



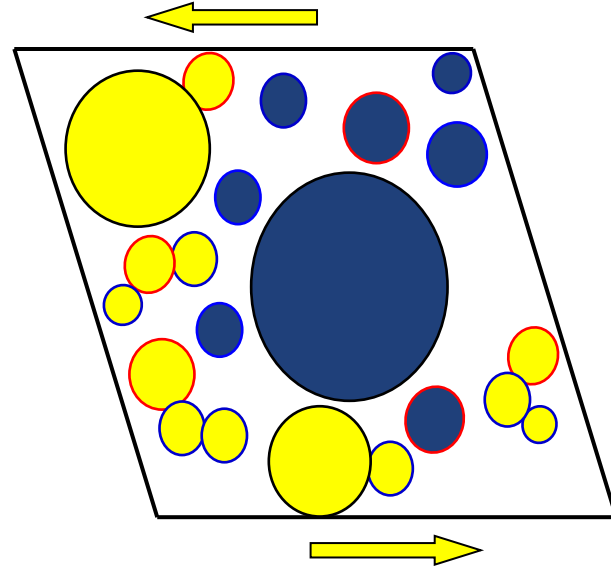
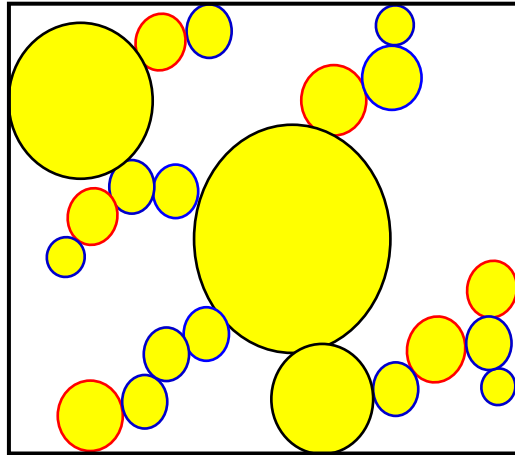
Chemical Admixtures for blended cements: More problems or more solutions?

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presented by Timothy Wangler

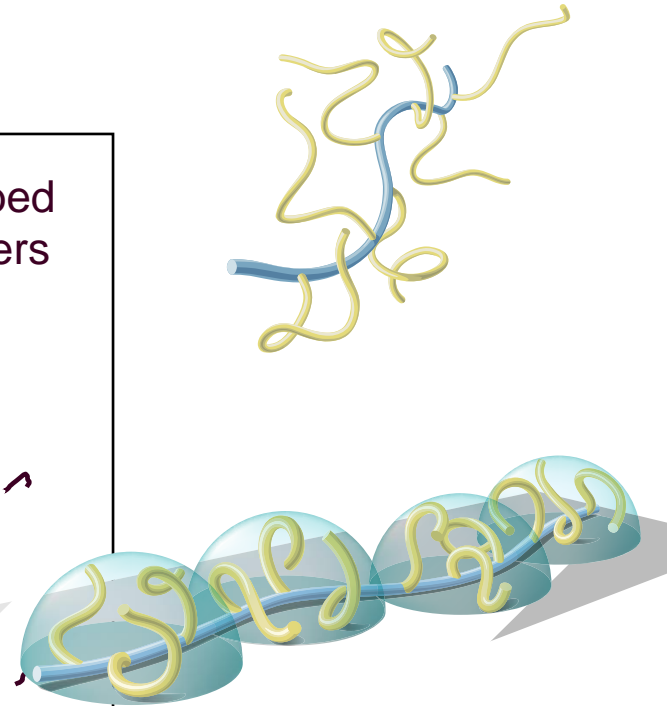
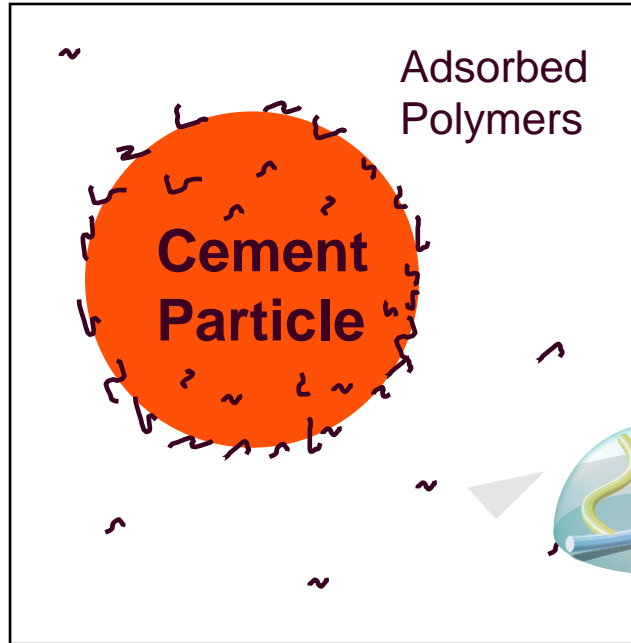
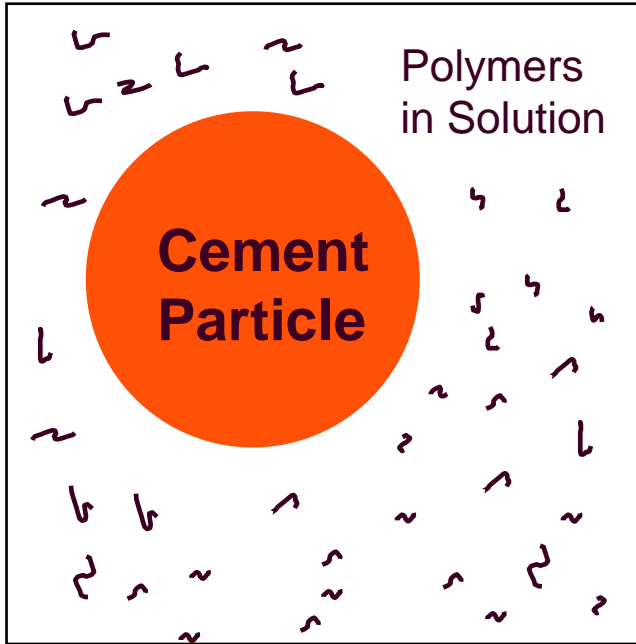
Part 1: Background on Superplasticizers

Yield stress

- Yield stress can be viewed as a **solid-liquid phase transition** that takes place if enough interparticle bonds can be broken for the system to flow

