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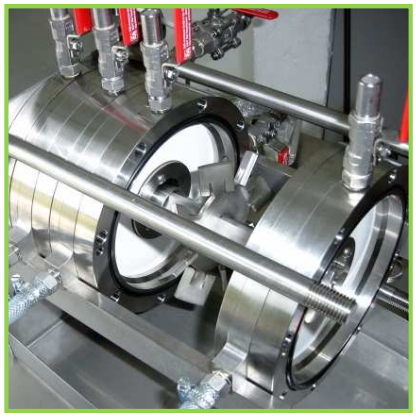
DYNO Filter

Dynamic Crossflow Filtration



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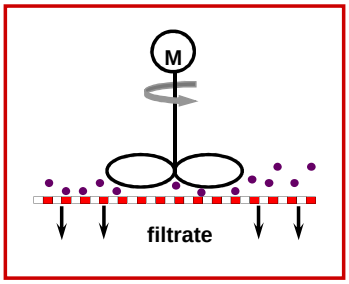
Dynamic Crossflow Filtration with the BOKELA DYNO Filter

Dynamic Membranfiltration - Dynamic Sieve Filtration - Dynamic Precoat Filtration

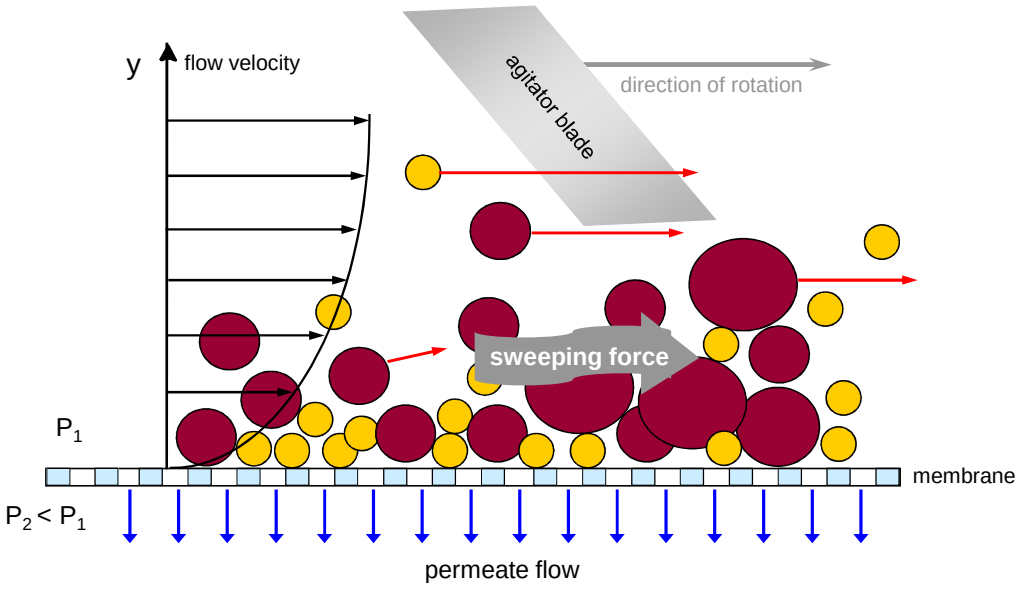
- Separation of solid particles > 0.01 µm (micro and ultra filtration)
- Dead end filtration: absolute clear filtrate
- Complete solids recovery
- High flow rates even with highly concentrated suspensions
- High end-concentrations (like firm filter cakes)
- Classification even at high concentrations
- Slimy, jelly smooth particles which are difficult to separate
- Suspensions with high viscosity, plastic or thixotrope characteristics
- Washing
- Hermetically sealed process
- Continuous operation



