



WORLD BREWING CONGRESS

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#ElevateBeer



Blocking Layers in the Lautering Filter Cake – Influence of Particle Size and Shape

Jörg Engstle

Chair for process systems engineering

Technical University of Munich



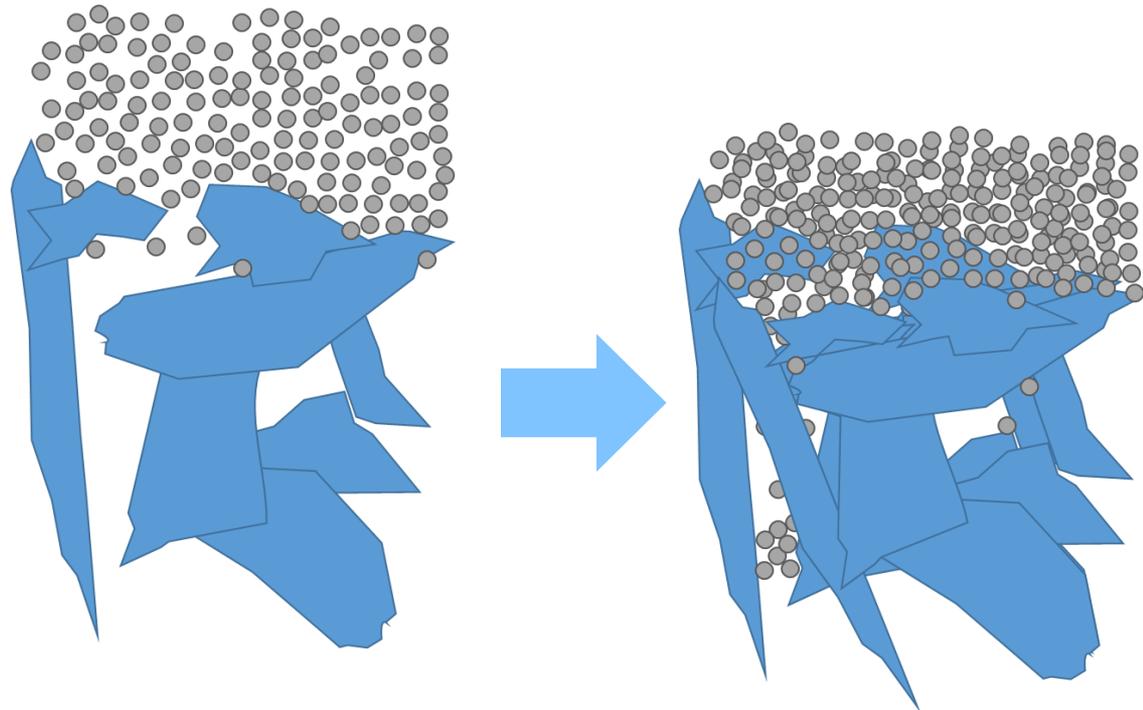
Motivation

- Lautering and mashing as bottleneck for brew house operations
 - Problems based on unsatisfactory raw material quality
 - Layered cake structure
 - Lautering still a kind of black box operation
- Blocking mechanisms?
→ Role of fine particles?
→ Influence of single layers?



Lautering – Procedural Characterization

- Solid liquid separation
- Filtration followed by filter cake washing
- Filtration mechanisms:
 - Cake filtration
 - Surface filtration
 - Deep bed filtration



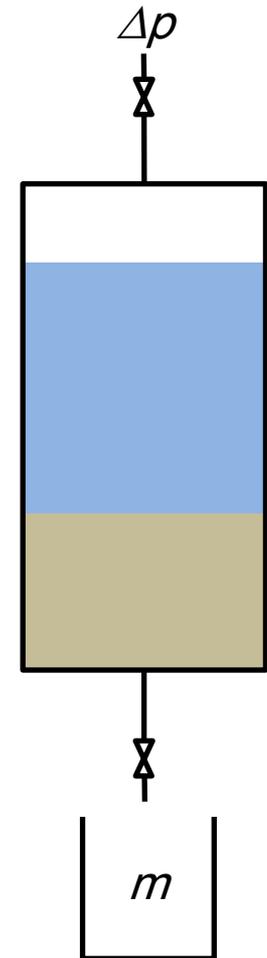
Methods

Filtration performance:

- spent grains cake is cut in horizontal layers
- cake layer is transferred in filter cell
- wort is pressed through cake layer at given pressure
- measuring mass vs. time

Layer characterization:

- Particle size distribution → laser diffraction / sieve analysis
- Particle form → image analysis
- X-ray Microtomography



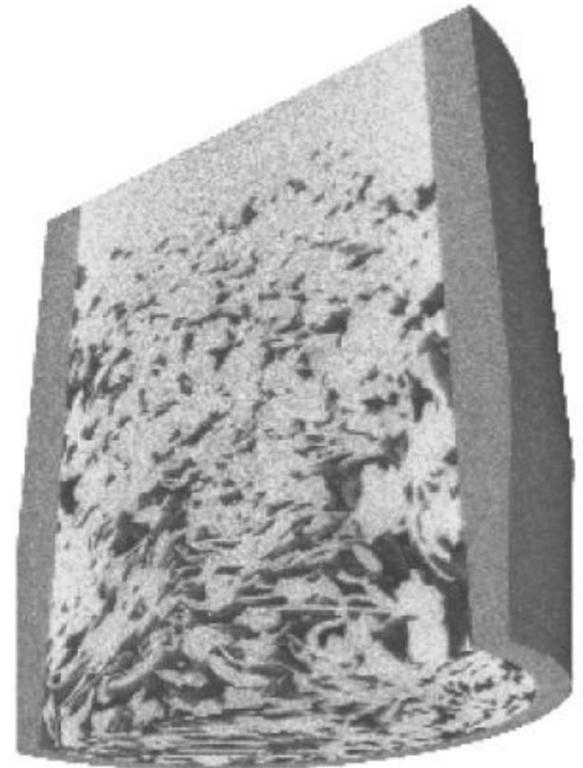
Arrangement in Layers

- sedimentation → formation of different layers
- Macroscopic: 2 layers
- different layer properties
 - measurement necessary
 - influence on filtration performance
 - finer grid



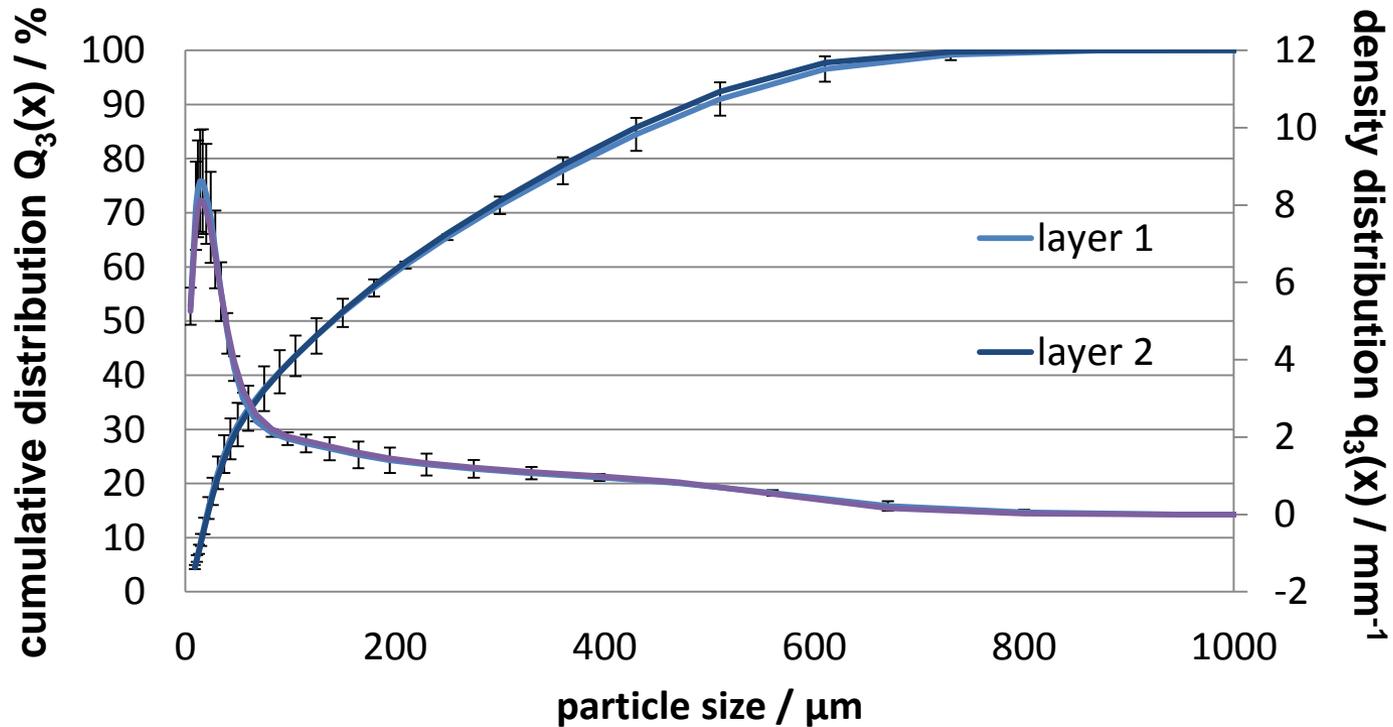
μ -CT (X-Ray Microtomography)