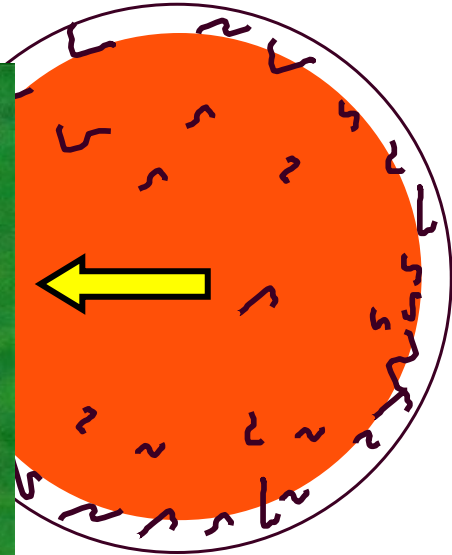


Adsorption



Steric Repulsion

$$F_{\text{attraction}} \gg \frac{1}{\text{separation}^2}$$



Surface coverage versus layer thickness

Affinity is key

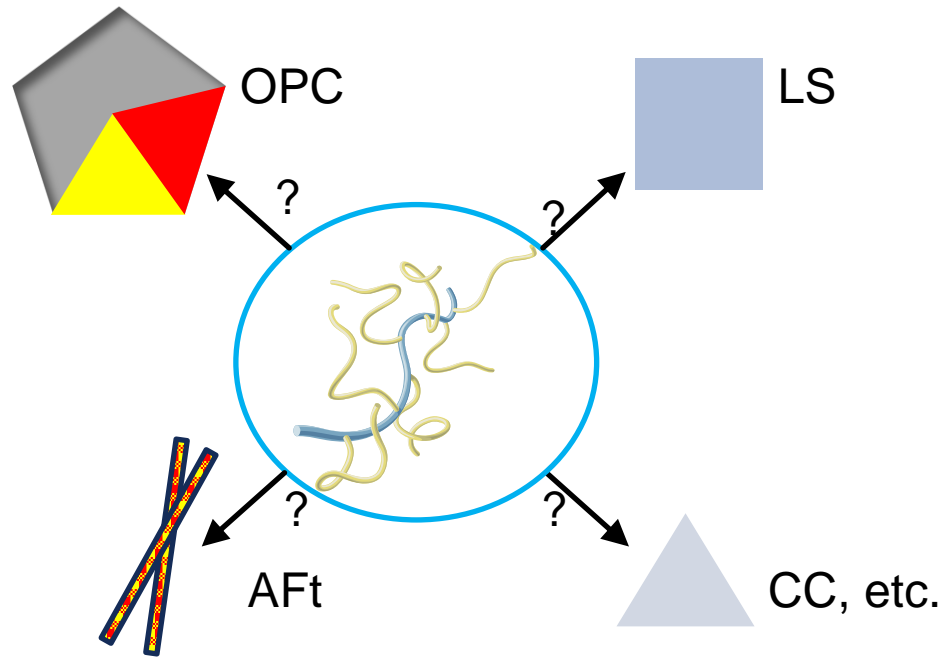
Surface coverage
controlled

Conformation is key

Layer thickness
controlled



Superplasticizers in blended cements

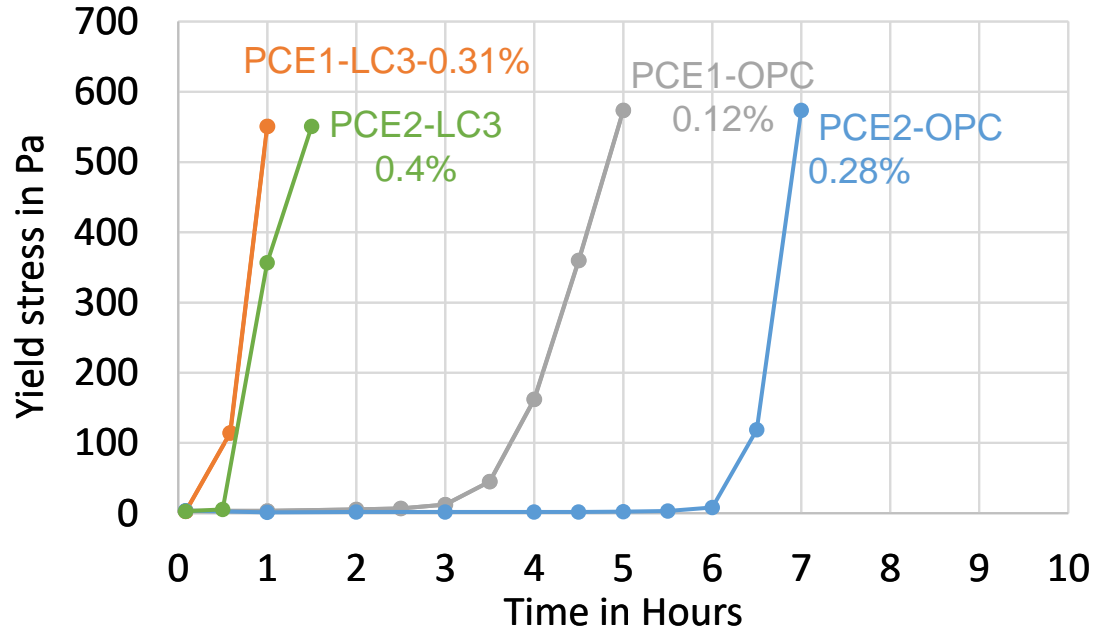


Part 2: Evidence of flow loss in superplasticized LC3

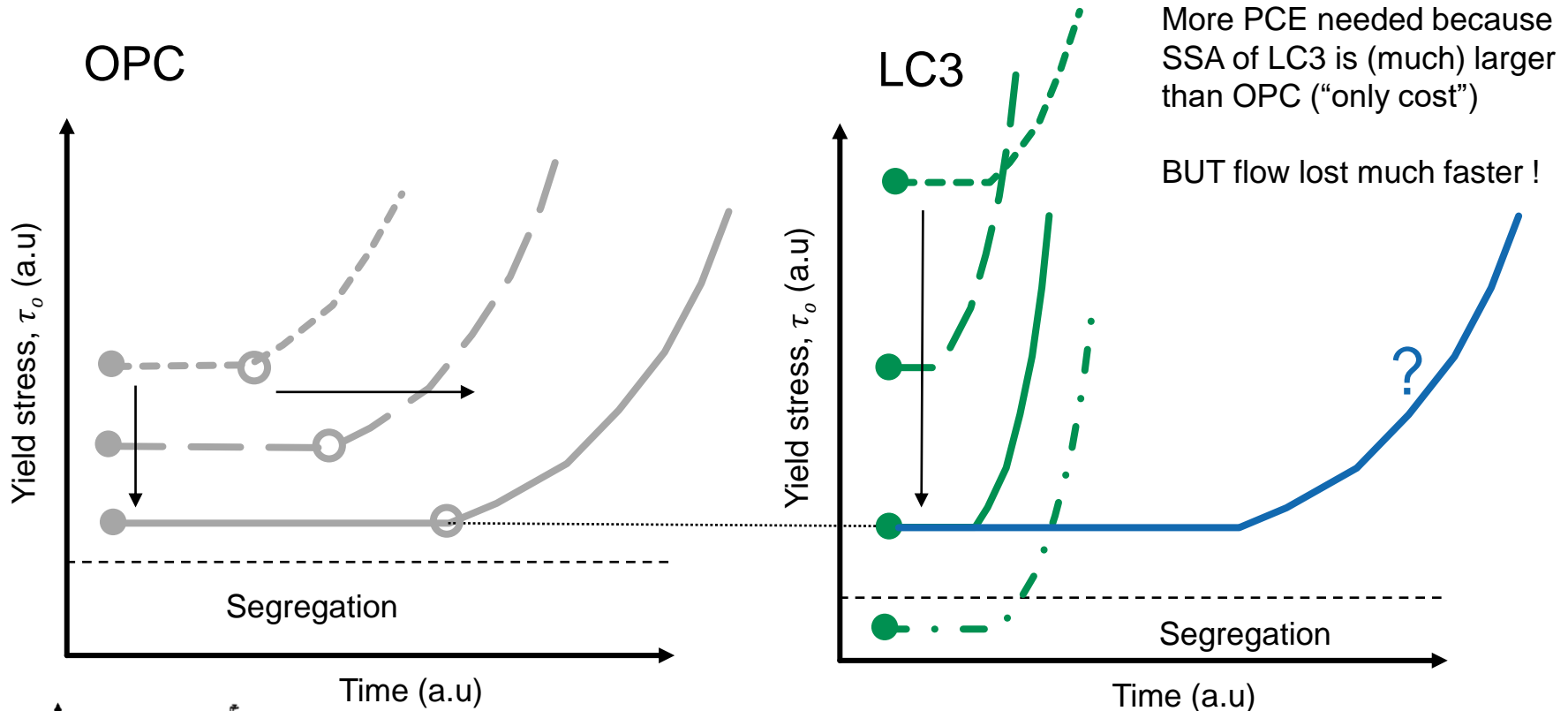
How serious and fast can flow loss be?