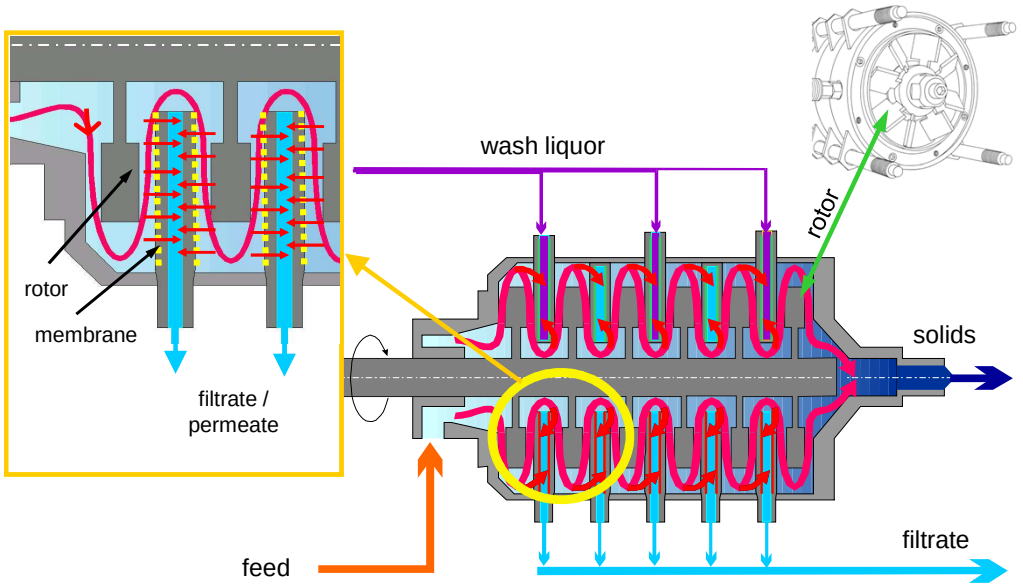
- **Cross flow (shear stress) of the suspension** generated by a rotating agitator and not by a pump
- **Filter media** disc-shaped filter elements installed near to a rotating agitator

Dynamic Crossflow Filtration with the BOKELA DYNO Filter

Flow forces on a particle

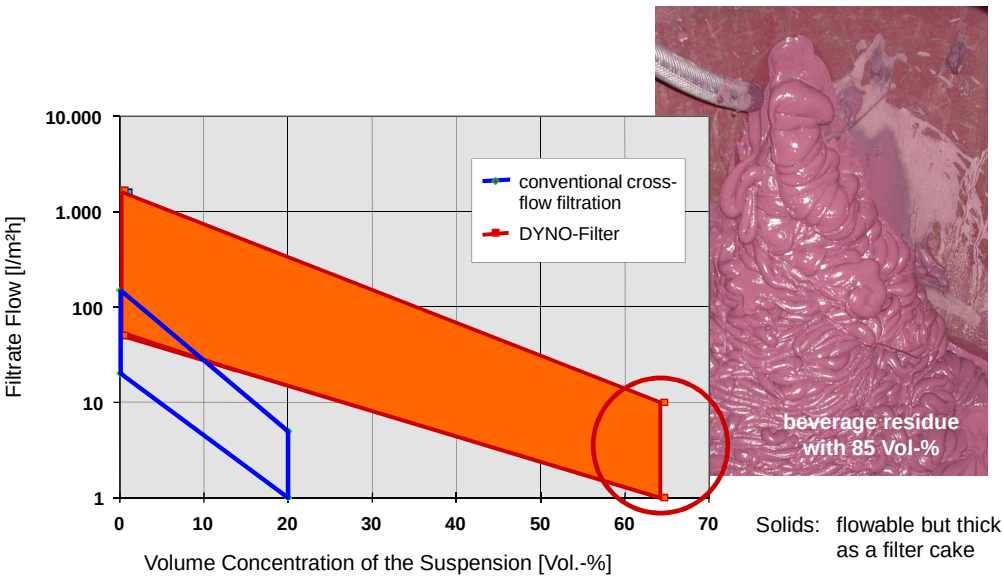


Meander-Shaped Suspension Flow



Dynamic Membrane Filtration

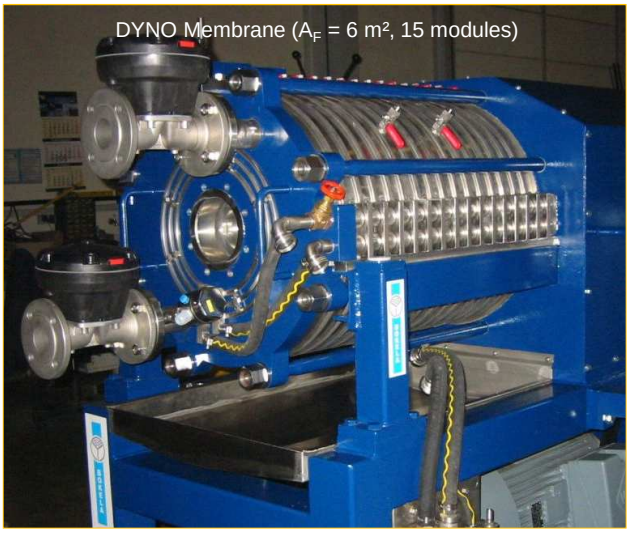
High flow rates even with highly concentrated suspensions



