



Technological challenges in scaling up

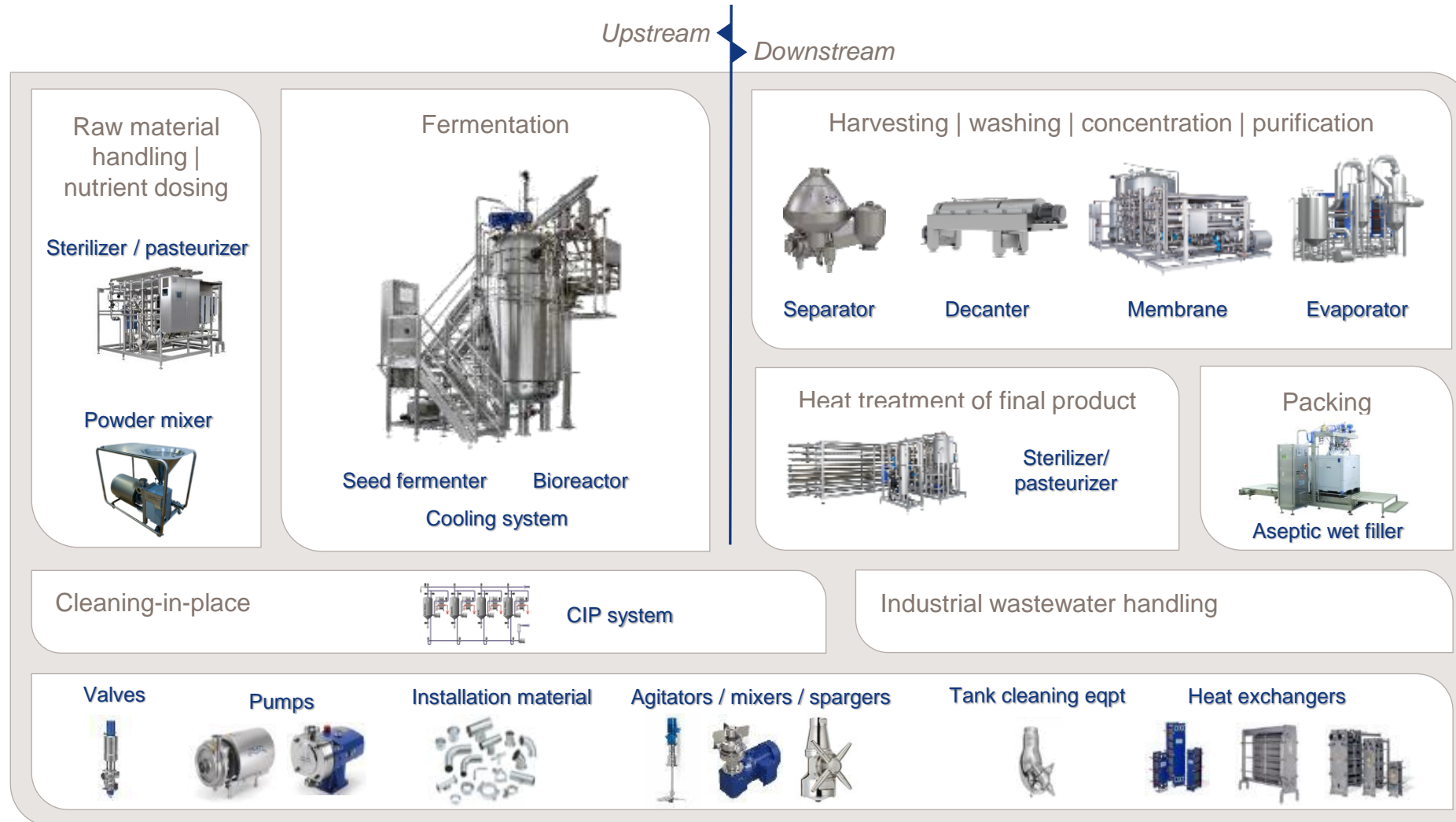
– Biomass fermentation

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Our portfolio for the fermentation industry



Alfa Laval approach to fermentation scaleup



MANUFACTURER

- Final product specifications & quality criteria
- Fermentation parameters & pilot process description
- Raw materials
- Targeted capacity and production costs

COLLABORATION



ALFA LAVAL

- Pre-identification of main scaleup challenges
- Discussion about best-suited technologies & components
- **Validation trials (own test facilities or customer site)**
- First approach to capital and operation costs

Biomass and precision fermentation scaleup



MAIN TYPES OF SCALEUP CHALLENGES

TECHNOLOGY

- FLUID PROCESSING
- HYGIENE
- SUSTAINABILITY

PROFITABILITY

- CAPITAL COSTS
- OPERATION COSTS

Technology challenges of biomass fermentation



FLUID PROCESSING

- TRANSFER
- HEATING & COOLING
- SPARGING
- AGITATION & MIXING
- SEPARATION
- PASTEURIZATION
- CONCENTRATION

HYGIENE

- CIP INSTALLATION AND PROCEDURES
- DISINFECTION
- (STERILIZATION)

SUSTAINABILITY

- WASTE, CO2 FOOTPRINT
- ENERGY OPTIMIZATION
- WATER REUSE

CHALLENGES

- MEDIA PREPARATION
- ATEX INGREDIENTS
- VISCOSITY
- PARTICLES
- HEAT TRANSFER
- O2 DIFFUSION
- FOAMING
- ...