- non invasive 3D-image analysis
- grey scale images due to density differences
- results:
 - porosity gradient
 - pore size gradient
 - varying properties along the cake height



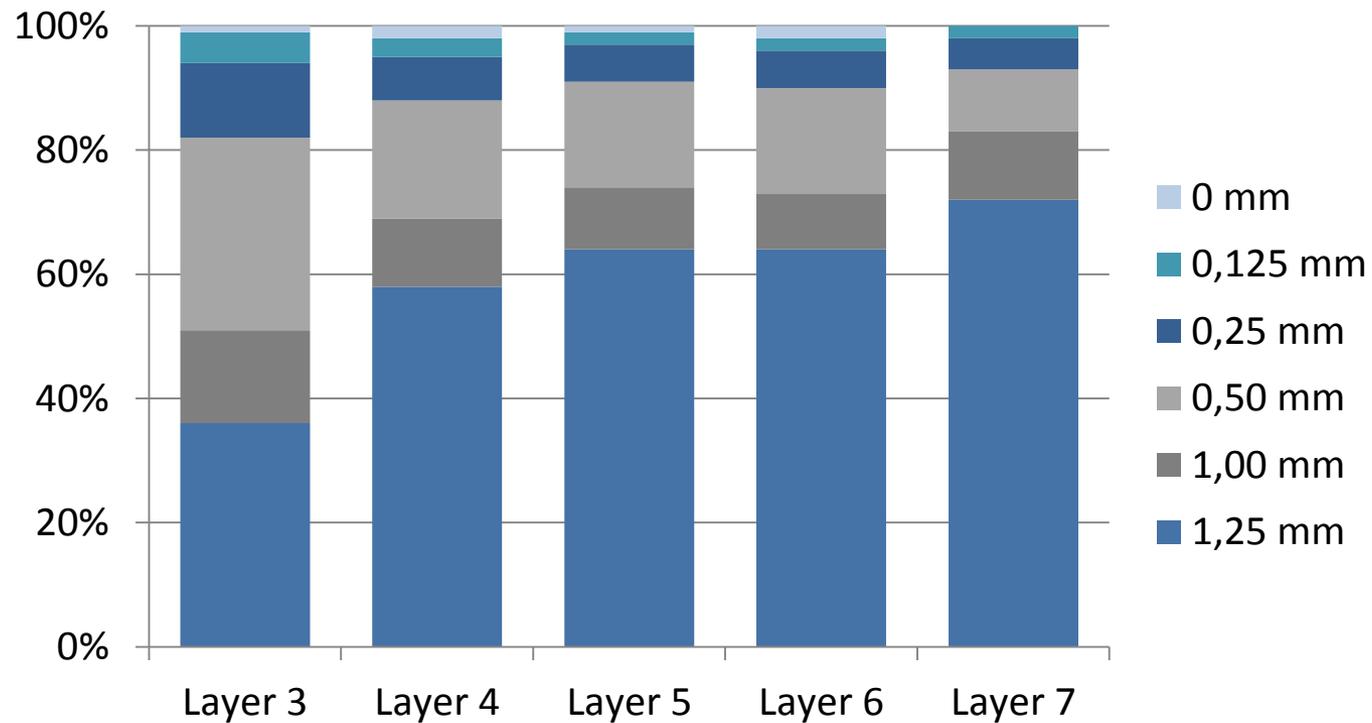
Particle Size Distribution – Fine Fraction

