

COHORIS

Continuous enzymatic hydrolysis in oscillatory flow rheology as process intensification strategy for biorefineries

Programm / Ausschreibung	FORPA, Forschungspartnerschaften NATS/Ö-Fonds, FORPA OEF2020	Status	laufend
Projektstart	01.10.2021	Projektende	30.09.2024
Zeitraum	2021 - 2024	Projektlaufzeit	36 Monate
Keywords	Oscillatory Flow Bioreactor, energy- and ressource efficiency, process intensification, biorefinery		

Projektbeschreibung

Despite intensive research activities in biorefineries on sustainable biomass conversion to value-added products, key steps such as hydrolysis, remain bottlenecks in technical and economic efficiency and require radical intensification.

Typically, the hydrolysis step is processed in stirred tank reactors (STRs), however the process economics are limited by challenges such as the energy intense and insufficient mixing with unstructured heat and mass transfer, and as a result restricted biomass loading. Furthermore, the slow reaction kinetics require long residence times. Building on previous research results with significant increase in turnover of enzymatic hydrolysis in OFB, COHORIS will investigate in detail the possible procedural modes of operation for a continuous process, as well as the potential reduction of energy intensity and improved hydrolysis kinetics (effect of turbulent flow on enzyme-substrate binding, product inhibition mitigation). The OFB will be evaluated in detail on cellulose hydrolysis and transferred to protein hydrolysis applications. The process intensification potential is calculated and presented for 3 significant applications in biorefineries. This PhD proposal aims achieve detailed understanding on the following research hypotheses:

Hypothesis 1:

Continuous enzymatic hydrolysis of slurries with high solid loading is possible in OFB due to the ability to decouple local flow velocity and residence time

Hypothesis 2:

Oscillatory flow bioreactors can lead to a reduced energy intensity of the overall process, due to optimized mixing operation with oscillations on the medium and continuous operation mode.

Hypothesis 3:

Swirl flow rheology in oscillatory baffled reactors enhances hydrolysis kinetics (optimized enzyme-substrate binding / reduced product inhibition due to local turbulences)

COHORIS shall result in a comprehensive understanding of the (positive) rheological effects and its correlation on the

enzymatic mechanisms, such as on enzyme-substrate binding or product inhibition throughout the course of enzymatic conversion. On engineering level optimal oscillatory operating windows will be determined for enabling continuous mode processes at ideal mixing patterns and thus minimal energy requirement. The deep process understanding shall be based on cellulose hydrolysis and further investigated on applications such as protein hydrolysis in order to achieve a scale-able and reliable technology design for intensification of a variety of biorefining operations.

Projektpartner

- AEE - Institut für Nachhaltige Technologien (kurz: AEE INTEC)