# Determination of cake compression and swelling by analytical centrifugation

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Recently, it has been shown, that cakes formed by sludge on membranes in membrane bioreactors are compressible. This significantly reduces filtration performance as compression accelerates at constant flux operation, where pressure is gradually increased to compensate for the increasing resistance [1]. However, it is not known to which extent compressed cakes swell as pressure is released, e.g. during relaxation in membrane filtration. Cake swelling can explain the reduction of filtration resistance by relaxation, whereas lack of swelling can explain the irreversibility of fouling. To further understand the role of cake compression and swelling on filtration properties, it is relevant to investigate the degree of swelling of cakes and how this depends of the cakes physical chemical characteristics.

Previous studies have shown that analytical centrifugation can be applied to assess cake compressibility [2,3]. In this study, this methodology was further developed to characterize the compressibility and the swelling of cakes after compression. Analytical centrifugation was used to monitor cake height at different compressive pressures by varying suspensions solid concentration and rotation speed. Each sample was centrifuged at a low (reference) rotation speed to form a cake, a higher compressive rotation speed to compress the cake, followed by centrifugation at the reference rotation speed again to swell the cake.

The results confirmed that inorganic colloids (anatase) had a low compressibility and sludge cakes a high compressibility. After compression, the sludge cakes swelled 50-80 % back to their original thickness, hence, there was a high degree of reversibility of compression. A high degree of compressibility and swelling was also observed for synthetic particles consisting of a polystyrene core and a thick, hydrated polyacrylic acid shell, in contrast to particles with a thin hydrated shell. This indicates that the hydrated shell is important for compression and swelling. The compressibility of cakes consisting of pure culture microorganisms (*Pseudomonas*) was studied as well, but no equilibrium cake height was reached within 100 min i.e. the compression was slow compared to other type of materials. In general, the reversibility of compression was inversely proportional to the height of the cake layer. Thus, thin cakes were more easily hydrated after releasing compressive pressure than thick cakes. Further, it was found that the rate of compression was inversely proportional to the cake height in accordance with the consolidation theory.

**References:**

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