Solids: flowable but thick as a filter cake

Dynamic Membrane Filtration

Filtration of a white pigment with DYNO L-Type 6-15-MF



DYNO Membrane (A_F = 6 m², 15 modules)

Product

- fine pigment
- x_{50} << 1 µm
- spec. surface 40 m²/g
- c_{feed} = 13 wt-% DS

Process requirements

- high end concentration
- no air inclusions
- pastous flow behaviour

Performance

- 39 wt.-% DS in the concentrate
- viscosity 25,000 mPas
- 200 l/m²h filtrate

Dynamic Membrane Filtration / Diafiltration

DYNO Filter in Pharma Design

Washing of a micro-fine pharmaceutical suspension with salt and active ingredient

DYNO Filter L-Type (A_F = 8 m²) in the Workshop, Pharma Design

Product

- suspension with NaCl: 10%
- active product: 3.5%
- particle size: 1 – 50 µm
- thixotropic behaviour

Target

- NaCl < 0.1 %
- active product > 7.5 %
- sanitary design
- temperature: < 30°C
- low wash water demand (Diafiltration)
- sterilization of machine
- automatic cleaning
- short dead time between batches
- high throughput

Dynamic Membrane Filtration

Separation of Nano-Sized Particles

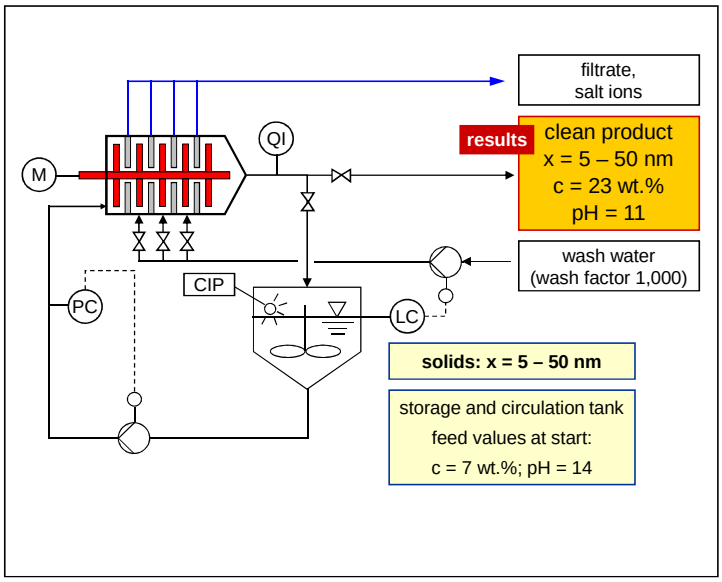
Batch operation for filtration & washing

Product specification:

- nano-scale chemical product
- x = 5 - 50 nm
- c_{Feed} = 7 wt%

Target:

- high end concentration of solids
- pH-value reduction from pH = 14 to pH = 11
- salt ions reduction



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Performance Data for Membrane Filtration

PRODUCT	characteristics / process features	feed concentration [wt-%]	concentration of retentate [wt-%]	filtrate throughput [m³/m²h]
industrial waste water		0.3	**11**	**0.9**
red mud		30	**65**	**0.3**
TiO_2	abrasive, high porosity	34 40	**59** **50**	**0.4** **1.0**
ultramarine		17	**55**	**0.3**
yellow pigment		4.5	**20**	**0.4**
molybdenum orange	high intrinsic viscosity	5	**50**	**0.75**
silica acid SiO_2		13	**40**	**0.8**
boric carbide	abrasive	21	**52**	**0.15**
glaze for ceramics	washing out of slimy contents	33	**79**	**0.15**
calcium carbonate	X_{50} < 1 µm	45	**70**	**0.1**
nano scale chemical product	nano particles: x = 5 – 50 nm	5 5	**30** **40**	**0.17** **0.12**

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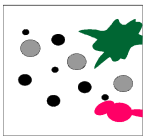
Dynamic Sieve Filtration with the BOKELA DYNO Filter