The problem with (some) LC3

- Initial dosages adjusted for same flow spread
 - Higher dosages for LC3
- Flow lost much faster with LC3 than OPC



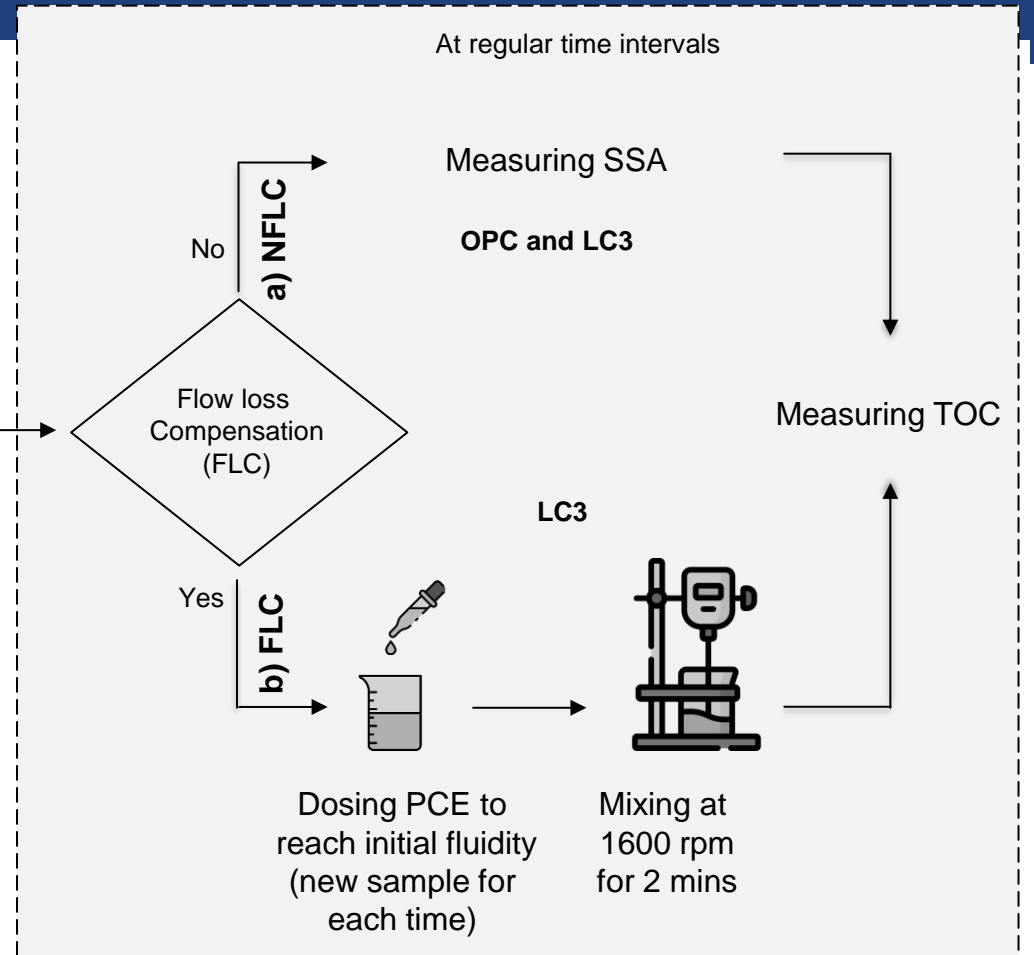
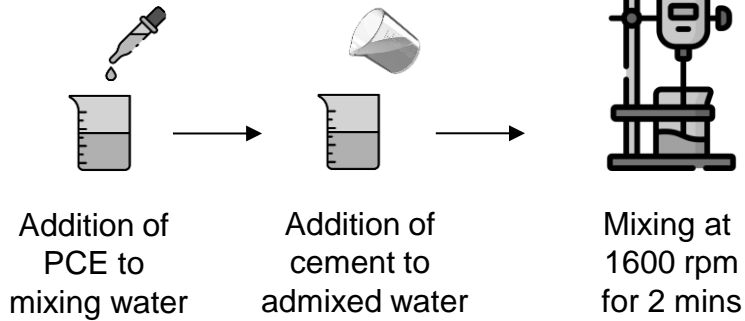
Schematic illustration of OPC and LC3 flow retention