layers 1 & 2 are homogeneous

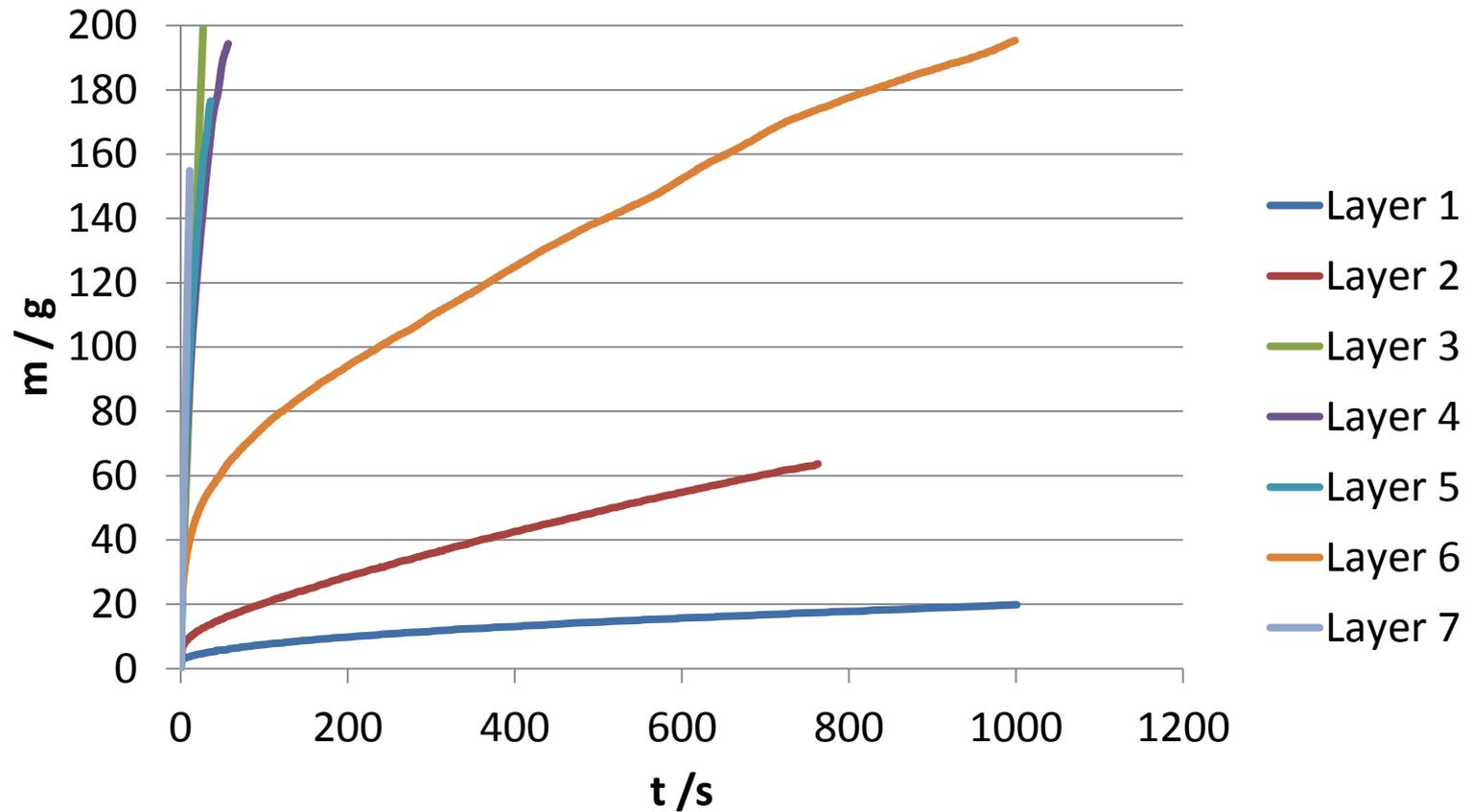


Particle Size Distribution – Coarse Fraction

layers 3 – 7: the deeper the coarser



