Fraunhofer
CBP

PROCESS CARD GAME

Batch Reactor N4766

Nominal volume	0.3 L
Throughput	1 to 2 batches/day
Pressure absolute	0 to 200 bar
Temperature	20 to 350 °C
Application/ Special features	heterogeneous or homogeneously catalyzed hydrogenations and oxidations

Batch Reactor BR1000

Nominal volume	1.2 L
Throughput	1 to 2 batches/day
Pressure absolute	0 to 200 bar
Temperature	20 to 300 °C
Application/ Special features	heterogeneous or homogeneously catalyzed hydrogenations and oxidations

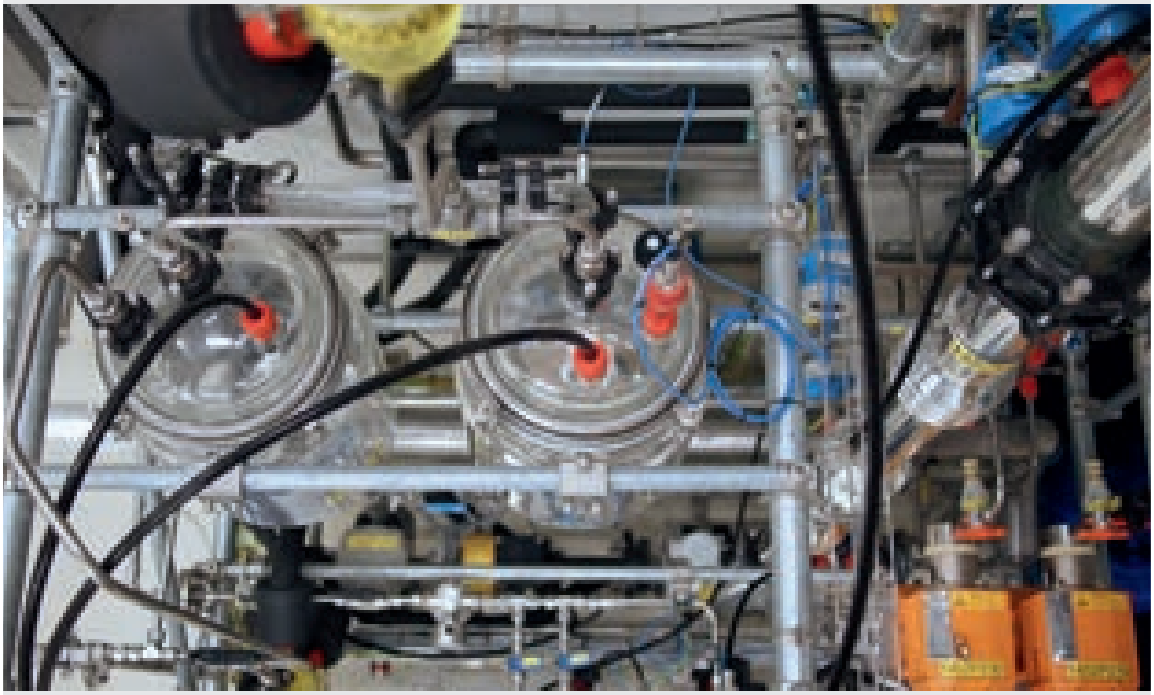
Batch Reactor 1620

Nominal volume	50 L
Throughput	1 batch/day
Pressure absolute	0 to 98 bar
Temperature	20 to 300 °C
Application/ Special features	heterogeneous or homogeneously catalyzed hydrogenations and oxidations

