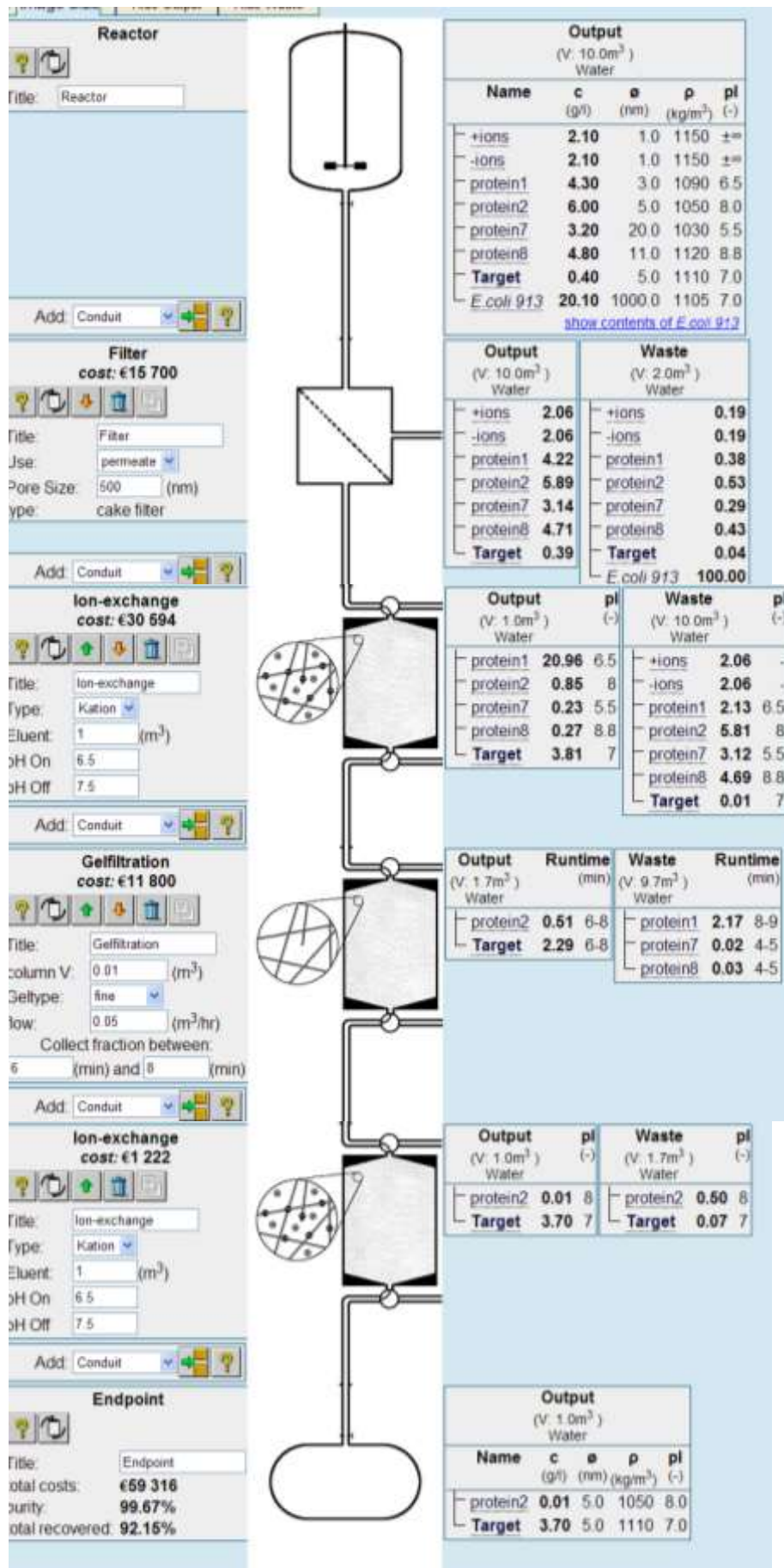


SIMULACIJA ZAKLJUČNIH PROCESOV

1. Ekstracelularni protein, suboptimalni parametri



Here is the end result of your downstream process:

Output (V: 1.0m ³) Water					
Name	c (g/l)	o (nm)	p (kg/m ³)	pl (-)	
protein2	0.01	5.0	1050	8.0	
Target	3.70	5.0	1110	7.0	

Results per Unit					
unit		purity	yield	waste (m ³)	costs (€)
Reactor		0.90		0.00	0
Filter		1.75		2.01	15 700
Ion-exchange		14.60		10.00	30 594
Gelfiltration		81.71		9.65	11 800
Ion-exchange		99.67		1.67	1 222
Endpoint		99.67		0.00	0

End Results	
Concentration Target Protein:	3.70kg/m ³
Total recovered:	3.70kg (92.2%)
Concentration pollutants:	0.01kg/m ³
Purity:	99.7%
Waste:	23.3m ³
Costs:	€59 316

Intracelularni protein, suboptimalni parametri

Make your design here. To see a summary of your design with some feedback, go to [the overview](#)

Image Size: Hide Output Hide Waste

Reactor

Title: Reactor

Add: Conduit

Centrifuge

cost: €20 200

Title: Centrifuge

Use: pellet

Σ (size): 200 (m²)

Resuspend in: 2.5 (m³)

Add: Conduit

Disruptor

cost: €4 811

Title: Disruptor

N: 2000

ΔP: 9 MPa

ΔT = 2°C φ = 5000m³h⁻¹

Add: Conduit

Filter

cost: €4 450

Title: Filter

Use: permeate

Output (V: 10.0m³)

Water

Name	c (g/l)	σ (nm)	ρ (kgm ⁻³)	pl (-)
+ions	2.10	1.0	1150	±=
-ions	2.10	1.0	1150	±=
protein1	4.30	3.0	1090	8.5
protein2	6.00	5.0	1050	8.0
protein7	3.20	20.0	1030	5.5
protein8	4.80	11.0	1120	8.8
E. coli 912	20.10	1000.0	1105	7.0

[show contents of E.coli 912](#)

Σ (size): 200 (m²)

Resuspend in: 2.5 (m³)

Add: Conduit

Output (V: 2.5m³)

Water

+ions	0.01
-ions	0.01
protein1	0.05
protein2	0.06
protein7	0.08
protein8	0.25

Waste (V: 10.0m³)

Water

+ions	2.10
-ions	2.10
protein1	4.29
protein2	5.98
protein7	3.18
protein8	4.74

Σ (size): 200 (m²)

Resuspend in: 2.5 (m³)

Add: Conduit

Output (V: 2.5m³)

Water

+ions	0.81
-ions	0.81
protein1	0.05
protein2	0.46
protein7	0.08
protein8	0.25
E. coli 912	0.85
protein3	0.95
protein4	0.16
protein5	0.64
protein6	1.03
Target	1.59
Debris	79.55

Waste (V: 10.0m³)

Water

+ions	2.10
-ions	2.10
protein1	4.29
protein2	5.98
protein7	3.18
protein8	4.74

Add: Conduit

Output (V: 2.5m³)

Water

+ions	0.79
-ions	0.79
protein1	0.05

Waste (V: 2.0m³)

Water

+ions	0.02
-ions	0.02
protein2	0.01

Use: permeate
 Pore Size: 80 (nm)
 type: cake filter

Add: Conduit

Ion-exchange
 cost: €2 770

Title: ion-exchange
 Type: Kation
 Eluent: 0.05 (m³)
 pH On: 6.7
 pH Off: 7.5

Add: Conduit

Gelfiltration
 cost: €1 900

Title: Gelfiltration
 column V: 0.001 (m³)
 Geltype: fine
 flow: 0.001 (m³/hr)
 Collect fraction between:
 30 (min) and 36 (min)

