Early-Age Microstructure Evolution of Cement Pastes

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In-situ observation of cement pastes microstructures

The objective of this research is to make in-situ observations on fresh cement paste microstructures by using a conventional SEM during setting and to understand the physical growth in cement particles and different phases at early age for different mixtures qualitatively and also quantitatively.

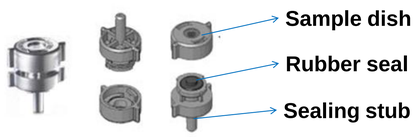
Cement paste setting

- Cement particle
- Dispersion
- Growth
- Agglomeration
- Flocculation
- Wide range of other reactions

Methodology:

Advanced scanning electron microscopy technique
- Quantomix wet SEM technology

Conventional SEM



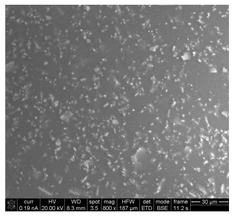
Quantomix-202C Capsule
http://www.quantomix.com/tec_lit/QX202cUserManual.pdf

Sample preparation:

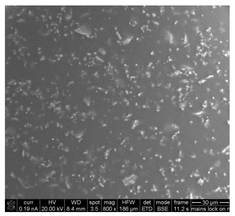
1. Preparing multi-well plate for QX-capsule
2. Applying sample via conventional pipetting
3. Quick sealing the QX-capsule
4. Placing the QX-sample in SEM chamber

SEM image of cement pastes

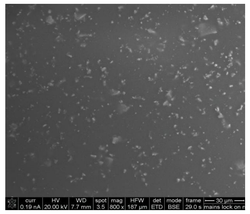
Three different cement pastes microstructure evolutions were observed using Quantomix capsule system



a) w/c = 0.5



b) w/c = 0.6

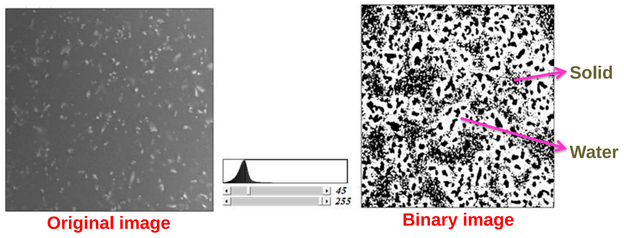


At 30 min age

c) w/c = 0.7

SEM image analysis: Thresholding

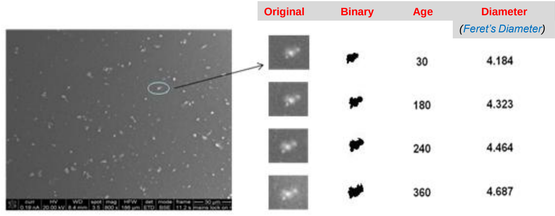
Volume fraction (Area fraction):



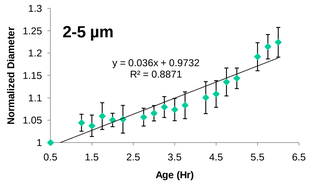
Original image

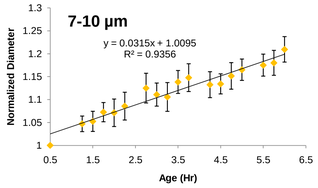
Binary image

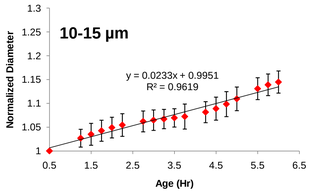
Single particle:



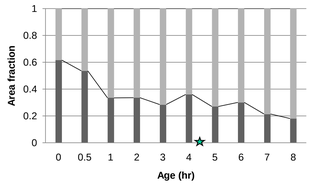
Single particle growth



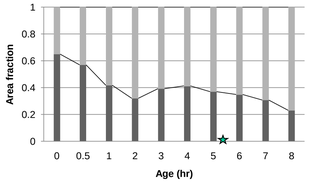




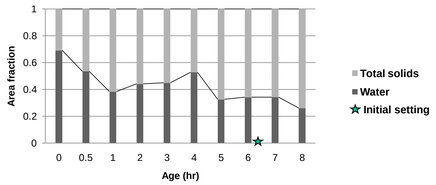
Area fraction evolution



a) w/c = 0.5



b) w/c = 0.6



c) w/c = 0.7

Conclusions

1. Using Quantomix capsuling system, the physical changes in microstructure of fresh cement pastes can also be studied easily.
2. In general an increment of 14-25% in cement particle's diameter is observed at age of 6 hours after mixing the cement paste.
3. Due to the less intensity of the cement particles, among the three mixtures, the hydration rate is more for w/c = 0.7 mixture.
4. For all mixtures at initial setting time approximately 50% reduction in its original water content is observed, which can help in prediction of setting times at microstructural level for fresh cement pastes.