Reaction and Extraction Plant 1510

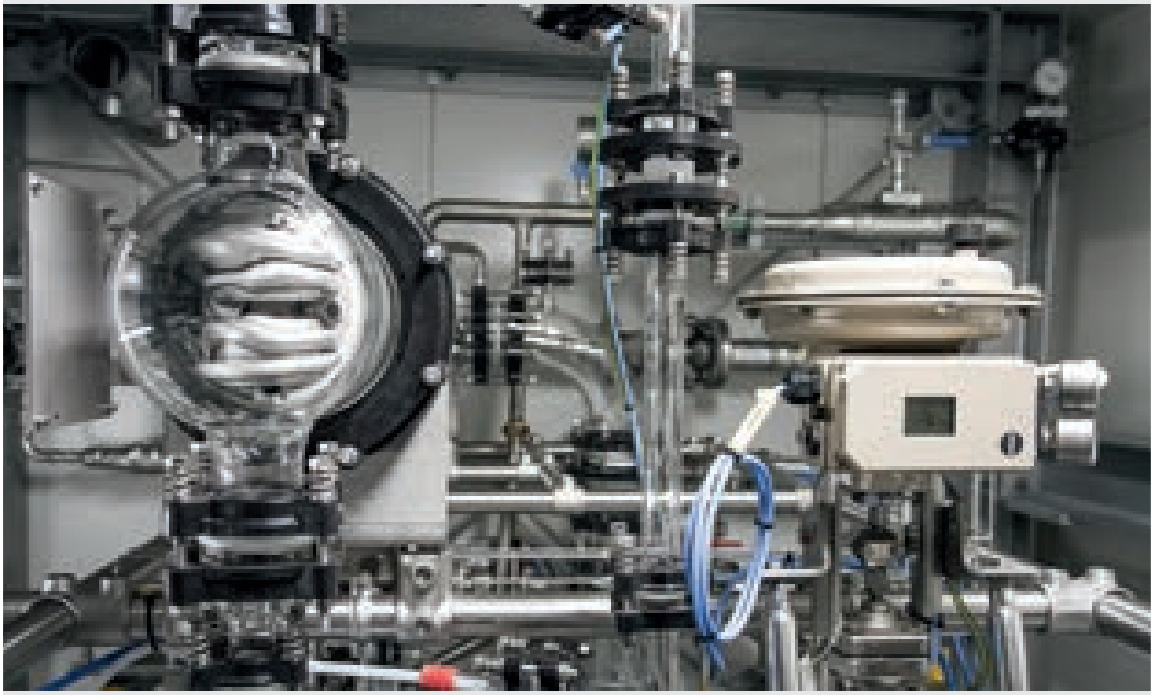
Nominal volume	100 L reactor 4 × 100 L feed & product vessels 10 L extraction column
Throughput	10 L/h distillate 20 to 80 L/h extraction
Pressure absolute	0.05 to 1 bar reaction 1 bar extraction
Temperature	-20 to 200 °C reaction 20 to 65 °C extraction
Application/ Special features	reaction and extraction with solvent recovery, liquid-liquid countercurrent extraction

Vacuum Distillation Plant 1652



Nominal volume	10 L sump 300 L feed vessel
Throughput	1 to 10 L/h
Pressure absolute	0.01 to 1 bar
Temperature	20 to 160 °C
Application/ Special features	normal or azeotropic rectification