Principle of Dynamic Sieve Filtration

Feed



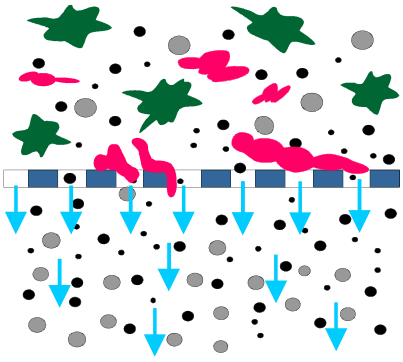
Concentration of coarse particles

c_{coarse} = 50 ppm

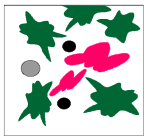
Metal sieve: 20 µm

separation of low concentrated coarse particles

flow direction



Retentate



Concentration of coarse particles

c_{coarse} = 5.000 ppm

$V_{retentate}$ = 0,001 V_{zu}
(minimal product loss)

Filtrate

c_{coarse} = 1 - 5 ppm

c_{fine} = 10 - 50 %

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Dynamic Sieve Filtration with the BOKELA DYNO Filter

Main Characteristics

- continuous separation of coarse particles
- sieve cut down to 5 µm
- high feed concentration sieving at high viscosity and thixotrope flow behaviour
- minimal product loss with discharge of the coarse particles
- hermetically sealed apparatus
- automatic and self cleaning apparatus
- cooling or heating during sieving
- sieving without air contact

Typical Application Data

- throughput performance:
  up to 20,000 l/h per machine
- feed concentration:
  1 - 50 (60) % (still pumpable)
- retentate concentration:
  enrichment of coarse fraction by factor 20 - 500
- energy demand: 2 – 4 kW / m²
- rotor speed: 2 – 6 m/s
- pressure: 0.1 – 6 bar
- filter medium:
  multi-layered sinter medium
  (3) 20 – 200 µm
- sieve cleaning:
  short-timed, pulsed backflush

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Dynamic Sieve Filtration with the BOKELA DYNO Filter

Typical Applications

- finest minerals like $BaCO_3$, SiC, BC, etc.
- lattices
- white pigments like TiO_2, $CaCO_3$, kaolin, etc.
- polymeric dispersions
- emulsions, dispersions in the food industry like chocolate, cocoa butter, mayonnaise, etc.
- downstream from colloid or ball mills or similar comminution technologies

DYNO Sieve Filter
for High Viscous Polymeric Suspension

Product specification:

- highly viscous polymeric suspension of 2 liquid components with suspended organic solids
- solids consistency: soft with changeable form
- feed concentration (a + b)
  - a) x = 2 - 10 µm: 30 Vol-%
  - b) x = 10 - 500 µm: 10 - 1,000 ppm

Target(s):

- separation of the coarse particles
- sieve cut of 20 µm
- no dilution

Apparatus demands:

- continuous process
- automatic discharge of the coarse fraction (> 20 µm)
- minimum filter throughput: 4 m³/h
- hermetically closed apparatus with little space demand
- explosion protection
- feed control via feed pressure control range: 50 - 100 % of throughput
- automatic operation, start-up and shut-down
- self-cleaning apparatus
- solvent resistant materials

DYNO Sieve Filter
for High Viscous Polymeric Suspension

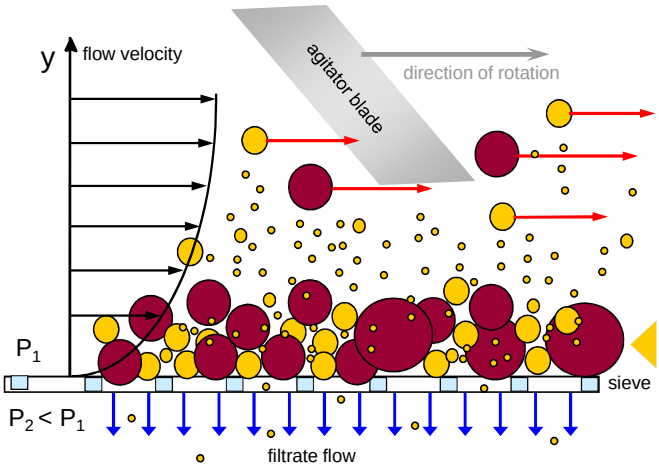
Performance Data of a 12 m² DYNO Filter

feed pressure	1.5 bar
feed concentration	30 Vol.-%
viscosity	1,000 mPas
viscosity of water	1 mPas
sieve cut	20 µm
concentration of coarse particles	(x > 20 µm)
• in the feed	20 ppm
• in the concentrate	5,000 ppm
• in the filtrate	< 5 ppm
filtrate throughput	4,000 l/h
regular sieve maintenance	> 1 year