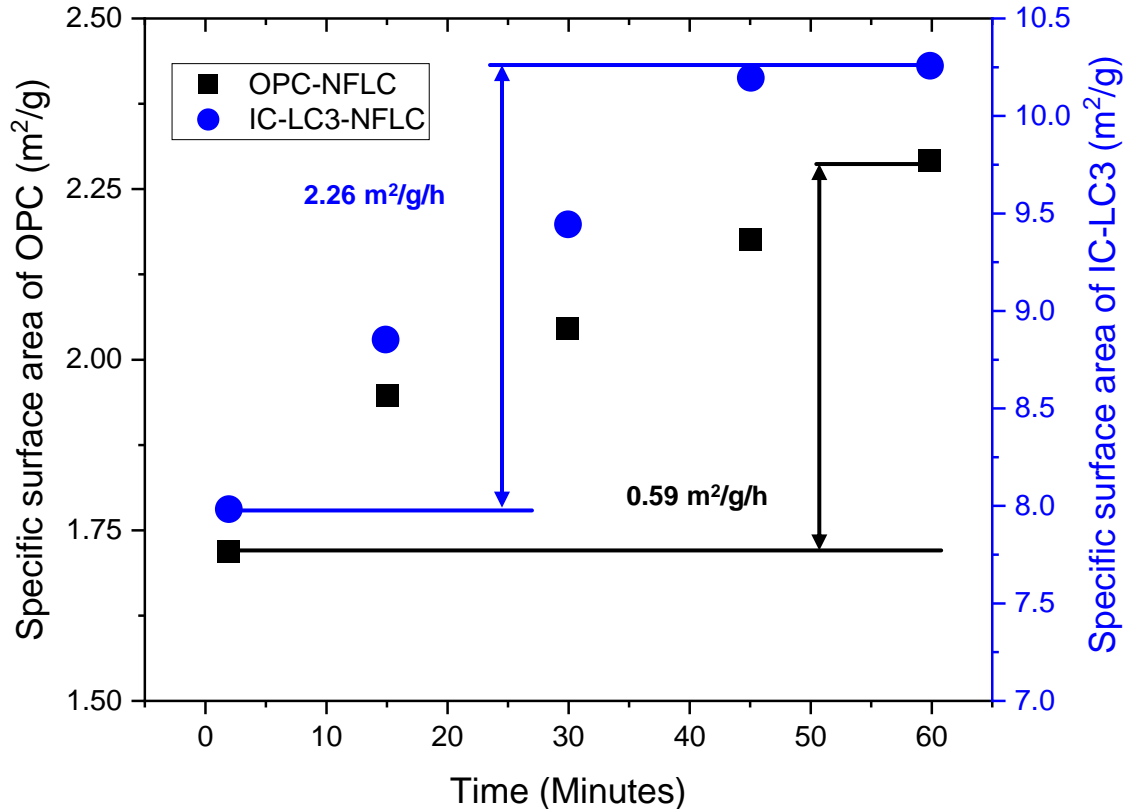
Part 3: Explaining flow loss in superplasticized LC3

What mechanism causes loss of fluidity?