Vacuum Distillation Plant 1250

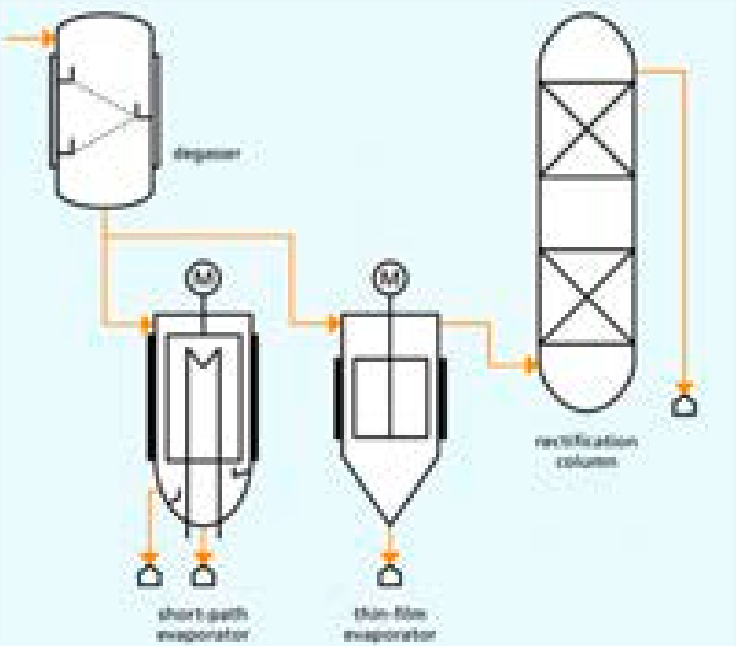


Nominal volume	1500 L feed vessel
Throughput	1 batch/day
Pressure absolute	0.2 to 1 bar
Temperature	20 to 130 °C
Application/ Special features	distillation of solvents, ATEX rated, packed column with 12 theoretical trays

Falling Film Evaporator 1280

Nominal volume	600 L feed vessel
Throughput	1 batch/day, 60 kg water/h evaporation (water)
Pressure absolute	0.2 to 1 bar
Temperature	20 to 100 °C
Application/ Special features	concentration of sugar syrup

High Temp. Vacuum Distillation 1520



Nominal volume	600 L feed vessel
Throughput	max. 50 kg/h feed rate
Pressure absolute	0.001 to 100 mbar short-path evaporation/5 to 100 mbar thin-film evaporation
Temperature	max. 300 °C short-path ev. max. 350 °C thin-film ev. max. 380 °C rectification
Application/ Special features	distillation of temperature sensitive high boiling compounds

Lab-sale Vacuum Rectification Plant

Nominal volume	2.5 L
Throughput	–
Pressure absolute	0.01 to 1 bar
Temperature	up to 270 °C
Application/ Special features	for temperature sensitive components and components with a high boiling point like oils and fats, useable for solvents

Hydrothermal Plant 1610

Nominal volume	5.7 L flow reactor
Throughput	ca. 250 NL/min fresh gas ca. 500 NL/min cycle gas
Pressure absolute	5 to 100 bar
Temperature	20 to 380 °C
Application/ Special features	heterogeneous or homogeneous catalysis of gases with cycle gas loop (e.g. MeOH synthesis), ATEX rated

Continuous High-Pressure Reactor 1640

Nominal volume	2.5 L flow reactor
Throughput	5 to 20 kg/h
Pressure absolute	50 to 300 bar
Temperature	50 to 350 °C
Application/ Special features	homogeneous catalyzed reactions of dissolved lignin or hemicelluose feeds

Fixed Bed Reactor 1210

Nominal volume	400 L
Throughput	100 to 500 kg of wood/week
Pressure absolute	1 to 37 bar
Temperature	20 to 200 °C
Application/ Special features	pulping and extraction of lignocellulosic biomass, ATEX rated

Hydrolysis Reactor 1270

Nominal volume	1000 L
Throughput	batch operation
Pressure absolute	0 to 7 bar
Temperature	20 to 100 °C
Application/ Special features	enzymatic hydrolysis or extraction of pulp, segment impeller for high solid concentrations

Bioreactor 1422

Nominal volume	75 L
Throughput	batch and fed-batch operation
Pressure absolute	1 to 3 bar
Temperature	8 to 121 °C
Application/ Special features	aerobic and anaerobic cultivation of heterotrophic microorganism (BSL1)

Fermenter Cascade 1120

Nominal volume	11,410 L (10 L | 100 L | 300 L | 1000 L | 10,000 L)
Throughput	batch, fed-batch or continuous operation
Pressure absolute	1 to 3 bar
Temperature	8 to 121 °C
Application/ Special features	aerobic and anaerobic cultivation of heterotrophic and methylotrophic microorganism (BSL1)

