

LABOR, TECHNIKUM & AUFTAGSFORSCHUNG

LABORATORY, PILOT PLANT & CONTRACT SERVICES



Heinrich Frings GmbH & Co. KG

LABORDIENSTLEISTUNGEN

LABORATORY SERVICES

1. Routine analyses
2. Raw material treatment
3. Test fermentation
4. Nutrient development
5. Rheological analysis
6. Unit operation tests
7. Mini plant design
8. Process development
9. Sensor development
10. Calibration services



PILOTANLAGEN UND PIOTPROZESSE

PILOT PLANT AND PILOT PROCESSES



1. Fermentation Scale-up/scale-down and process development
2. Process transfer and process evaluation
3. Filtration test & process development
4. Mixing trials
5. Aeration test
6. Purification trials
7. Equipment tests



ESSIG TESTANLAGE: 7-L ACETATOR POOL

VINEGAR TEST PLANT: 7-L ACETATOR ARRAY



Laboratory ACETATORS for small-scale vinegar production

- Repeated batch vinegar-fermentation
- Repeated fed-batch vinegar fermentation
- Continuous vinegar fermentation
- Vinegar production raw material testing
- Process development
- Evolutionary screening
- Working volume: 5-7 L
- Material: 1.4404/PVC Food
- Aeration/agitation: Frings rotor/stator turbine, up to 0.2 vvm
- Aeration efficiency: 90 % O₂ consumption in vinegar fermentation
- Temperature control: internal coil
- Foam handling: Foam Disc
- Sensors: EtOH, T, L, ..

ESSIG-PILOTANLAGE

VINEGAR FERMENTATION PILOT PLANT



200-L ACETATOR pilot plant according to industrial standards

- Repeated-batch vinegar fermentation
- Repeated fed-batch vinegar fermentation
- Continuous vinegar fermentation
- Sequential Kombucha fermentation
- Bacterial gluconic acid fermentation
- Production of fermented softdrinks
- Starter culture production
- Material: 1.4404/PVC Food, ATEX certified-Feed
- Aeration/Agitation: Frings rotor/stator turbine, up to 0.2 vvm
- Temperature control: internal coil
- Foam handling: foam centrifuge
- Sensors: EtOH, T, L,..

ROUTINEANALYTIK

ROUTINE ANALYTICS



Laboratory section for analytics

- Measuring component concentration
- Determining optical properties
- Analyzing rheological parameters
- Sample preparation for external analysis
- Unit operation trials (Mixing, separation, filtration, precipitation,..)

- NIR Spectroscopy
- UV/VIS spectroscopy
- Density (flexural vibration)
- Viscosimetry with Couette viscosimeter
- Refractometry
- Enzyme kit application lab
- Wet chemistry analyses
- Destillation

1500-L BIOREAKTOR

1500-L BIOREACTOR



PROREACT 75 G

Sterile Bioreactor for high-cell-density-fermentation with low-viscosity media,

- Batch fermentation
- Fed-batch fermentation
- Fermentation using mechanical defoaming
- RQ-controlled fermentation
- Gas/liquid-reaction (bio)-processes
- Gas-stripping (bio)-processes
- Working volume: 1,000 L
- Material: 1.4435 electropolished Ra < 0.4 µm
- Agitation/Aeration: Frings rotor/stator-turbine 7.5 kW
- Foam: antifoam or foam centrifuge 3 kW
- Aeration rate: up to 2 vvm
- Sensors: T, p, pH, pO₂, RQ, EtOH, MeOH, ...
- Automation: SIEMENS S7/TIA Portal

20-L BIOREAKTOR

20-L BIOREACTOR



PROREACT 5 P

Process development/seed bioreactor, sterilizable, software for advanced control

- Seed fermentation
- Batch fermentation
- Fed-batch fermentation
- Repeated-batch fermentation
- Continuous fermentation
- Recipe-based process development
- Integration of unit operations
- Working volume: 15 L
- Material: 1.4404 electropolished Ra < 0.8 µm
- Agitation/Aeration: Frings rotor/stator-turbine 1.1 kW
- foam: antifoam or foam centrifuge 250 W
- Aeration rate: up to 2 vvm
- Sensors: T, p, pH, pO₂, RQ, EtOH, MeOH, ...

20-L BIOREAKTOR

20-L BIOREACTOR



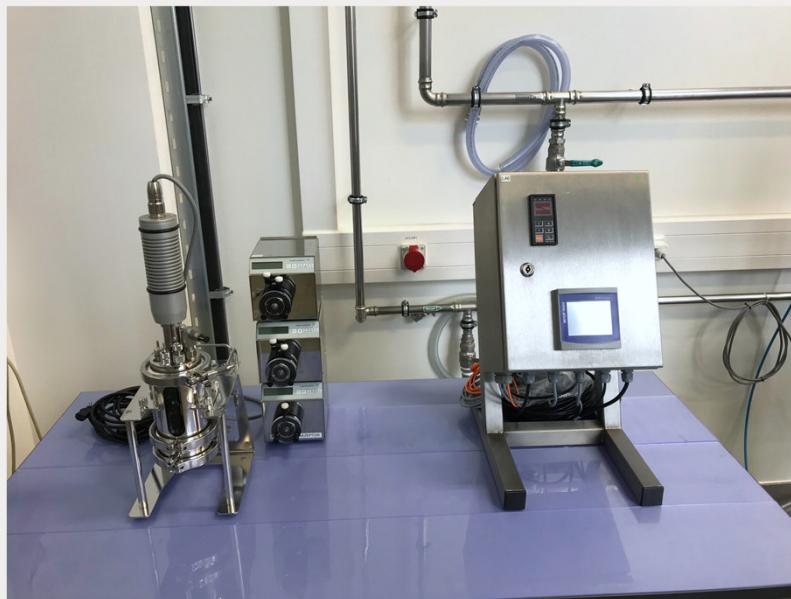
PROREACT 5 B

„Yeast Standard“ Bioreactor

- Seed fermentation
- Batch fermentation
- Fed-batch fermentation
- Working Volume: 15 L
- Material: 1.4404, $R_a < 0.8 \mu\text{m}$
- Agitation/Aeration: Frings Rotor/Stator-Turbine 1.1 kW
- Foam: antifoam or foam centrifuge 250 W
- Aeration rate: up to 2 vvm
- Sensors: T, p, pO_2 , pH, RQ, EtOH, MeOH, ...
- Automation: SIEMENS S7