Case story

Scaling up fermented meat substitute from lab to demo production



CUSTOMER REQUEST : SCALE UP FROM 150 L TO 1.5 M3 BATCH SIZE

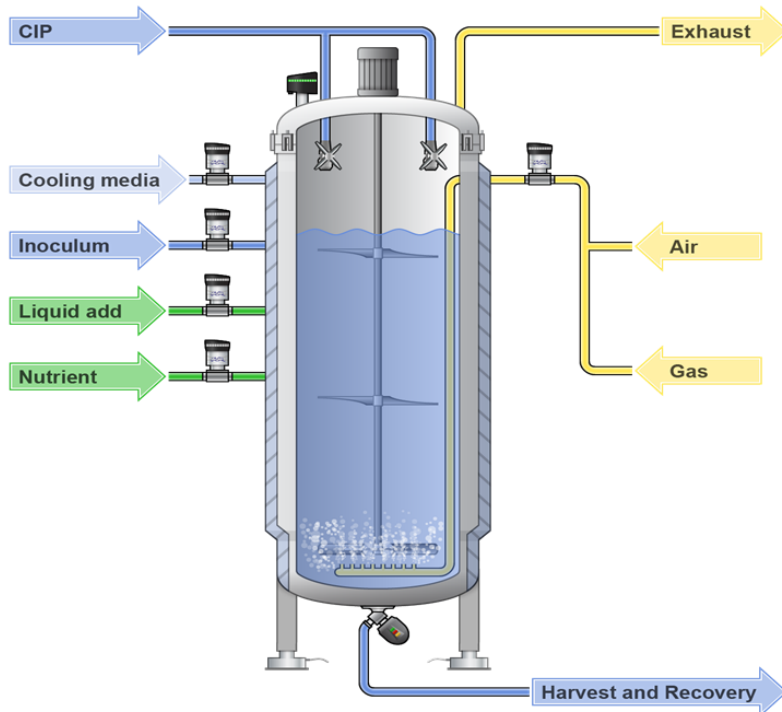


PRODUCT, PROCESS & SCALING UP IMPACT

Meat substitute final use	→ focus on production cost
Fungi strain	→ high hygiene but not aseptic
Fast growing strain	→ high O2 requirement and heat release
Foaming during fermentation	→ headspace & anti-foam
Fibrous product	→ fouling risk and CIP issues
Thick consistency at end of fermentation	→ high viscosity during transfer and mixing issues
High solid load 15-20%	→ preferred centrifuge separation

Case story

From closed tank to external loop design



Static multi-purpose
pilot closed fermenter

PILOT REACTOR FEATURES

- External cap / heating & cooling
- Mechanical agitation
- Bottom static sparging with Rushton high-shear mixer