Flow through Cake Layers – Results

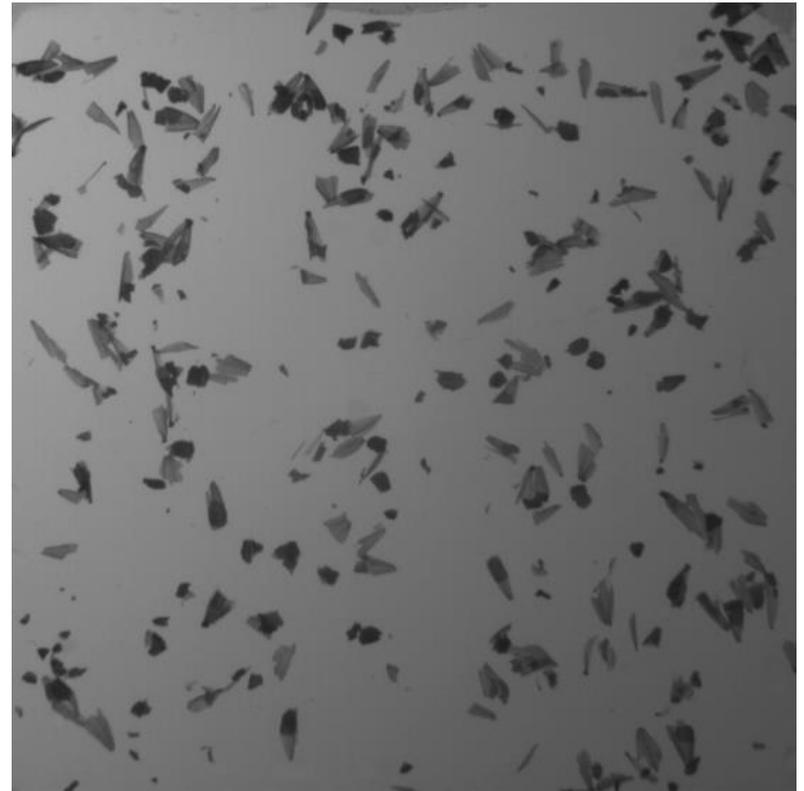
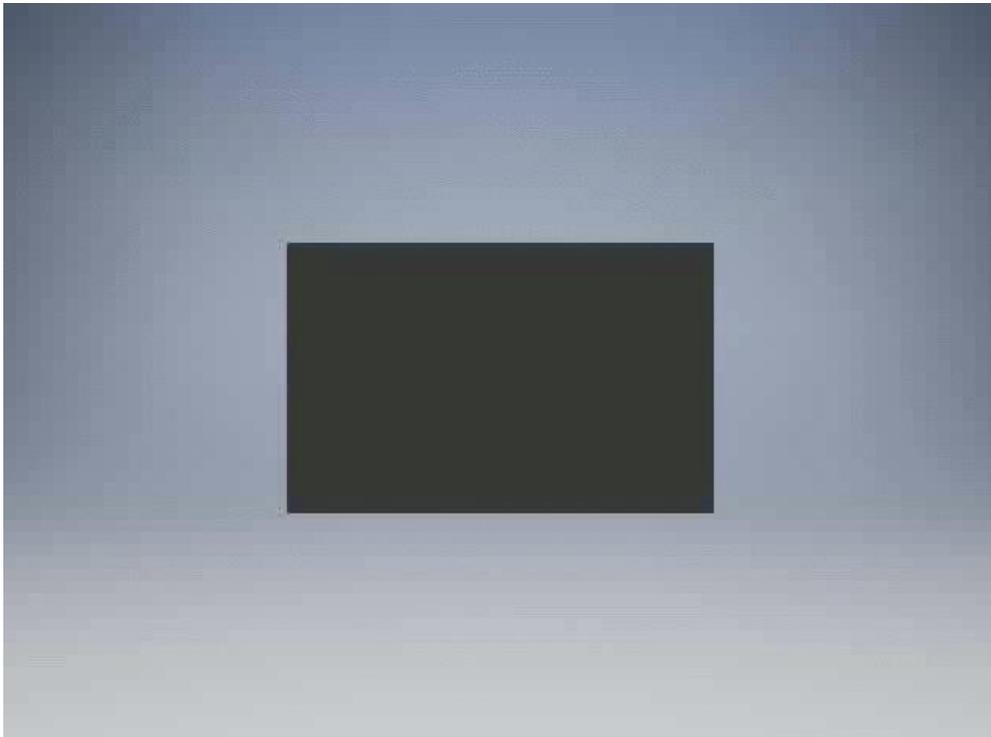


