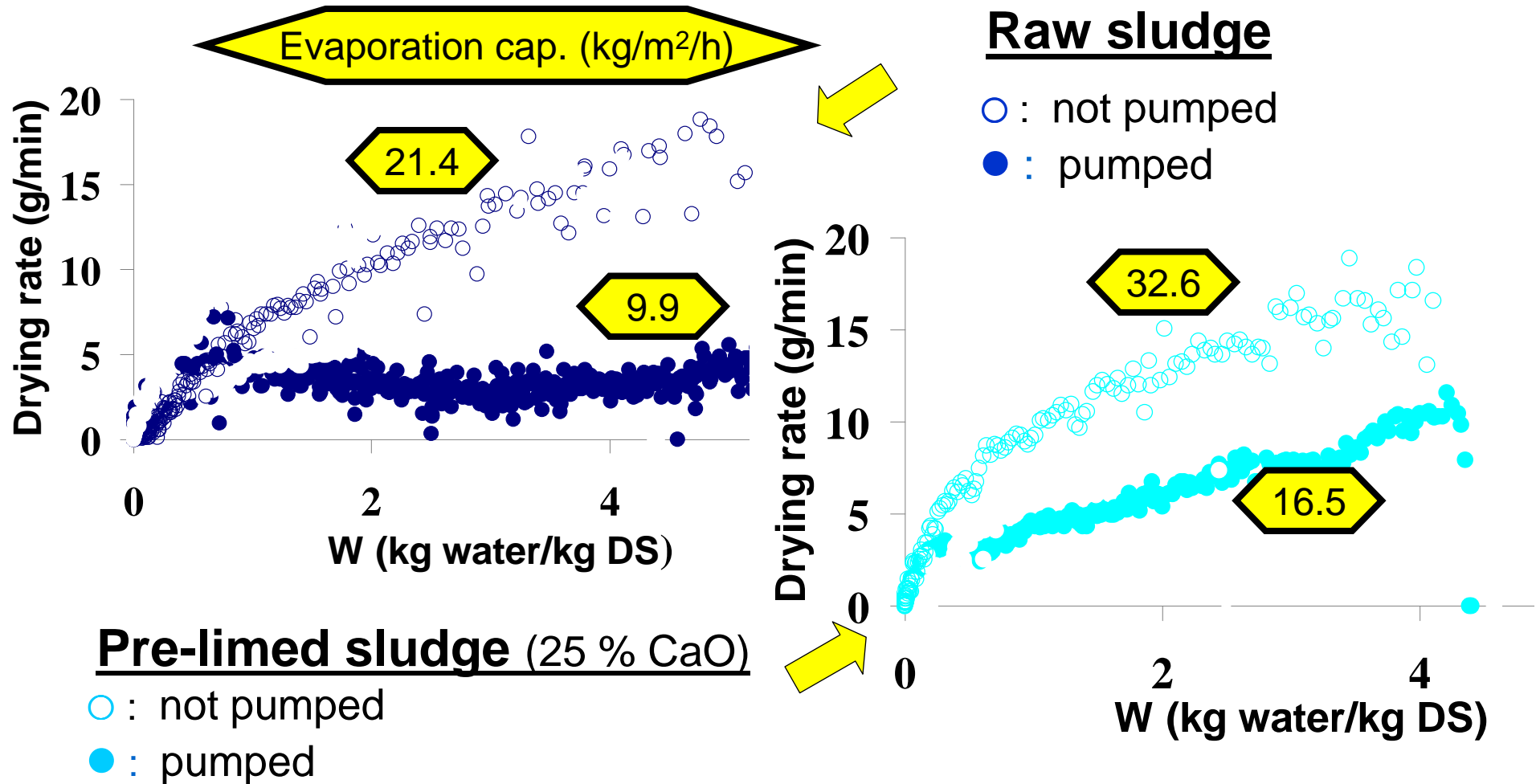
Influence of liming: sludge B

- Pre- or post-liming ? \Rightarrow - Acceleration of drying in both cases
- Pre-liming > Post-liming



Influence of pumping: sludge C

Progressive cavity pump (Moineau type)



