

Demonstration of creep during filtration

Christensen, Morten Lykkegaard; Bugge, Thomas Vistisen; Kirchheiner, Anders Løvenbalk; Keiding, Kristian

Publication date:
2007

Document Version
Early version, also known as pre-print

[Link to publication from Aalborg University](#)

Citation for published version (APA):

Christensen, M. L., Bugge, T. V., Kirchheiner, A. L., & Keiding, K. (2007). *Demonstration of creep during filtration*. Poster presented at European Congress of Chemical Engineering, København, Denmark.

General rights

Copyright and moral rights for the publications made accessible in the public portal are retained by the authors and/or other copyright owners and it is a condition of accessing publications that users recognise and abide by the legal requirements associated with these rights.

- Users may download and print one copy of any publication from the public portal for the purpose of private study or research.
- You may not further distribute the material or use it for any profit-making activity or commercial gain
- You may freely distribute the URL identifying the publication in the public portal -

Take down policy

If you believe that this document breaches copyright please contact us at vbn@aub.aau.dk providing details, and we will remove access to the work immediately and investigate your claim.



Demonstration of creep during filtration



Morten L. Christensen, Thomas V. Bugge, Anders L. Kirchheiner and Kristian Keiding

Department of Biotechnology, Chemistry and Environmental Engineering, Aalborg University, Denmark

Deformation of particles and particle structure is not an instant process as is assumed in current filtration models – if it takes time. This time dependent stress relation is called CREEP. As the specific filter-cake resistance (α) is a function of the compressibility α will be time dependent if the system exhibit creep.

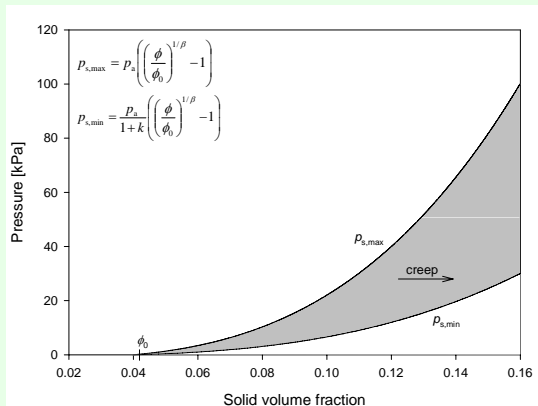


Figure 1: Development of solid pressure.

$p_{s,max}$ denotes the solid pressure of uncompressed particles whereas $p_{s,min}$ denotes the solid pressure of instantly compressed particles. Creep may be understood as the time dependent transition from $p_{s,max}$ to $p_{s,min}$.
Input data $\phi_0 = 0.04$, $p_s = 400$ Pa, $\beta = 0.32$ and $k = 2.336$

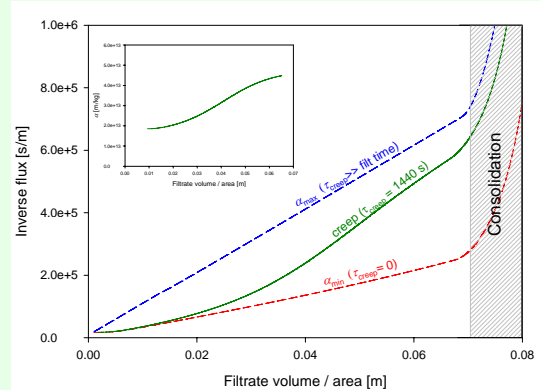


Figure 2: Ruths plot of a) uncompressed particles (in red), b) compressed particles, and c) a system which exhibits creep i.e. with a relaxation time comparable to the filtration time. The inserts shows Numerical simulation of cake filtration at 1 bar.

Input data $\phi_0 = 0.006$, $\alpha = 2.56 \cdot 10^{12}$ m/kg, $n = 1.6$, and data from Fig. 1.

Creep has been adopted in conventional filtration model by introducing a excess pressure defined in Eq. (1) as well as a time constant (τ_{creep}) and creep constant (k). Further existing constitutive equation has been slightly modified Eq. (2).

$$\text{Eq. (1)} \quad \frac{dp_{excess}}{dt} = k \frac{dp_s}{dt} - \frac{p_{excess}}{\tau}$$

$$\text{Eq. (2)} \quad \left(\frac{1-\epsilon}{1-\epsilon_0} \right)^{1/\beta} = \left(\frac{\alpha}{\alpha_0} \right)^{1/n} = 1 + \frac{p_s - p_{excess}}{p_a}$$

The creep phenomena is primarily expected when deformable organic slurries are filtered. As the creep phenomena is time dependent, the manifestation of creep will depend on the filtration time, subsequently the mass load of the filter.

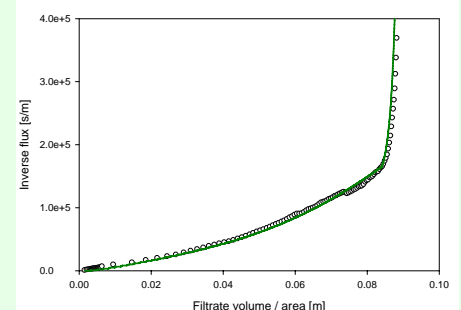


Figure 3: Filtration data of 6 g/L activated sludge (circles) at 1 bar along with the fitted line, based on a numerical model in which creep is accounted for (green line).

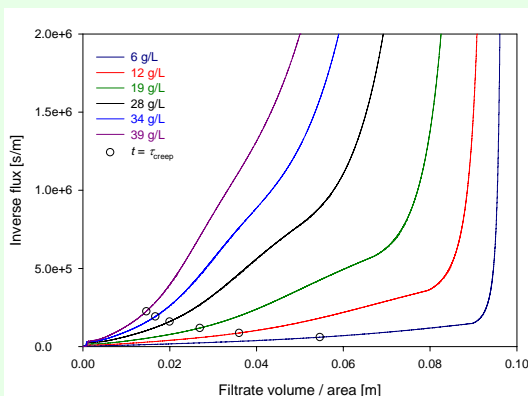


Figure 4: Ruths of model filtration with varying solid concentrations (Data corresponding to the creep relaxation, τ_{creep}). As the solid concentration increase, less filtrate is produced in a given time, and hence the transition from a lower resistance to a higher resistance occurred at lower filtrate volumes.

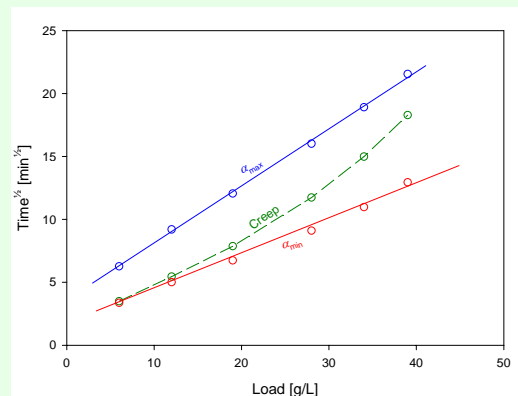


Figure 5: Crucial to the scaling of the filtration process is the relation between the time it takes to produce a given filtrate volume (t_v) and the mass load of the filtrate (m_L) i.e. $t_v \propto m_L^2$ or $t_v^{1/2} \propto m_L$. In the figure is shown t_v (at 0.04 m³ of filtrate per area, m²), m_L relationship for uncompressed particles (red line) and compressed particles (blue line). Both of these exhibits the expected $t_v^{1/2} \propto m_L$ relationship. For the system that exhibits creep is seen that the t_v, m_L - relationship does not hold.