ATEX Fermenter 1423

Nominal volume	500 L
Throughput	batch and fed-batch operation
Pressure absolute	1 to 6 bar
Temperature	8 to 121 °C
Application/ Special features	aerobic and anaerobic cultivation of heterotrophic microorganism (BSL1), fermentation under flammable conditions, ATEX rated

Disc Stack Separator Clara 80 1443

Nominal volume	–
Throughput	0.5 m^3/h
Pressure absolute	1.5 to 3 bar
Temperature	8 to 60 °C
Application/ Special features	solid-liquid separation

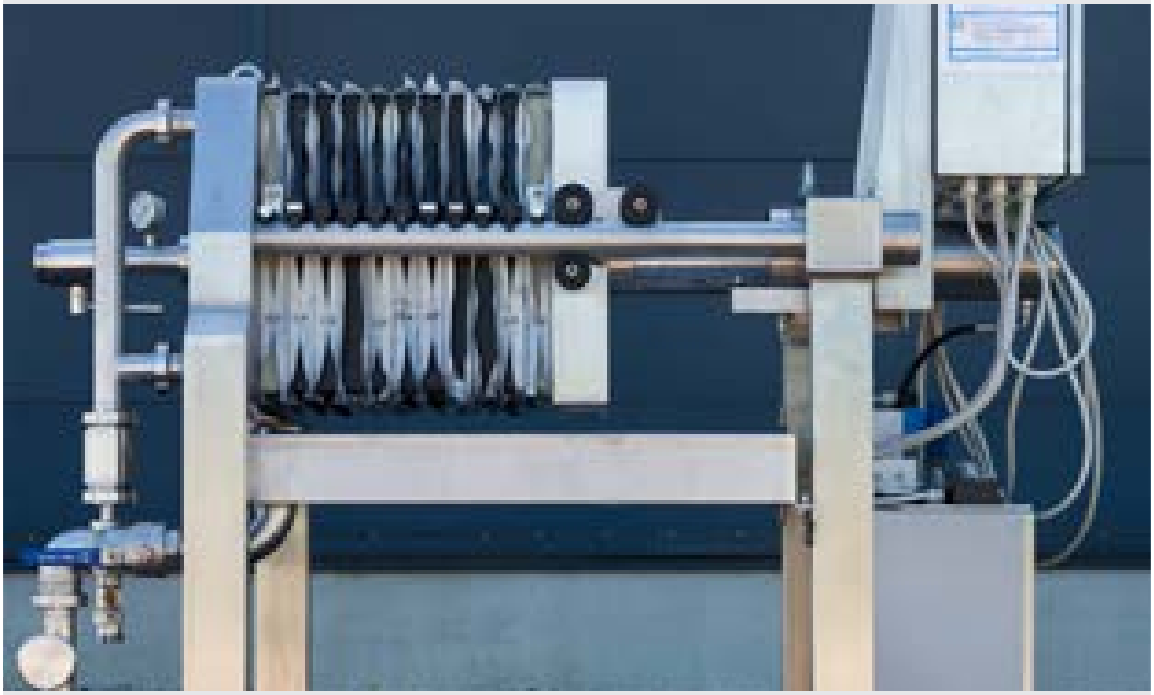
Disc Stack Separator Clara 200 1144

Nominal volume	–
Throughput	2 m^3/h
Pressure absolute	1.5 to 3 bar
Temperature	8 to 60 °C
Application/ Special features	solid-liquid separation

High-Pressure Homogenizer 1145

Nominal volume	–
Throughput	0.4 m^3/h
Pressure absolute	1 to 1000 bar
Temperature	8 to 60 °C
Application/ Special features	cell disruption

Filter Press 1441



Nominal volume	cake volume: 50 L standard filter plate
Throughput	–
Pressure absolute	1 to 11 bar
Temperature	5 to 40 °C
Application/ Special features	solid-liquid separation