SCALING UP IMPACT

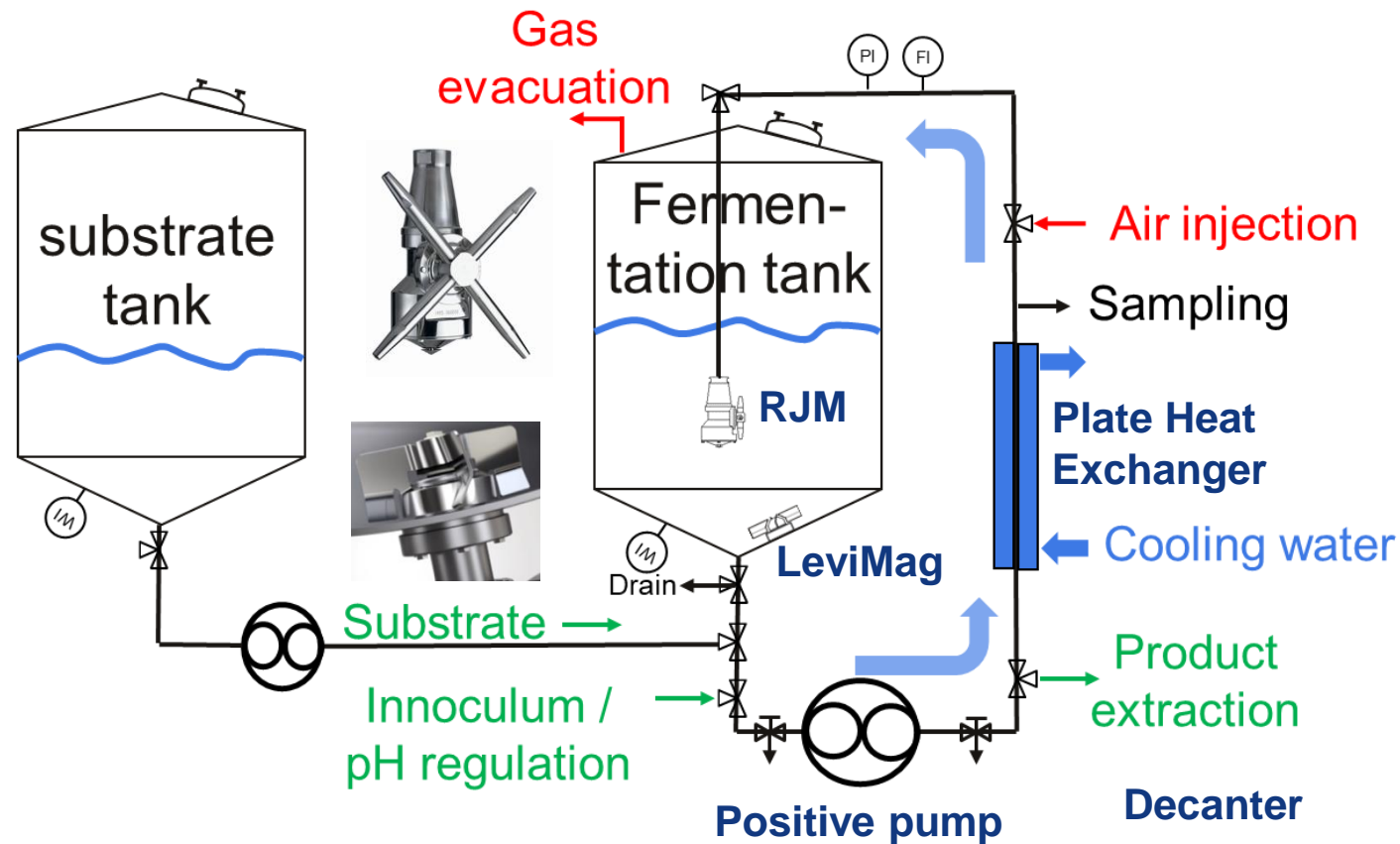
- Low heat-exchange efficiency
- Reduced effect for high viscosity at end of fermentation
- High power needed
- High heat dispersion and frigorific use for cooling

Case story

From closed tank to external loop design



ALFA LAVAL PROPOSAL : RETROFIT TANK WITH EXTERNAL LOOP



Case story

Solving scaling up challenges



ACTION	BENEFITS
Retrofit of brewery process tank	Reduce capital cost with food-grade components and sanitation procedure
RJM & LeviMag	Low-energy alternative to high-shear mixer / sparger
Positive pump for circulation loop	Low energy, not affected by rising viscosity or particles
Plate Heat exchanger	Low investment, high energy efficiency
Decanter	High capacity, low energy, high recovery yield

Case story

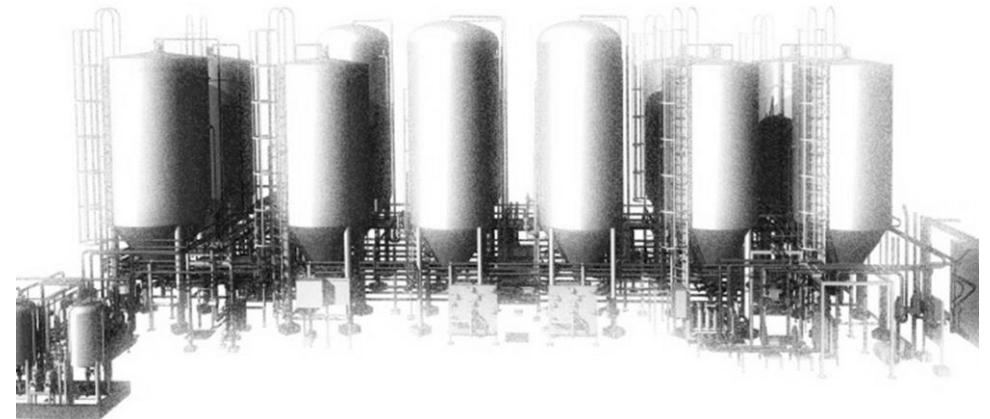
Next scaling up focus issues



**FOAMING
CONTROL**



**OPTIMIZE COMPONENTS
SELECTION**



**SCALING UP TO PRODUCTION
CAPACITY**

Every microorganism and product is different



NEW PROJECT = NEW CHALLENGES ! TRIALS ARE THE KEY TO SCALING UP