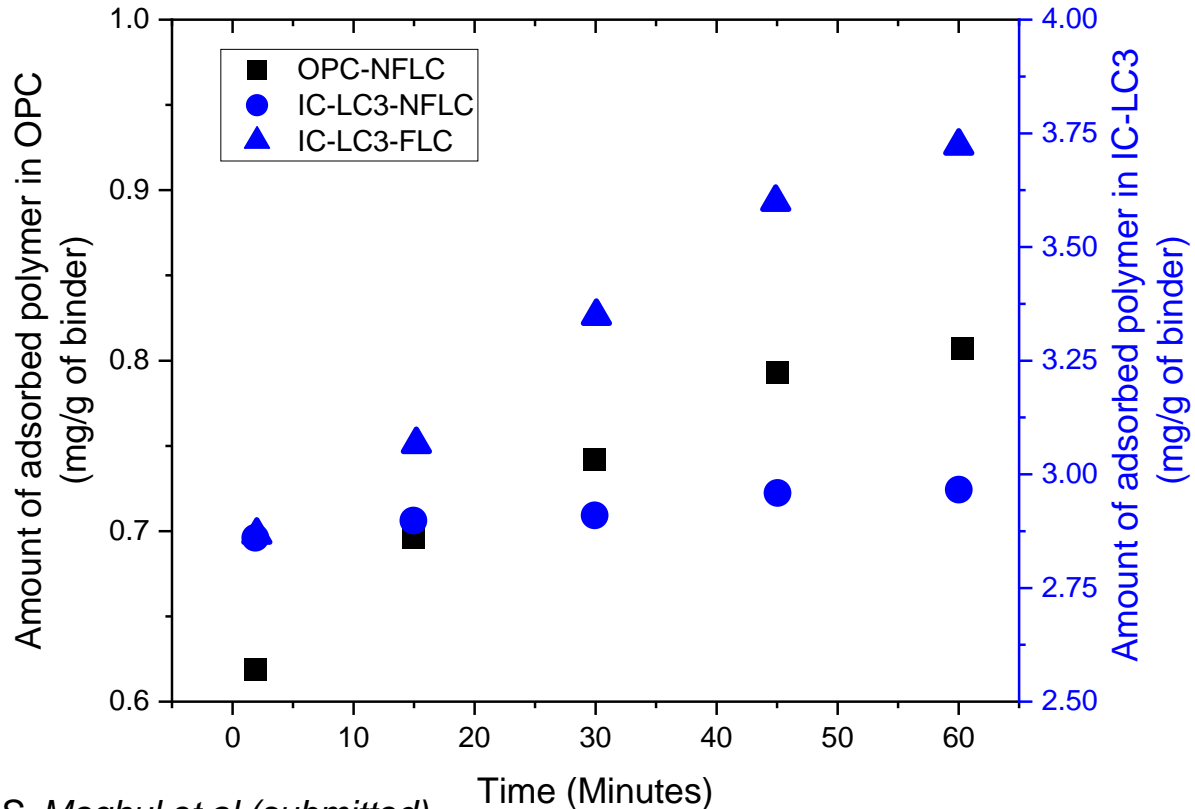
Experimental Setup



Evolution of specific surface area

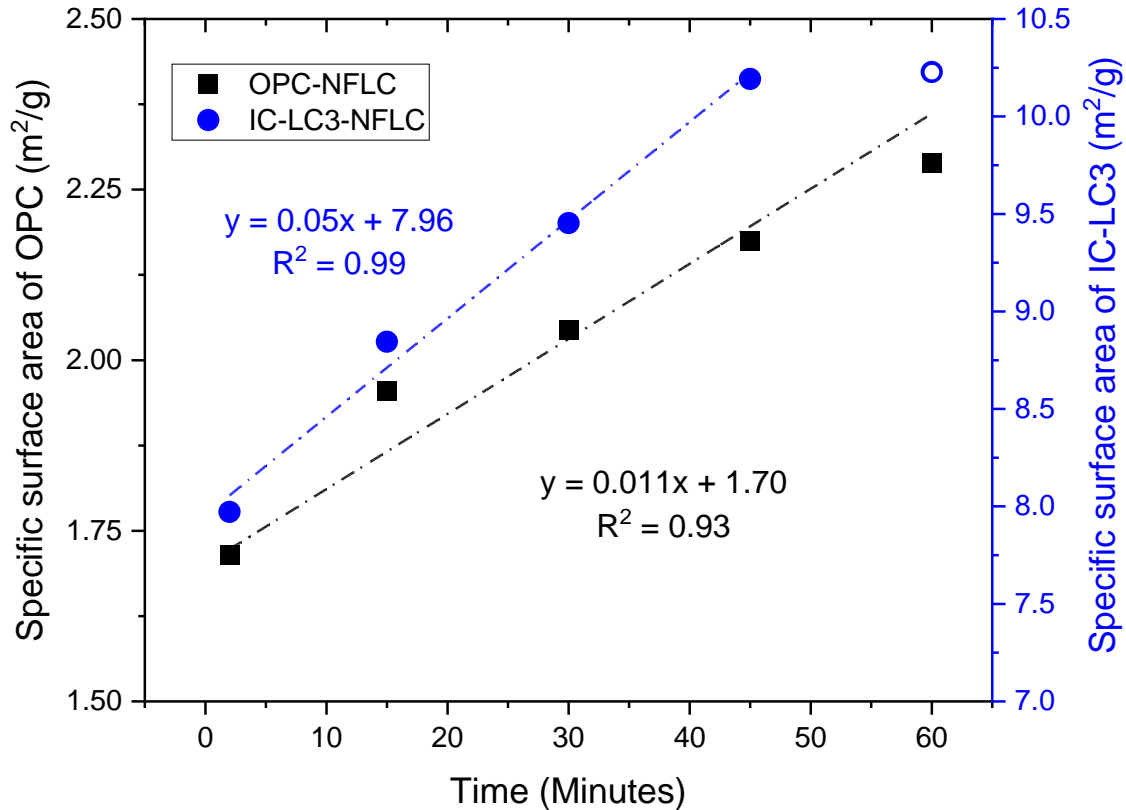


Adsorption of PCE over time

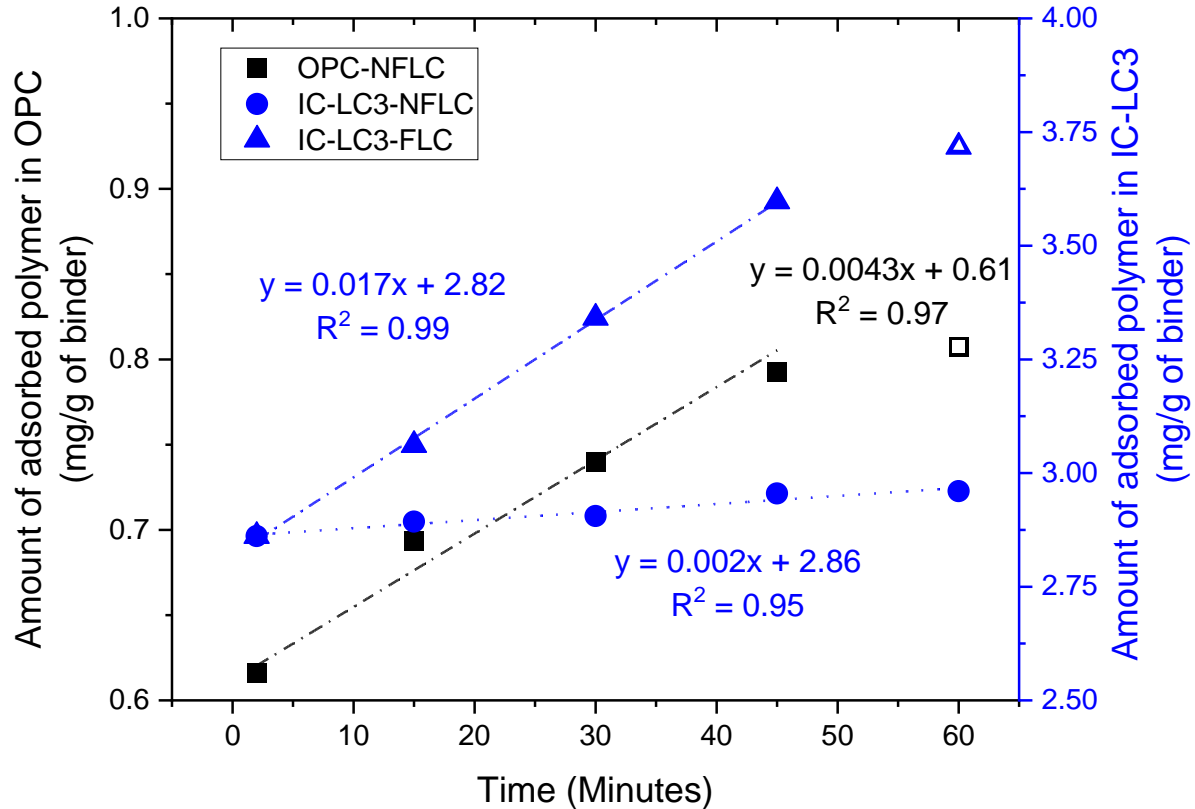


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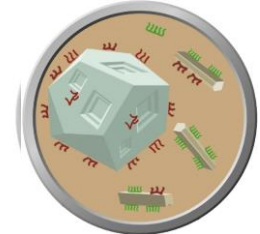
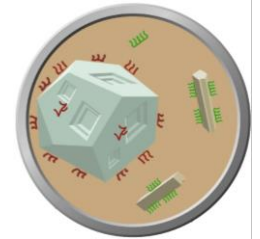
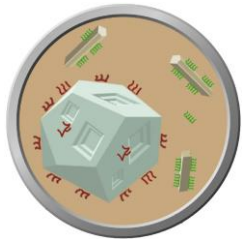
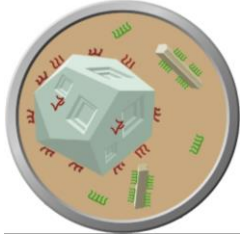
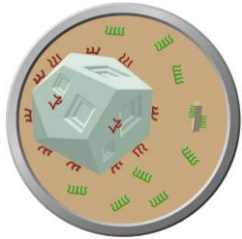
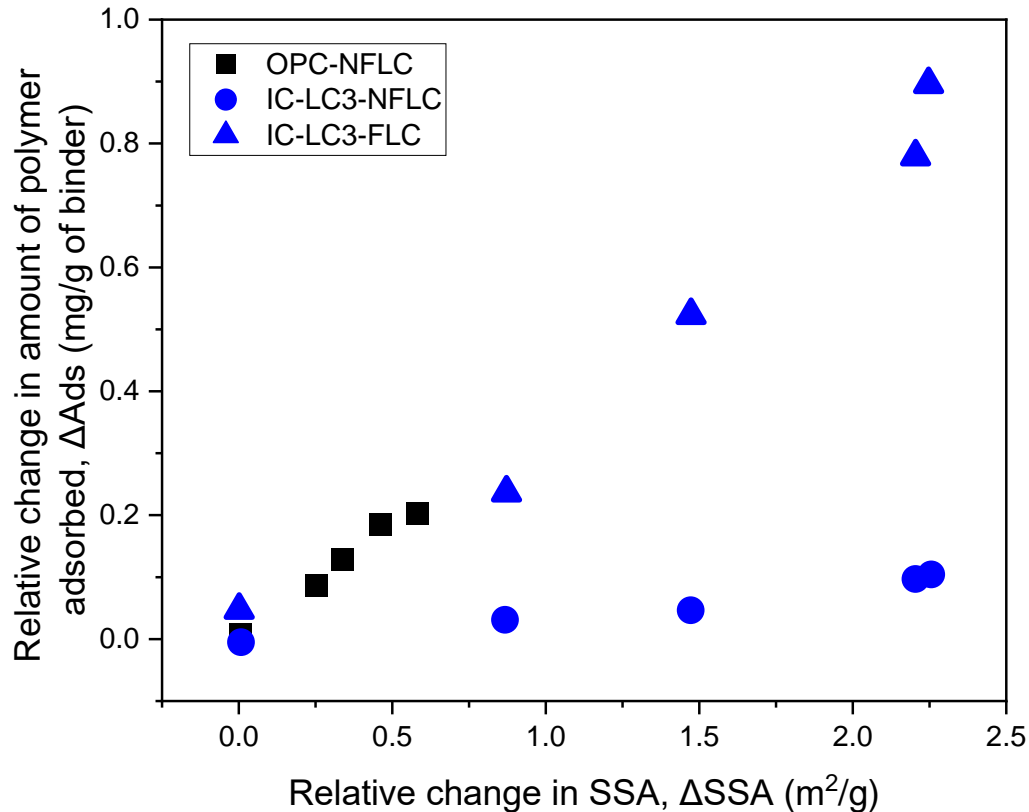
Evolution of specific surface area



