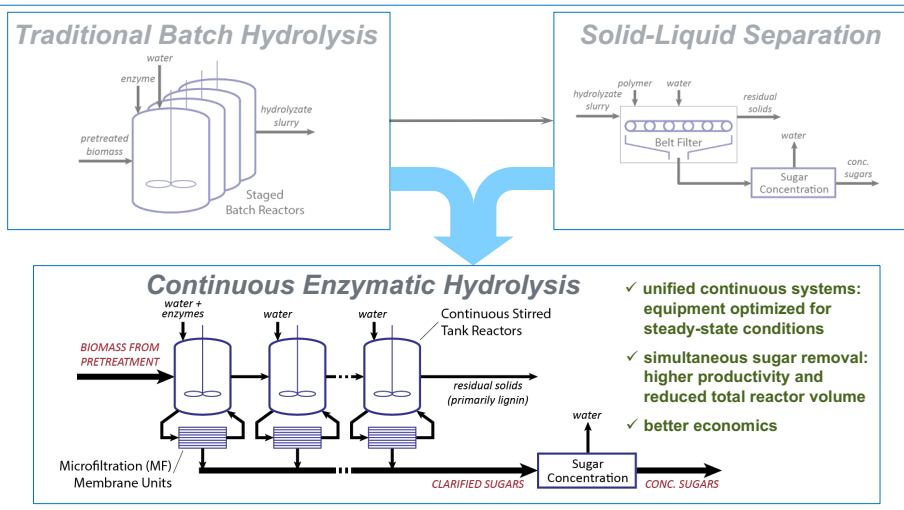


Process Intensification and Scale-up of a Continuous Enzymatic Hydrolysis and Separation Process

David A. Sievers, James J. Lischeske, and James D. McMillan
Catalytic Carbon Transformation & Scale-Up Center

Process Intensification for Better Performance



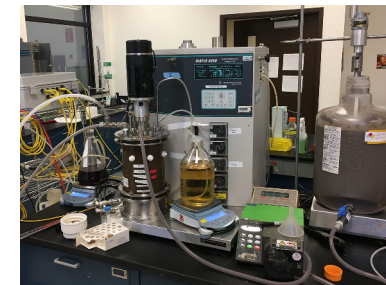
Key Parameters

SOLIDS LOADING	
	INSOLUBLE SOLIDS LOADING
reactor vessel design	size & assc. costs (5% IS) standard vertical horiz. paddle blend.
pumping & agitation	power & assc. costs
membrane performance	permeate flux rate size & assc. costs
produced sugars	additional concentration costs

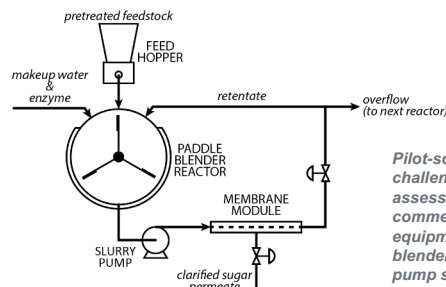
MEMBRANE PUMPING RATE	
	RECIRCULATION VELOCITY
	pump power & assc. costs
	permeate flux rate
	membrane size & assc. costs

PRETREATMENT TYPE	
flowability	● dilute-acid thermochemical
	● deacetylated & mechanically refined
	● enzyme digestibility

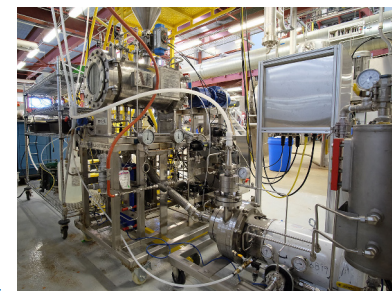
Bench-Scale to Pilot-Scale



bench-scale experiments* proved concept and informed process pains: vertical stirred-tank reactor limited to low insoluble solids loading (<5% IS), poor feeding and pumping performance and low flux.



Pilot-scale setup*: technical challenges addressed while also assessing performance of commercially-available equipment. Horizontal paddle blender and DiscFlo slurry pump successfully used up to 12% IS.



*Experimental setups operated as single first stage of n-stage array.

Successful scale-up is demonstrated and key parameters have been explored with challenges identified. Future work aims at global optimization of processing costs and greenhouse gas emissions using experimental data and Virtual Engineering modeling of each subsystem's integrated performance.