Role of Uppermost Layers



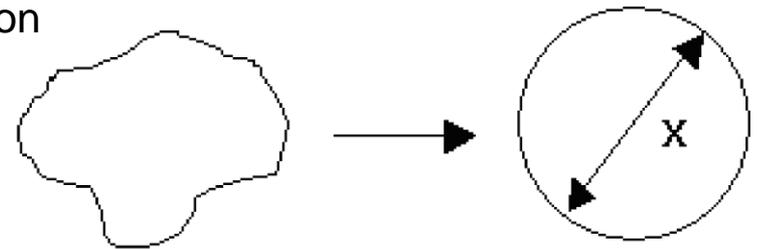
Particle Form Analysis

- Dynamic image analysis
- Static image analysis to eliminate random particle orientation

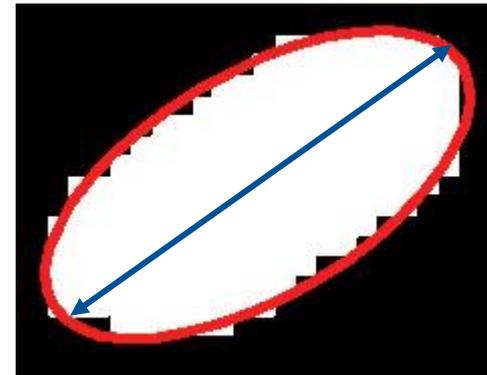


Particle Form Analysis

- Calculate EQPC as measure for size of projection area
 - Calculate Major Axis Length as measure for particle form
- Big Major Axis Length but small EQPC
= elongated fibers
- Big Major Axis Length and big EQPC
= disklike particles