0,75 L BIOREAKTOR

0.75 L BIOREACTOR



PROREACT 1 B

Small Scale Bioreactor

- Seed fermentation
- Batch fermentation trials
- Fed-batch fermentation trials
- Continuous chemostat
- Continuous pH-Stat
- Continuous EtOH-Stat
- Combination with PROREACT 5 to Multi-cellreactor for scale-up purposes
- Working volume: 500 mL
- Material: 1.4404, borosilicate glass
- Agitation: Rushton turbine 250 W
- Foam: antifoam dosing
- Aeration rate: up to 2 vvm
- Sensors: T, pO₂, pH, Foam ...
- Automation: Acetomat II/Mettler

HYGIENISCHE TF-FILTRATIONSANLAGE

HYGIENIC CROSS-FLOW FILTRATION PLANT



Liquid/Solid-Separation by Cross Flow Filtration

- Micro-filtration (MF) of biomass
- Sterile-filtration by MF
- Ultra-/nanofiltration
- System: One Loop System, one or two hollow-fiber modules
- Material: 1.4404 electropolished
- Design: Hgienic with SIP and CIP
- Circuit pump: centrifugal pump 15 kW
- Automation: SIEMENS S7/TIA Portal
- Membrane materials: polymeric, ceramic
- Membrane Surface: MF, UF, NF (e. g. 17 m² 0.2 µm PP MF)

Clearflow MF 02

TF-FILTRATIONSANLAGE

CROSS-FLOW FILTRATION PLANT



Clearflow MF C 02

Cross-Flow liquid-solid filtration

- Microfiltration
- Membranefiltration
- Contract-cleaning of hollow-fiber modules
- System: up to two hollow-fibre modules
- Material: 1.4404, brushed
- CIP-design
- Centrifugal Pump 7.5 kW
- Automation: SIEMENS Logo
- Membrane Material: polymeric
- Membrane Surface: MF, UF (e. g. 17 m² 0.2 µm PP MF)

RÖHRENZENTRIFUGE

TUBE CENTRIFUGE



Tube Centrifuge

High-speed tube centrifuge

- Continuous separation of cells from fermentation broth
- Separation of solids from liquids
- Liquid/Liquid-Separation
- Speed: up to 45,000 rpm
- Z-Value: up to 50,000g (x g)
- Throughput: e. g. 30 l/h (depending on process)

For centrifugation of larger volumes Frings can supply a centrifuge from cooperation partners

ENTSCHÄUMER-TESTANLAGE, LEIH-ENTSCHÄUMER DEFOAMER TEST EQUIPMENT, DEFOAMER RENTAL



Mini Plant Foam Separation

Foam Centrifuge FOAMEX 2 – FOAMEX 75

- Separation of liquids from gases/foams
- Test for foam stability in gravitational field
- Test for drainage in centrifugal field
- Speed: 3000/6000 1/min
- Z-Value: 400 (x g)
- Throughput: var.
- Nominal capacity: var.

Remark:

Different sizes of FOAMEX mechanical defoamers (FOAMEX of the size 2–75) are available for laboratory, pilot or at-scale test purposes

TANK FÜR RÜHR-/DURCHMISCHUNGSTESTS

STIRRER TEST TANK



Test tank for pilot scale mixing tests

- Mixing time determination in liquids and gases
- Aeration trials (Sulfite OTR determination)
- Validation of CFD-mixing models
- Material: 1.4404/PVC Transparent
- Volume: 2 m³
- Diameter: 1.2 m
- Extendable feet (for larger drive motors)
- Stirrer: on demand
- Sensors: Conductivity, pH, T, pO₂, O₂, ...

PROJEKTE (AUSWAHL)

PROJECTS (SELECTION)



Projects Biorefinery:

- Model-based continuous multistage ethanol fermentation
- Production of ethanol, gluten and CO₂ from rye
- Integrated production various products from dates

Projects Food:

- Production of vinegars from food byproduct streams
- Fermented softdrink production from various fruits
- Fractioning of high-IG colostrum by membrane processes

Projects Pharma:

- Foam separation for CHO-Fermentation
- Feeding process development for *P. pastoris* on MeOH
- Enhancing oxygen transfer rate (OTR) in GMP bioreactors

Projects Brewery:

- Yeast propagation with uninterrupted aeration
- Vacuum degassing of beer for „Beer-in-Box“ filler
- Control of dealcoholization with a membrane probe

Projects Mixing:

- Gas phase mixing for ATEX bioreactor headspace
- Liquid mixing time determination for CFD models
- Test equipment for jet sparging (in development)

Projects Filtration/Waste Water:

- Membrane selection for various liquids/solids
- MBR/SBR trials with aerated flat membranes
- Membrane purification of slop for boiler feed

Projects Chemistry:

- Oxydation of various metal-ions
- Integrated sulfite oxydation
- Crystallization and fiber loading in PCC reactors

Projects Automation:

- Fuzzy logic application in bioreactor control
- Use of differential-equation-based controllers
- Development of flow injection analyser for acetic acid