Vacuum Drum Filter 1141

Nominal volume	–
Throughput	0.35 m³/h
Pressure absolute	0.24 to 1 bar
Temperature	5 to 35 °C
Application/ Special features	solid-liquid separation

Filter Press 1230

Nominal volume	cake volume: 75 L standard filter plate 42 L membrane filter plate
Throughput	–
Pressure absolute	1 to 11 bar
Temperature	5 to 40 °C
Application/ Special features	solid-liquid separation, membrane filter plates for pressing the cake, ATEX rated

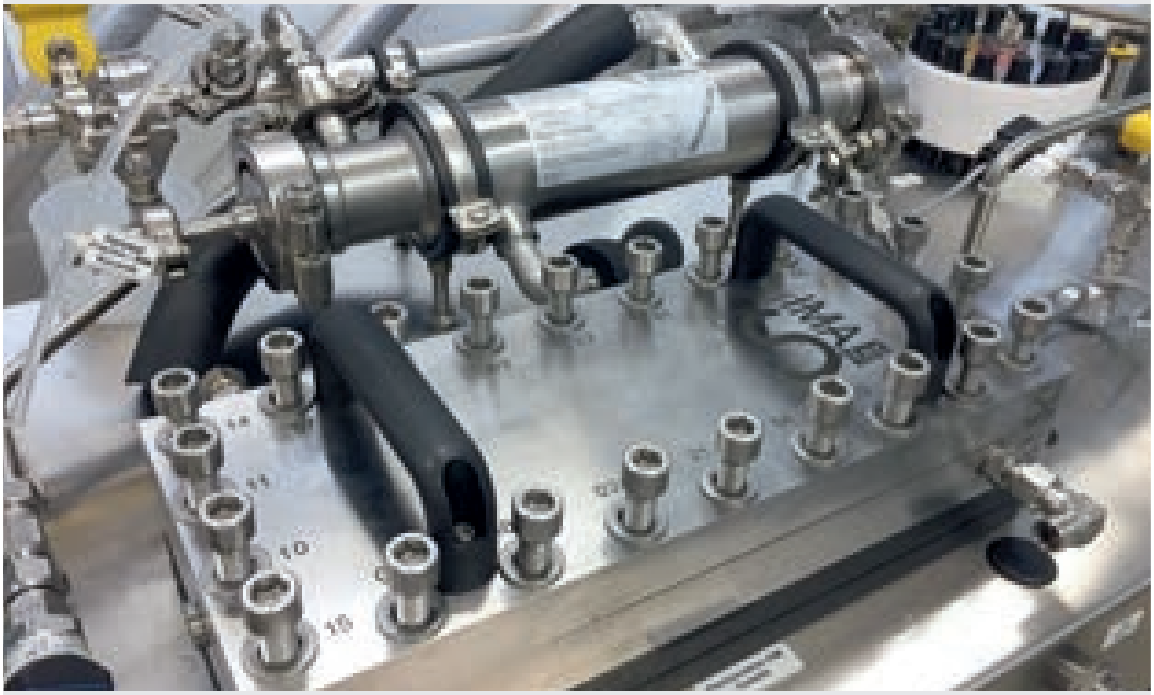
Tank Farm

Nominal volume	800 L | 1300 L | 2 × 2100 L | 2 × 4600 L | 2 × 9300 L
Throughput	–
Pressure absolute	1 to 4 bar
Temperature	8 to 95 °C
Application/ Special features	stirred storage tanks with pH- and temperature control

Mobile Tanks 1131 & 1132

Nominal volume	2 × 500 L
Throughput	–
Pressure absolute	1 to 4 bar
Temperature	8 to 95 °C
Application/ Special features	mobile stirred storage tanks with pH- and temperature control

Membrane Filtration LS60



Nominal volume	7.5 L feed tank
Throughput	max. 600 kg/h cross flow
Pressure absolute	1 to 60 bar
Temperature	5 to 80 °C
Application/ Special features	micro, ultra, nano filtration, reverse osmosis, membrane type: polymeric flat sheet and spiral wound, ceramic membrane