Dynamic Precoat Filtration with the BOKELA DYNO Filter

Dynamic precoat filtration is a combination of cake forming filtration and crossflow filtration. This process allows to completely recover solids form a suspension and to produce an absolutely particle-free filtrate.

Principle of Dynamic Precoat Filtration



A deposit of particles layer (1 – 2 mm) is generated on the filter medium under controlled conditions.

It serves as precoat medium and is removed by backflushing within certain time intervals.

precoat layer

DYNO Precoat Filter

Catalyst Recovery from an Organic Suspension

In a BDO production plant a catalyst has to be recovered from a hot organic suspension which comes from 12 reactors. The catalyst consisting of inorganic solids has to be recycled to the reactors.

Product

Hot organic slurry with suspended inorganic products (catalyst)

Separation task: absolute recovery of catalyst after reactor

Plant capacity: 140,000 t/a BDO (Butanediol), 12 reactor tanks

Size of particles: x = 1 - 10 µm:

Feed concentration: 6.9 wt.-%

Main Targets

- absolute recovery of catalyst
- no dilution
- no air/gas contact of catalyst
- closed and automatic operating system

product in basket filter

DYNO Precoat Filter

Catalyst Recovery from an Organic Suspension

Process and Apparatus Demands

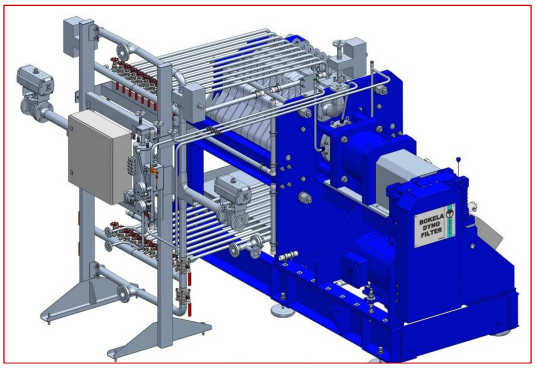
- continuous process
- particle free filtrate
- constant filtrate flow and constant pressure
- catalyst should remain suspended in the liquor
- low retention time of product inside filter, i.e recirculation of catalyst into the process as fast as possible
- hermetically closed apparatus with little space demand
- explosion protection (zone 2)
- modular machinery for 20% possible capacity increase
- automatic operation, automatic start-up and shut-down
- self-cleaning apparatus

DYNO Precoat Filter

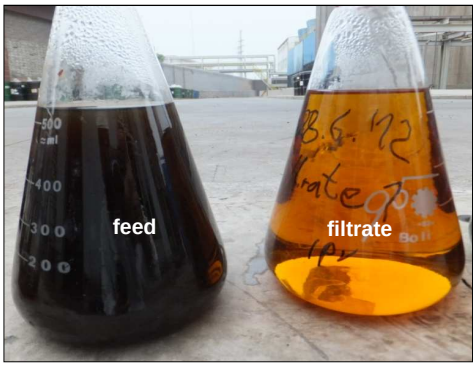
Catalyst Recovery from an Organic Suspension

24 DYNO Filter units with 10 m² filter area per unit are operated for catalyst recovery

Metallic filter media with open structure enable backflushing of filtrate to avoid clogging by depth filtration. The metallic filter medium serves as support for the precoat layer which is the real separation medium for this process.