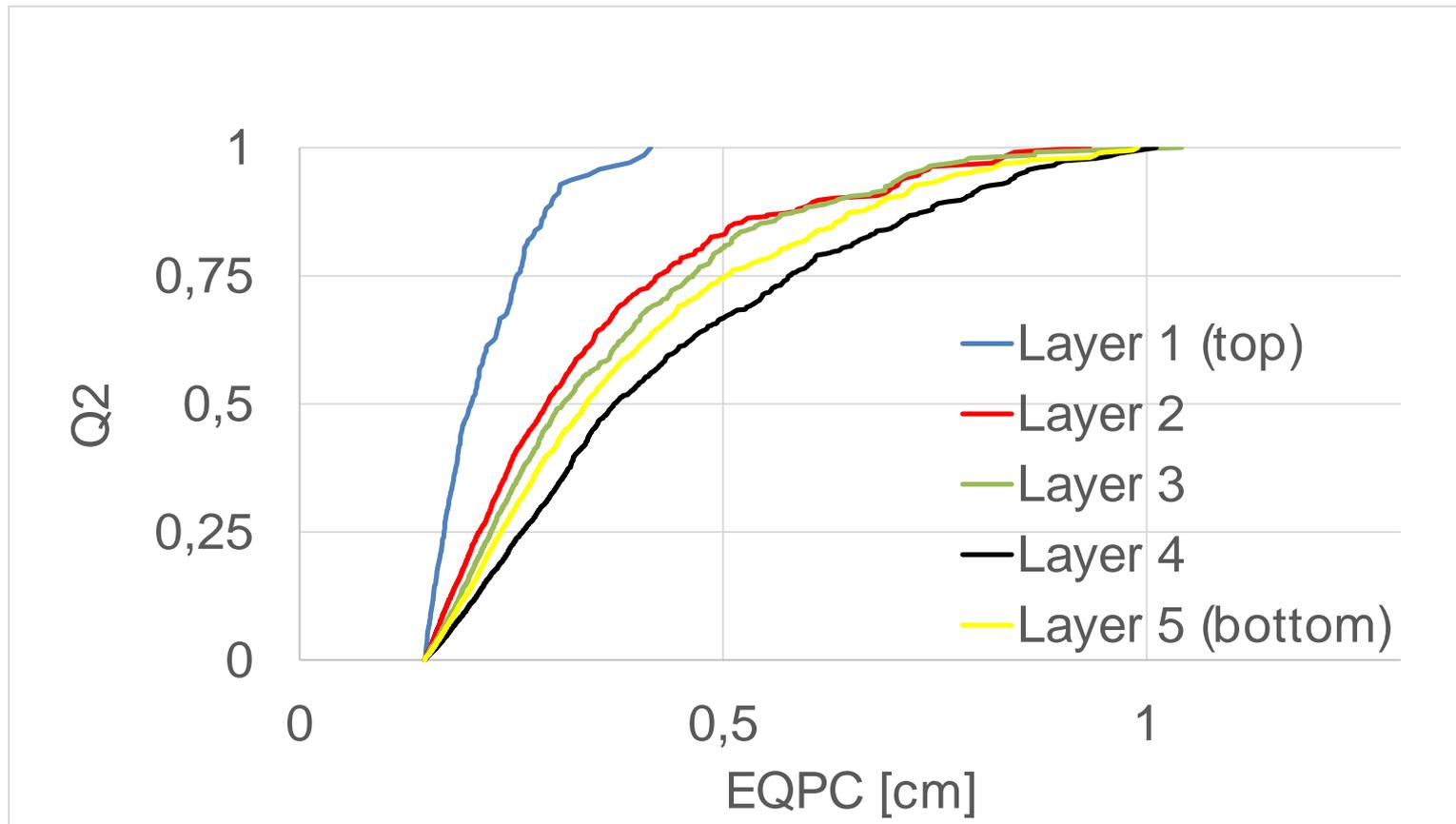


EQPC = Diameter of a circle of equal projection area

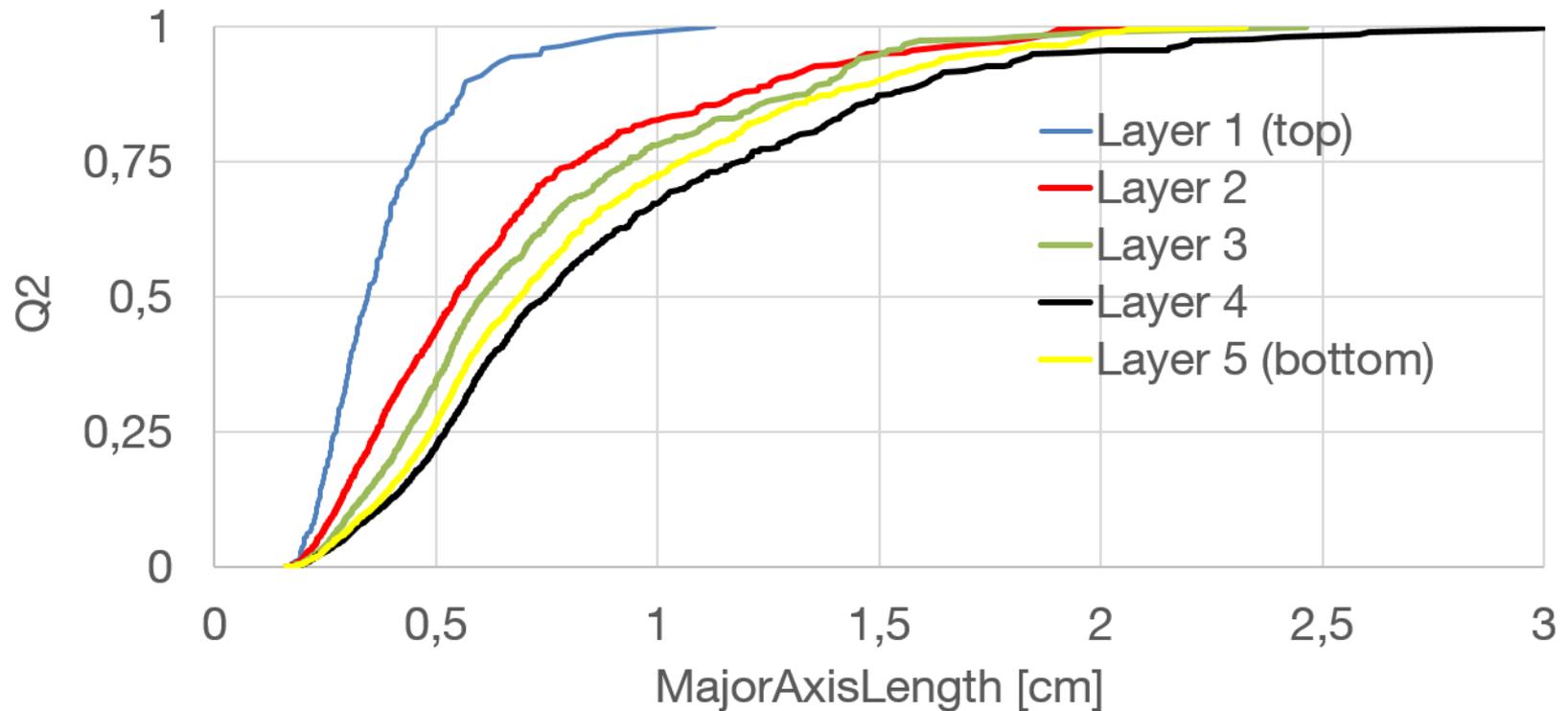


MajorAxisLength = Length of bigger axis in ellipse with same normalized second central moment

Size of Projection Area



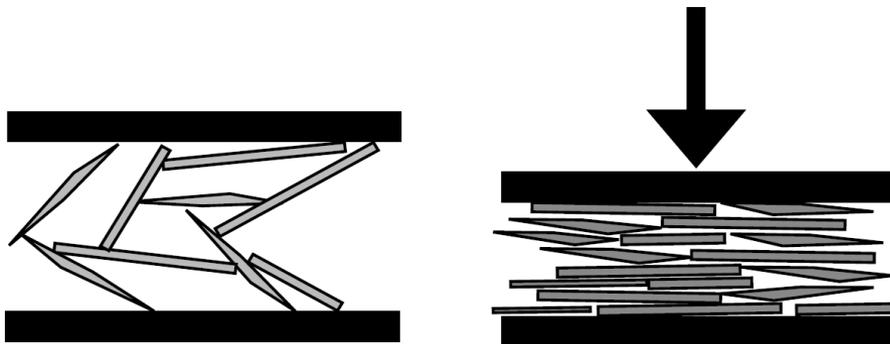
Form Factor Axis Length



Estimated Particle Form

High Major Axis Length and high EQPC:
→ Disk like particles

Blocking potential of disk like particles?
→ High compressibility



Conclusion

Blocking above false bottom because of disk like particles:

→ limiting factor for first wort run off

Fine and jellylike top layer:

→ limiting factor during sparging

Counteraction?

→ Homogenization of the filter cake (raking)

→ Equal distribution of all particles over the whole cake

→ Axial mixing is more important than loosening of the cake