Micro and Ultra Filtration Skid 1428

Nominal volume	min. 50 L
Throughput	max. 6 m³/h cross flow
Pressure absolute	1 to 5.5 bar
Temperature	ceramic micro filtration 8 to 121 °C ultra filtration 8 to 60 °C
Application/ Special features	crossflow and diafiltration, sterile micro filtration (0.5 m²), hollow fiber ultra filtration (5 m²), spiral wound modules (3838)

Micro and Ultra Filtration Skid 1143

Nominal volume	min. 100 L
Throughput	max. 30 m³/h cross flow
Pressure absolute	1 to 5.5 bar
Temperature	8 to 40 °C micro filtration 8 to 60 °C ultra filtration
Application/ Special features	crossflow and diafiltration, micro and ultra filtration, hollow fiber and spiral wound modules (8038)

Process Chromatography 1150

Nominal volume	7 to 35 L column volume
Throughput	max. 180 L/h feed rate
Pressure absolute	1 to 7 bar
Temperature	0 to 60 °C
Application/ Special features	product purification

High-Pressure Extraction Skid 1585K300

Nominal volume	2 L solid feed vessel 1.45 L extraction column
Throughput	10 kg/h
Pressure absolute	1 to 500 bar
Temperature	max. 80 °C
Application/ Special features	supercritical CO_2 and liquid propane extraction of liquid or solid feeds, cosolvent extraction possible

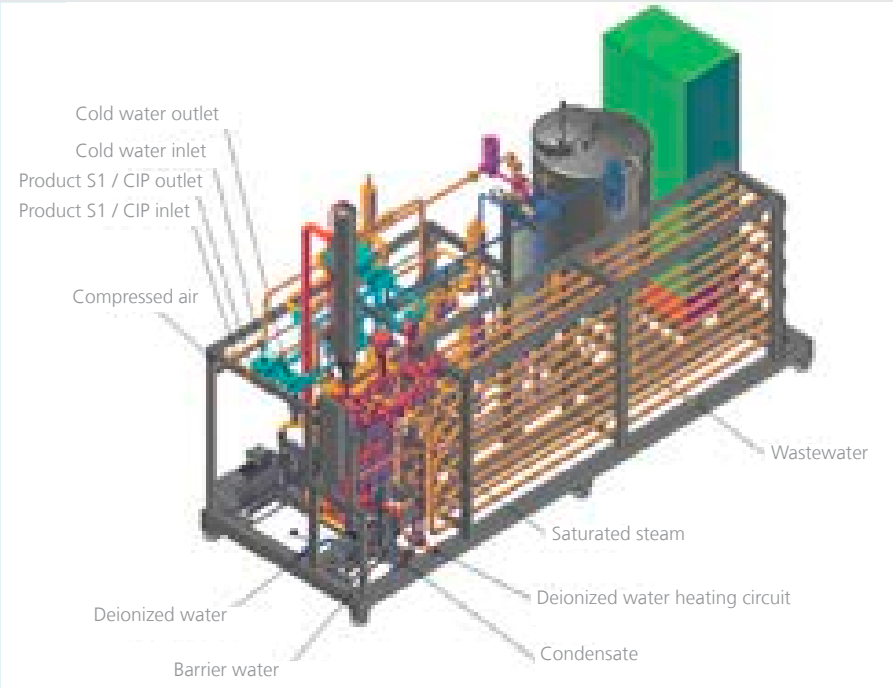
Spray Dryer 1161

Nominal volume	–
Throughput	max. 6 kg/h feed rate
Pressure absolute	1 bar
Temperature	140 to 300 °C
Application/ Special features	spray drying

Freeze Dryer 1162

Nominal volume	24 L
Throughput	12 L/d
Pressure absolute	0.1 to 1000 mbar
Temperature	-60 to 60 °C
Application/ Special features	freeze drying