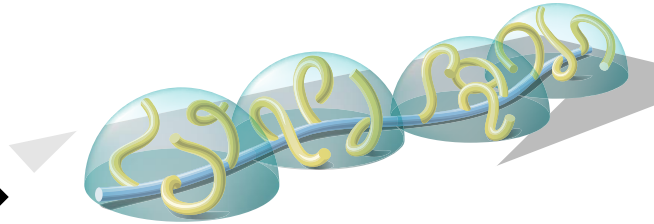
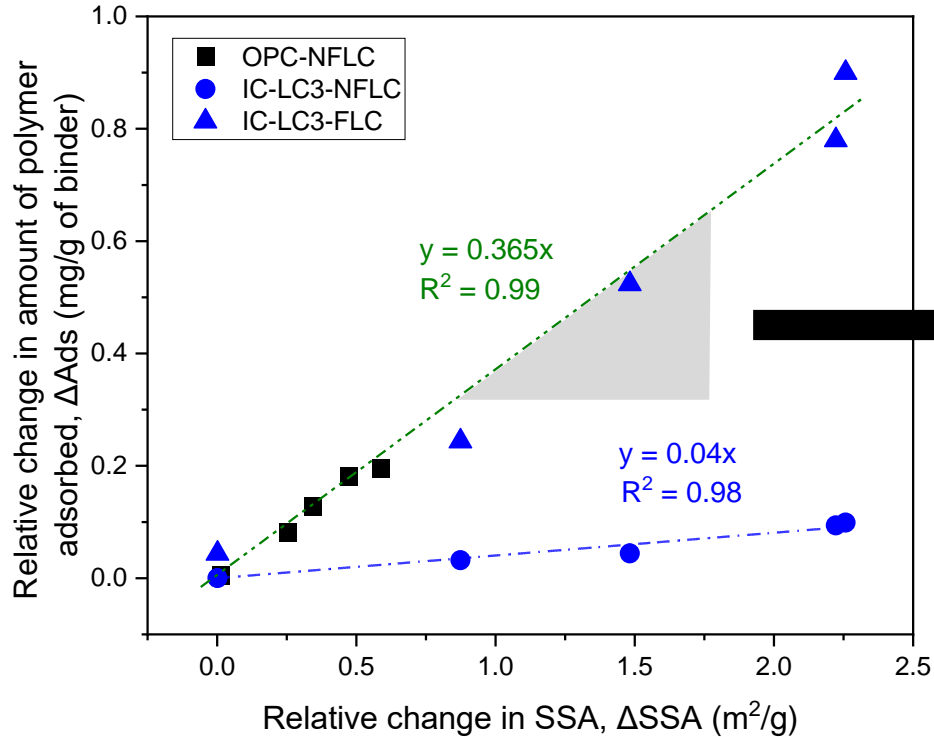
Adsorption of PCE over time



Change in adsorption versus change in specific surface area



Change in adsorption versus change in specific surface area



Part 4: A pragmatic solution to flow loss in LC3

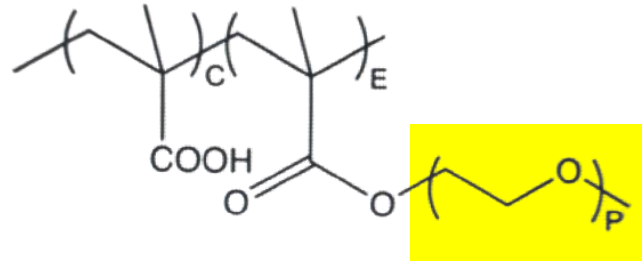
Can flow loss be mitigated? If so, how?

Approach to solving flow loss

- Based on previous findings, two approaches can be considered
 - Adding a polymer that does not adsorb initially, but only later in time
 - Should have higher affinity for newly formed surfaces
 - Does not solve the issue at its root
 - Potentially requires high dosages
- Blocking the initial reactivity
 - PCEs do not seem to do this effectively
 - Look at other chemical structures that might do this

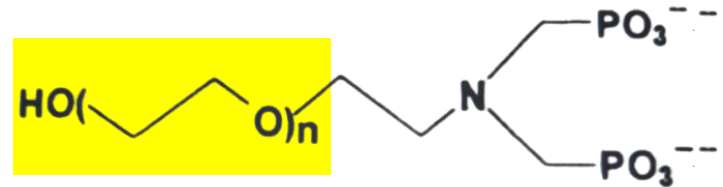
PCEs versus single chain diphosphonate superplasticizers

PCEs



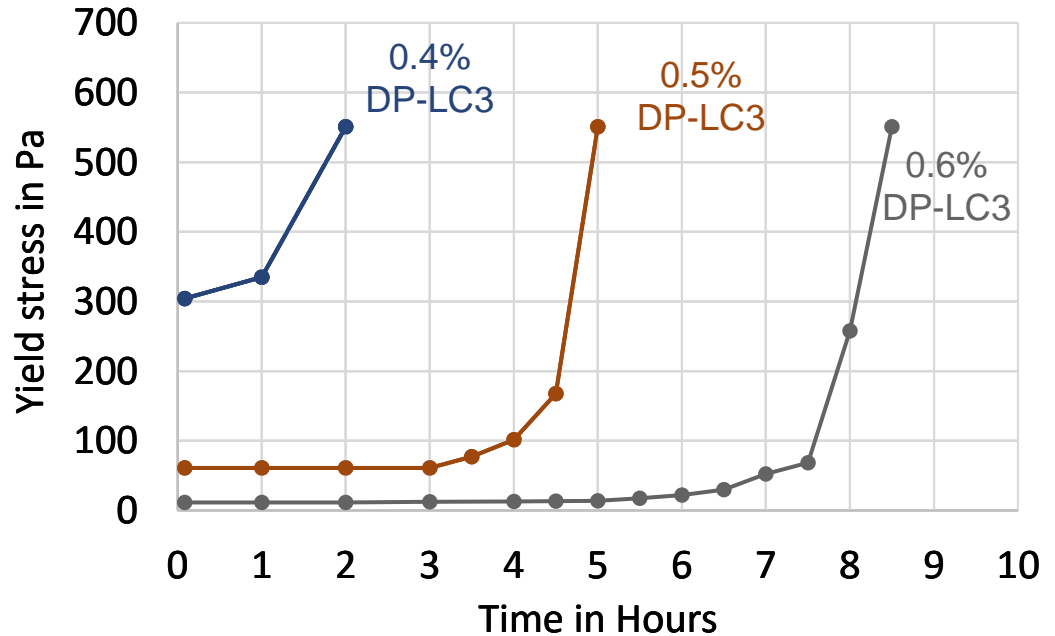
Di-Phosphonates

- Single chains
- Steric hindrance
- Strongly retarding
- Specialty product for oil well cement



