516b Separation of (Sub-)Micron Bioparticles by Selective Flotation

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Introduction Many biotechnological processes yield particle mixtures, such as products crystals and inclusion bodies with associated cells or cell debris. Particle-particle separation in biotechnology is mainly performed with centrifugation and filtration, which are ineffective when applied to the separation of small bioparticles with overlapping size and density distributions. An alternative to particle-particle separation is dissolution of one of the particle types followed by selective extraction. However, the solid product often contains the desired compound at high purity, giving direct isolation an advantage over the indirect separation by extraction. Selective flotation is a method that can be applied for particle-particle separation. It is currently used for the selective separation and concentration of particles, fibers and molecules, mainly in the mineral and paper industry. Flotation is based on the ability of particles in an suspension to attach to gas bubbles, which carry them up in the liquid phase due to buoyancy. If particle-bubble attachment is selective toward a specific class of particles, enrichment of these particles takes place at the top of the flotation device.

Research Particle-particle separation with flotation requires differences in flotation efficiency for the particles that need to be separated. In a previous study we showed that polyhydroxyalkanoate inclusion bodies can be recovered selectively from enzyme-treated fermentation broth, a suspension that contains inclusion bodies and cell debris particles, by dissolved-air flotation [1]. The selectivity of this flotation process was mainly caused by simultaneous selective aggregation of the inclusion bodies, which increased their flotation efficiency relative to that of the cell debris particles. These results show that selective aggregation is one of the key factors in separation of micrometer-sized bioparticles by selective flotation. The aggregation process depends on particle-particle interactions. Most bioparticles have rough and heterogeneous surfaces. The interactions between these particles therefore depend on the DLVO forces as well as the hydrophobic and steric interactions. In this work, we investigate the influence of the surface properties of bioparticles on their aggregation and flotation behaviour. For this purpose a model system was created that consists of 1 mm polystyrene particles that are coated with proteins (BSA, lysozyme and casein). The surface properties of these particles were determined with electrophoretic mobility measurements and contact angle measurements. Their aggregation behaviour could be predicted from their surface properties by taking into account the DLVO forces and hydrophobic and steric interactions. A window of operation was constructed for the separation of particles from a binary particle mixture. This window of operation was validated with aggregation and flotation experiments.

[1] Van Hee P, et al. 2004. Journal of Biotechnology and Bioengineering 88(1): 100-110. [2] Okada K, et al. 1990. The Canadian Journal of Chemical Engineering 68: 393-399.