High Temp. Short Time Sterilizer 1126



Nominal volume	–
Throughput	2 m^3/h
Pressure absolute	1 to 3.5 bar
Temperature	8 to 143 °C
Application/ Special features	continuous sterilization of liquid medium

Rapeseed Dehulling Plant 1540

Nominal volume	–
Throughput	95 kg/h
Pressure absolute	0.2 to 1 bar
Temperature	20 to 80 °C
Application/ Special features	dehulling of oilseeds (rapeseed), separation of kernels from hulls in fluidized bed

High-Pressure Lignin Depolymerization

Nominal volume	1 L feed vessel 12 to 71 mL reactor volume
Throughput	0 to 50 mL/min
Pressure absolute	1 to 300 bar
Temperature	25 to 350 °C
Application/ Special features	kinetic investigations on homogeneous catalyzed reactions of dissolved lignin and related model compounds

Continuous High-Pressure Reactor

Nominal volume	reactor 1: 400 ml volume reactor 2: 117 ml volume
Throughput	gaseous: max. 565 NL/h liquid: 0 to 50 mL/min
Pressure absolute	1 to 100 bar
Temperature	25 up to 400 °C
Application/ Special features	use case 1: heterogeneous catalyzed synthesis of methanol from synthesis gas | use case 2: synthesis of allyl alcohol + air/ ammonia to acrylonitrile

Crystallizer 1152

Nominal Volume	800 L
Throughput	batch
Pressure absolute	0.05 to 4 bar
Temperature	-15 to 95 °C
Application/ Special features	crystallization and precipitation in water and organic solvents, ATEX rated

Filter Dryer 1142

Nominal volume	625 L
Throughput	batch
Pressure absolute	0.05 to 5 bar
Temperature	8 to 140 °C
Application/ Special features	filtration (water and organic solvents), ATEX rated

Mobile Crystallizer 1451

Nominal volume	180 L
Throughput	–
Pressure absolute	0.05 to 4 bar
Temperature	-15 to 95 °C
Application/ Special features	crystallization, anchor stirrer

Batch Filtration Unit DN300x350

Nominal volume	25 L
Throughput	25 L per batch
Pressure absolute	0 to 1.5 bar
Temperature	5 to 40 °C
Application/ Special features	filtration of solvents, ATEX rated, PTFE filter | variable filter cloth

Premex High-Pressure Reactor (Lab Scale)

Nominal volume	1 / 2 L
Throughput	batch
Pressure absolute	350 bar
Temperature	400 °C
Application/ Special features	stirred reactor: heterogeneous or homogeneously catalyzed hydrogenations and oxidations

Screw Press

Nominal volume	15 L
Throughput	50 L/h
Pressure absolute	1 to 10 bar
Temperature	20 to 70 °C
Application/ Special features	solid liquid separation of oil seed ethanol suspension, Food Grade ATEX rated

Decanter

Nominal volume	–
Throughput	250 to 800 L/h
Pressure absolute	1 to 1.5 bar
Temperature	20 to 70 °C
Application/ Special features	solid liquid separation of oil seed ethanol suspension, Food Grade ATEX rated

Analytics

Equipment	Methods
HPLC coupled with DAD, RID, VWD	quantitative determination of sugars, sugar decomposition products, organic acids, phenolic compounds, alcohols
Size-exclusion chromatography	measurement of relative molar mass distribution of lignins
Headspace GC, online GC, GC coupled with MS, FID or TCD	screening for ingredients, quantitative determination of volatile substances (alcohols, acetone), phenolic compounds, fatty acids (FAME), gases (H_2, O_2, N_2, CO_2, CO, CH_4)
Elemental analysis	quantitative determination of nitrogen, carbon, hydrogen, sulphur and oxygen
Infrared spectrometer	screening functional groups; quantitative determination of ethanol and acetone

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