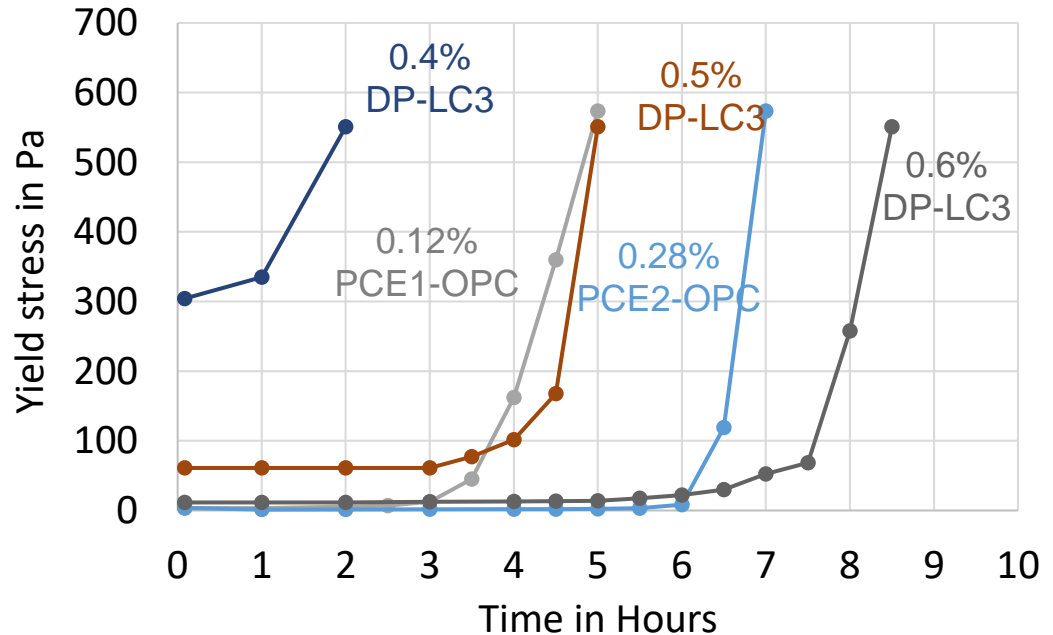
Dosage dependent flow and flow retention

- 0.4% too low
- 0.7% too high (segregation)



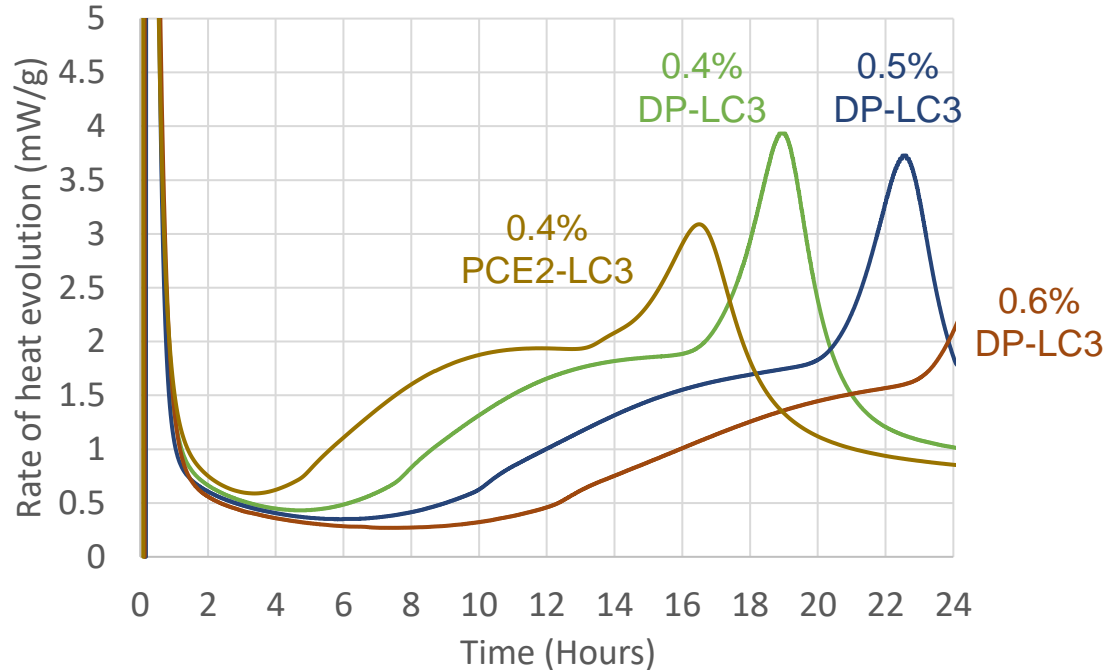
Dosage dependent flow and flow retention

- 0.4% too low
- 0.7% too high (segregation)
- 0.5% good compromise
 - Slightly higher starting yield stress
 - Similar flow retardation



