392c Steps in Development of a Counter-Current Centrifugal Separator for Use in Downstream Processing

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Sustainable manufacturing of chemical products will play an important role in the future. More and more chemicals will be produced from renewable resources employing biotechnology. The success of such production will depend not only on the upstream but also on engineering solutions in the downstream processes in which separation and purification have a crucial role. Therefore, the development of a range of novel selective separation methods, tailored for specific applications will be required. Among this new developments are to be novel mechanical systems for selective separation of mixtures solids in liquids [1]. Many biotechnological products are bioparticles: precipitates, crystals, aggregates, cell/organelle fragments. The production of these particles is performed in media which contain also other suspended materials such as insoluble by-products, whole cells and cell debris. Currently, there is no commercially available full-scale mechanical technique for the controlled selective separation of micron-size bioparticles from such mixtures. One of the possible directions in the quest for an efficient mechanical method are further developments in the field of centrifugation. A hybrid centrifugal device, which utilizes a combination of centrifugal forces and counter-current liquid flow, can be applied. Such a device was first developed by Colon for analytical purposes [2]. Devices of various designs and employing the same principle have been successfully applied for classification of mineral particles [3, 4] and starch grains [5]. Counter-current centrifugal devices enable not only classification but also contacting of adsorbent material with a liquid phase [6] and washing of solids and their controlled concentration [7]. All these applications can in the future find a place in a biotechnological production as an efficient substitution for classical centrifugal and other techniques. Our work presents steps in the development of a centrifugal counter-current separator for bioseparation processes and also analyses other possible fields of use. First step in the development was a simple lab-scale device, constructed to study basic principles of centrifugal counter-current separators with model suspensions. Second, a new device, working at higher rotational speed was built and separation with different systems is studied. For better understanding of the complex hydrodynamics in counter-current centrifugal separators, computational fluid dynamics was used as a tool. Characteristics of a flow field inside separation chambers of different geometries were investigated and we were able to compute fluid and solids flow patterns and to reveal mechanisms of separation.

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