Add: Conduit

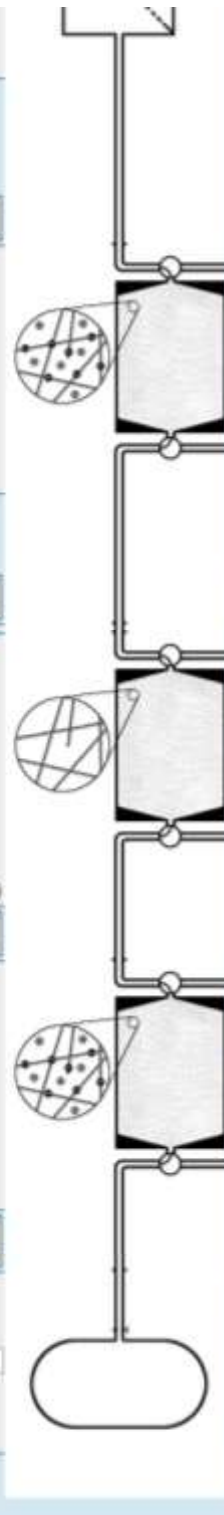
Ion-exchange
 cost: €1 043

Title: ion-exchange
 Type: Kation
 Eluent: 0.05 (m³)
 pH On: 6.5
 pH Off: 7.5

Add: Conduit

Endpoint

Title: Endpoint
 total costs: €35 173
 purity: 99.99%
 total recovered: 90.64%



protein	concentration	pI
protein1	0.07	6.5
protein2	0.45	8
protein7	0.07	5.5
protein8	0.25	8.8
protein3	0.94	7
protein4	0.16	4
protein5	0.62	5
protein6	1.01	9
Target	1.56	

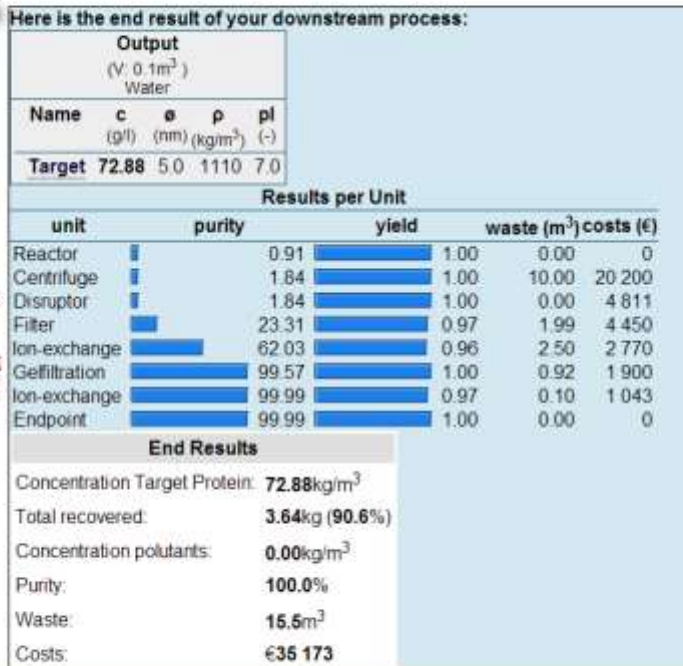
protein	concentration	pI
protein8	0.01	
<i>E. coli</i> 912	1.07	
protein3	0.02	
protein5	0.02	
protein6	0.03	
Target	0.04	
Debris	100.00	

Output	pl	Waste	pl
(V: 0.1m ³)	(-)	(V: 2.5m ³)	(-)
Water		Water	
protein1	0.08	+ions	0.79
protein2	0.33	-ions	0.79
protein7	0.02	protein1	0.04
protein8	0.07	protein2	0.44
protein3	45.03	protein7	0.07
protein4	0.02	protein8	0.25
protein5	0.14	protein3	0.04
protein6	0.25	protein4	0.16
Target	75.05	protein5	0.62
		protein6	1.01
		Target	0.06