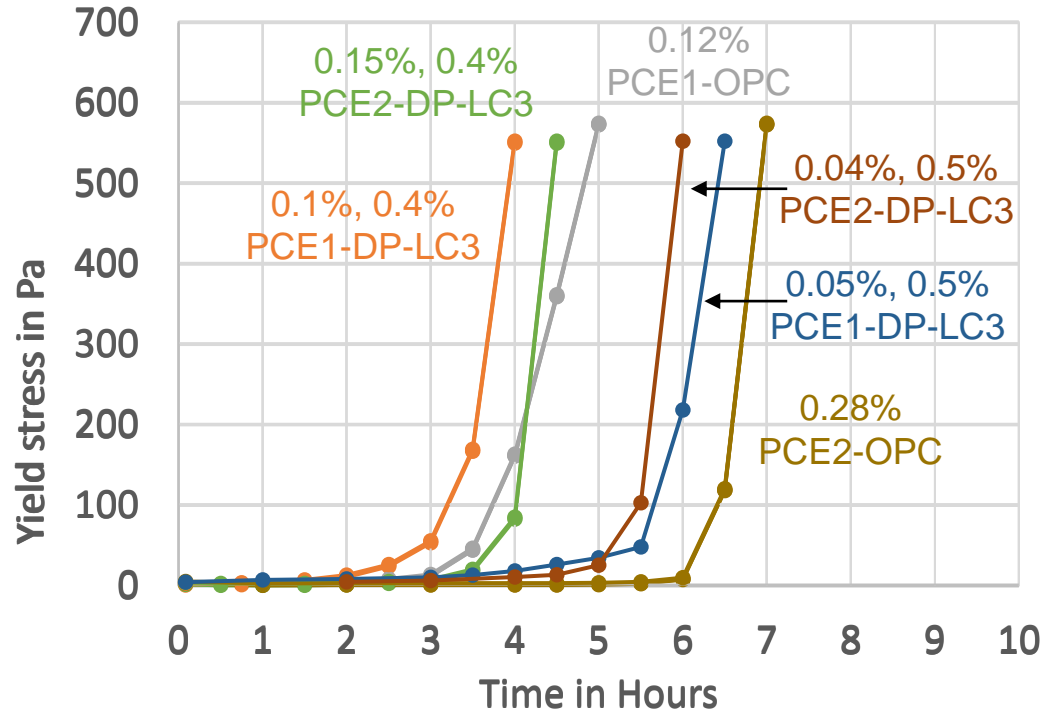
Hydration kinetics of LC3 with DP

- 0.5% good compromise for flow
- But excessive retardation
- Combine DP and PCE?

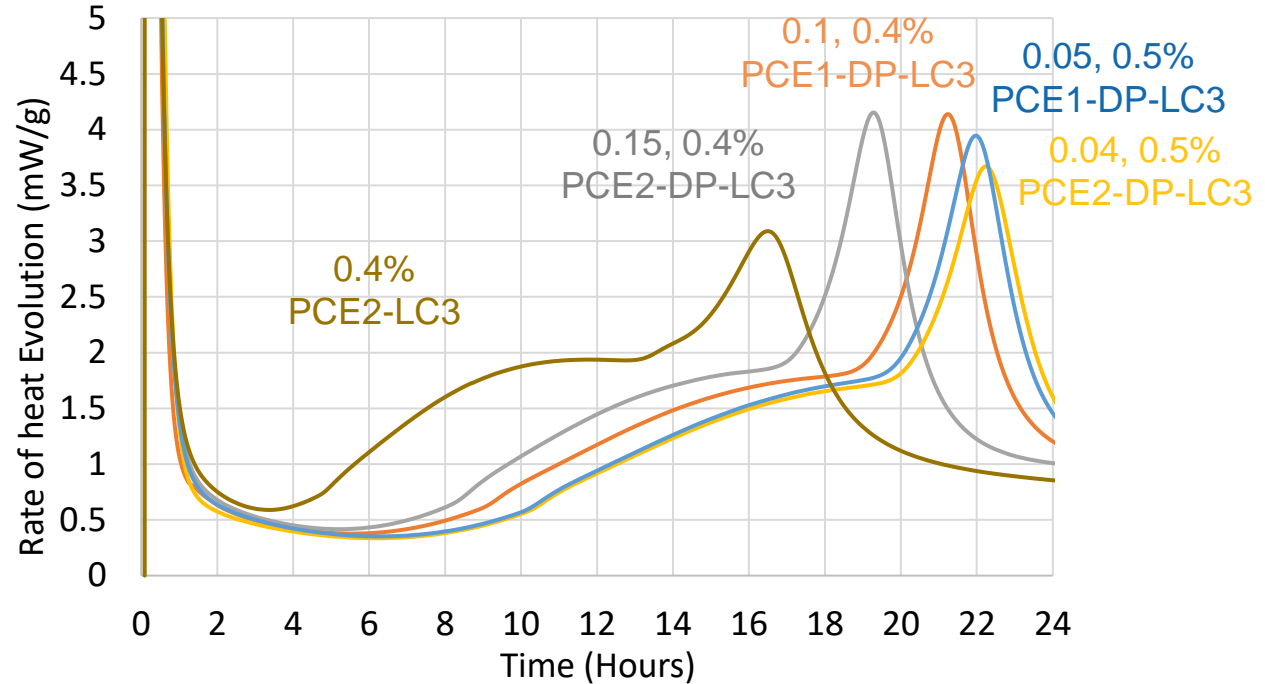


Flow of PCE and DP combinations

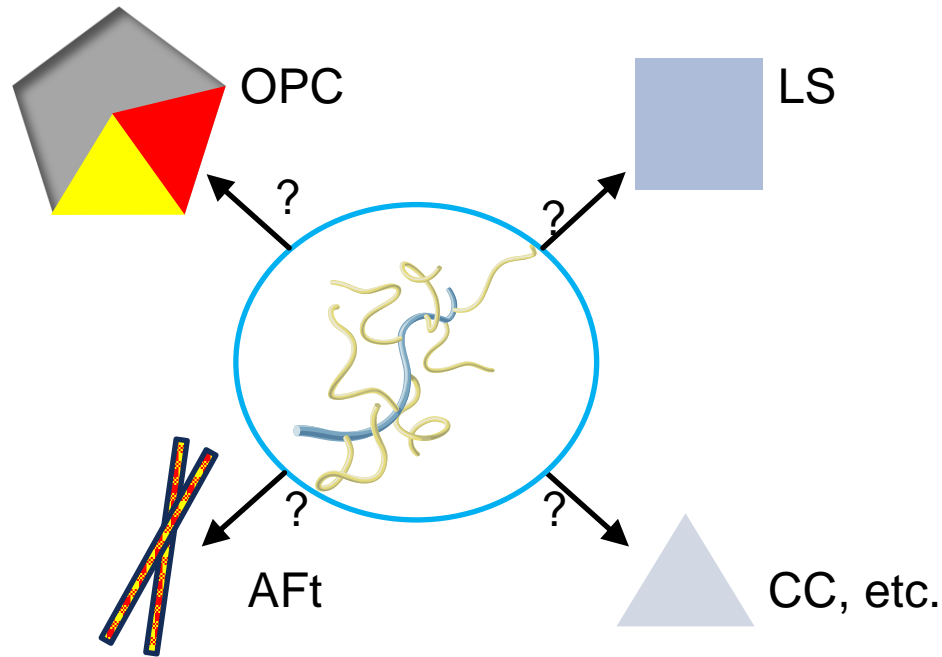
- Similar flow and flow retention



Hydration kinetics of LC3 with PCE-DP combinations



Superplasticizers in blended cements



Conclusions

- Flow loss of superplasticized LC3 is a direct result of rapid formation of additional surfaces
- Covering those surfaces compensates flow loss
 - Polymers with delayed adsorption may help
 - Dosage response is probably low
- Blocking the early reactivity, probably of the calcined clays is promising
 - Diphosphonates appear to do this effectively
 - Combined with PCE they offer good flow and flow retardation, without excessive retardation

Thank you for your kind attention

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