Rheology characterization

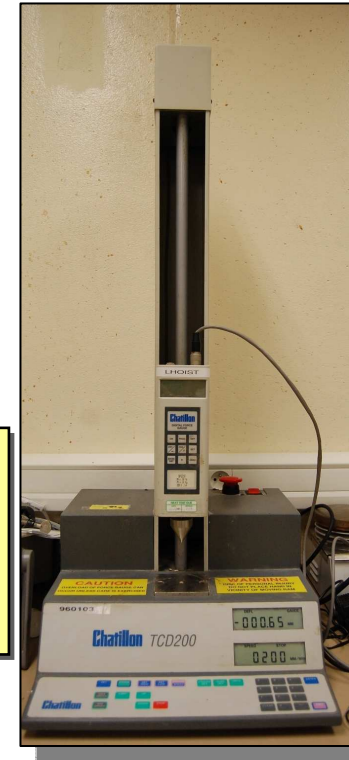
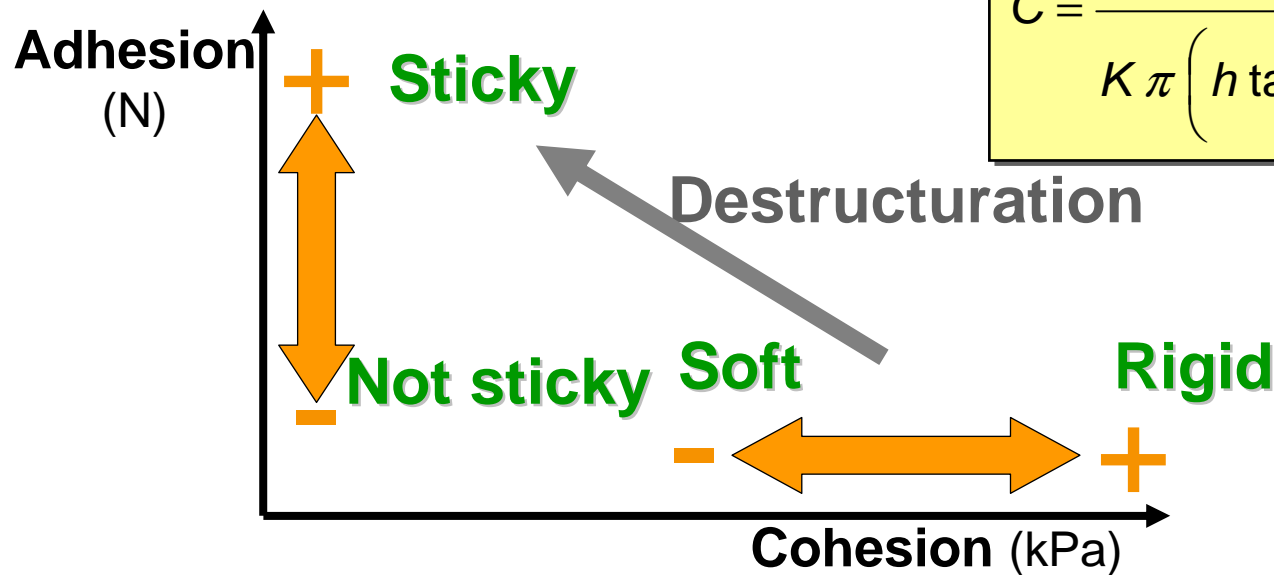
■ Penetrometry test

- Compressive and shear forces during penetration

↳ **Cohesion** (kPa): calculated from the applied force

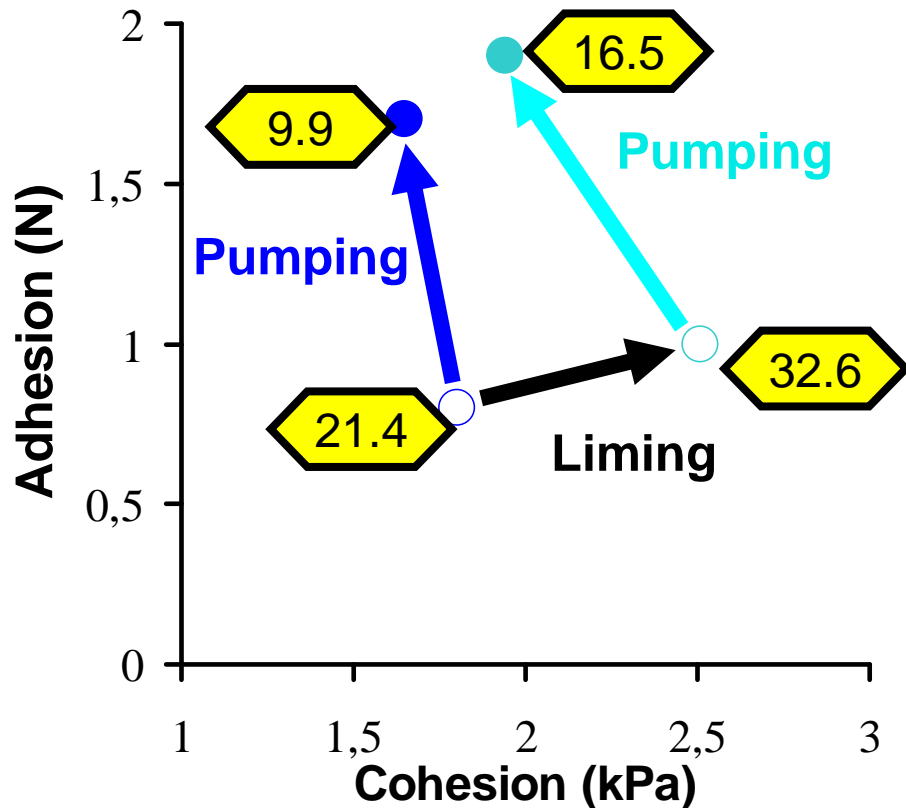
- Traction forces during probe withdrawal

↳ **Adhesion** (N): directly measured



Texturometer
Chatillon LCD-TCD200
Cone opening: $\beta = 30^\circ$

Rheology characterization : sludge C



- Pumping induces shear stress which destructures sludge
 - ↪ Increase of stickyness
 - ↪ Decrease of cohesion
- Liming strongly increases cohesion

Raw sludge

- : not pumped
- : pumped

Pre-limed sludge (25 % CaO)

- : not pumped
- : pumped

Texture visual observation: sludge C



Pumping
→



↓
Liming



Pumping
→



Conclusion

- **Backmixing** and **liming** (pre- and post-) have a positive effect on drying.
- **Post-liming** is less efficient possibly due to shear stress induced by mixing.
- Shear stress induced by **pumping** affects the sludge structure (destruction) and has a negative effect on drying.
- A good correlation between **drying performance** and **penetrometry** characterisation but... further works are needed to confirm these results.