Process Characterization of Additively Manufactured Stirrer Geometries for bioprocessing of non-Newtonian media

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Conventional methods of blended textiles waste recycling present significant challenges. An alternative strategy involves the biocatalytic separation of waste components through enzymatic hydrolysis of the cellulose fraction. This approach enables the recovery of a processable polyester product and the generation of a glucose-rich solution as a valuable secondary output. Particles in buffer solutions have complex flow behavior which makes it essential to use substrate specific, optimized stirrer geometries to maximize the mixing efficiency. The influencing variables are divided into material-specific (particle size, weight-specific surface area, chemical composition, etc.) and process-specific (stirrer speed, stirrer geometry, stirring strategy, reactor geometry, etc.). Material-specific factors have been previously investigated, which is why this study focused on the process-specific influencing variables, taking mixing efficiency over energy consumption into account.

In this study, various stirrer geometries were manufactured by FFF and characterized for their mixing efficiency. The data was recorded by measuring the motors current and voltage, the torque/speed curve and a computer assisted imaging analysis of mixing. Each geometry was evaluated at varying impeller speeds (20–180 rpm) and solid content (1-3 wt.%) at constant fluid volume of 1.5 liters to assess torque behavior and energy input. The global mixing time was evaluated at 3 wt.% and 180 rpm.