DYNO Filter for catalyst recovery



Particle-free filtrate

DYNO Precoat Filter

Catalyst Recovery from an Organic Suspension

24 DYNO Filter units with 10 m² filter area per unit are operated for catalyst recovery

DYNO Filters in the workshop

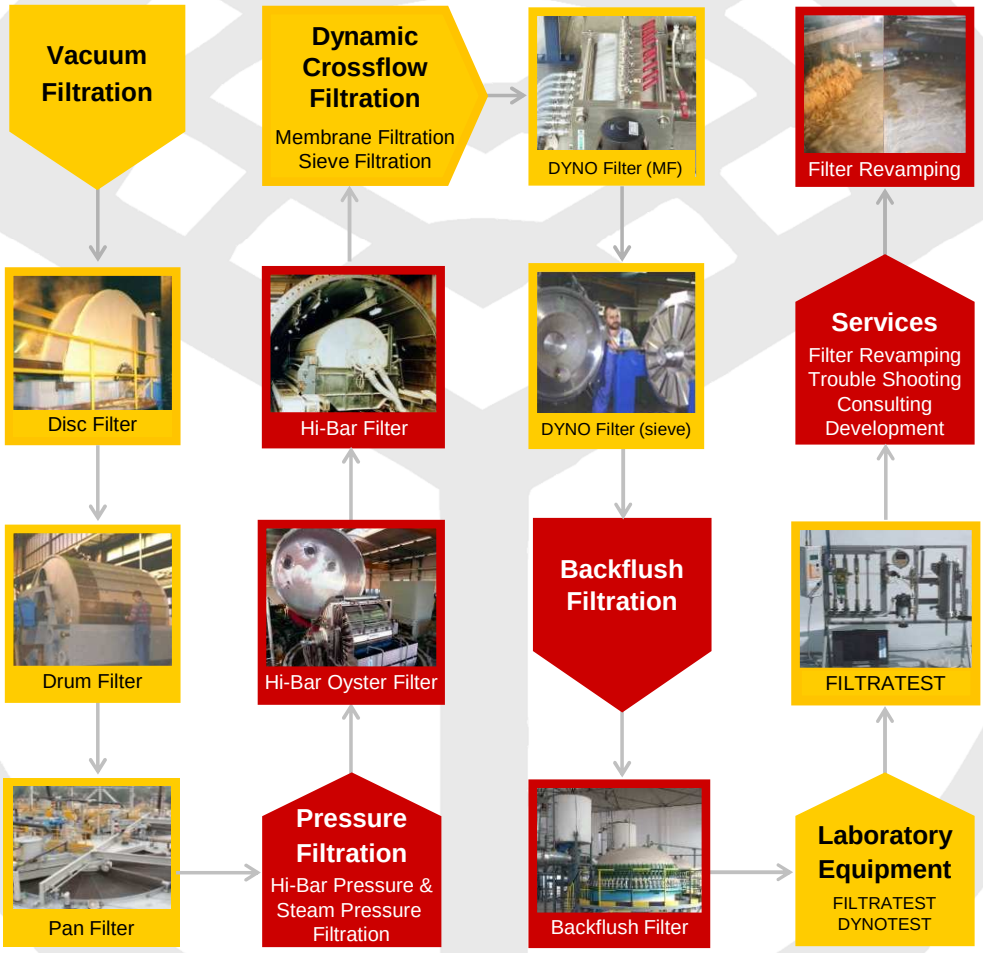
Machine data per unit		
Filter area	[m²]	10
modules	[-]	10
Power (installed)	[kW]	45
Process and operation data		
feed pressure	[bar]	7
feed solid concentration	[wt%]	6.9
feed flow	[kg/h]	10500
filtrate throughput	[kg/h]	3500
filtrate quality	[-]	particle free

Characteristics of DYNO Filter Processes

	membrane filter	sieve filter	precoat filtration / filter with metallic media
Principle / Target	Clear Filtration	Classifying	Clear Filtration
main application	thickening, washing, clear filtrate	separation and concentration of coarse particles while fine particles pass with the filtrate	generate clear liquid and recycling of solid particles back to the process
rotor speed	high	medium - high	low - medium
filter medium	membranes	metallic sieves (defined square mesh)	metallic media
backflush interval		seconds – minutes	Minutes – hours
valuable product	solids / filtrate	filtrate	solids / filtrate
pressure difference	medium - high	low	medium

Machine Sizes

Type	Filter Area	No. of Filter Modules	Filter Diameter	Drive
	[m^2]	[-]	[mm]	[kW]
Lab Membrane / Sieve	0.013	1	145	0.5
Pilot Membrane / Sieve	0.13	5	145	3
S Membrane / Sieve	0.4	10	200	< 5.5
M Membrane / Sieve	1.8	12	380	< 15
L Membrane / Sieve	8 / 4. 8	20 / 12	550	≤ 55
XL Sieve	12	12	850	≥ 45



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