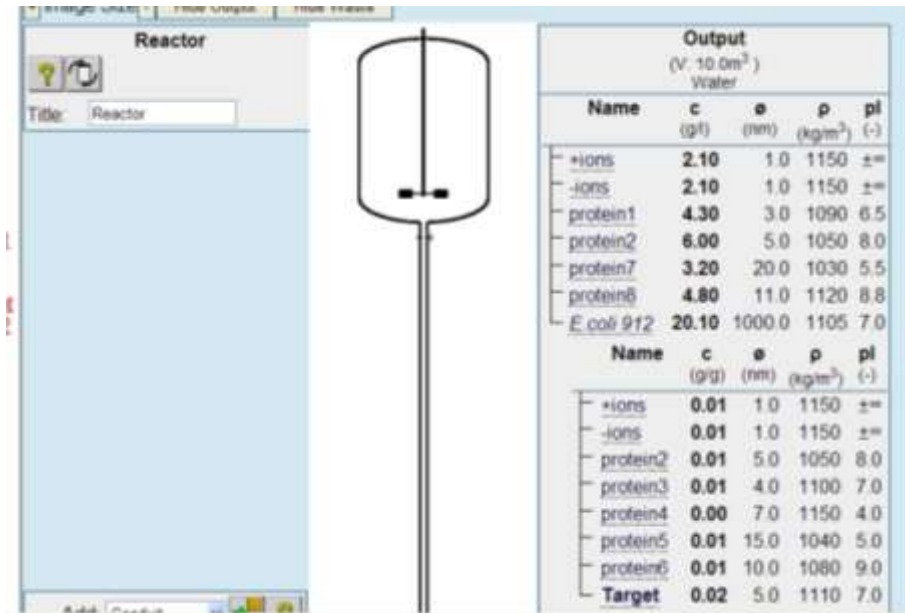
Output	Runtime	Waste	Runtime
(V: 0.1m ³)	(min)	(V: 0.9m ³)	(min)
Water		Water	
protein2	0.16	protein3	2.46
Target	37.52	protein5	0.01
		protein6	0.01

Output	pl	Waste	pl
(V: 0.1m ³)	(-)	(V: 0.1m ³)	(-)
Water		Water	
Target	72.88	protein2	0.16
		Target	1.08

Output	Name	c	ø	p	pl
(V: 0.1m ³)		(g/l)	(nm)	(kg/m ³)	(-)
Water					
Target	72.88	5.0	1110	7.0	



Intracelularni protein, najboljši izbrani parametri



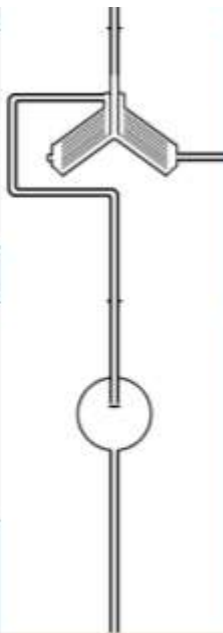
Centrifuge
cost: €20 200

Title: Centrifuge
Use: pellet
 Σ (size): 200 (m²)
Resuspend in: 3 (m³)

Add: Conduit

Disruptor
cost: €6 908

Title: Disruptor
N: 6
 ΔP : 65 MPa
 ΔT : 16°C ϕ : 18m³h⁻¹



Output (V: 3.0m ³) Water		Waste (V: 10.0m ³) Water	
+ions	0.01	+ions	2.10
-ions	0.01	-ions	2.10
protein1	0.04	protein1	4.29
protein2	0.05	protein2	5.98
protein7	0.06	protein7	3.18
protein8	0.21	protein8	4.74
<i>E. coli</i> 912	67.00		

Output (V: 3.0m ³) Water	
+ions	0.68
-ions	0.68
protein1	0.04
protein2	0.38
protein7	0.06
protein8	0.21
<i>E. coli</i> 912	0.39
protein3	0.80
protein4	0.13
protein5	0.52
protein6	0.85
Target	1.33
Debris	66.61

Add: Conduit

Filter
cost: €6 200

Title: Filter
Use: permeate
Pore Size: 80 (nm)
type: cake filter

Add: Conduit

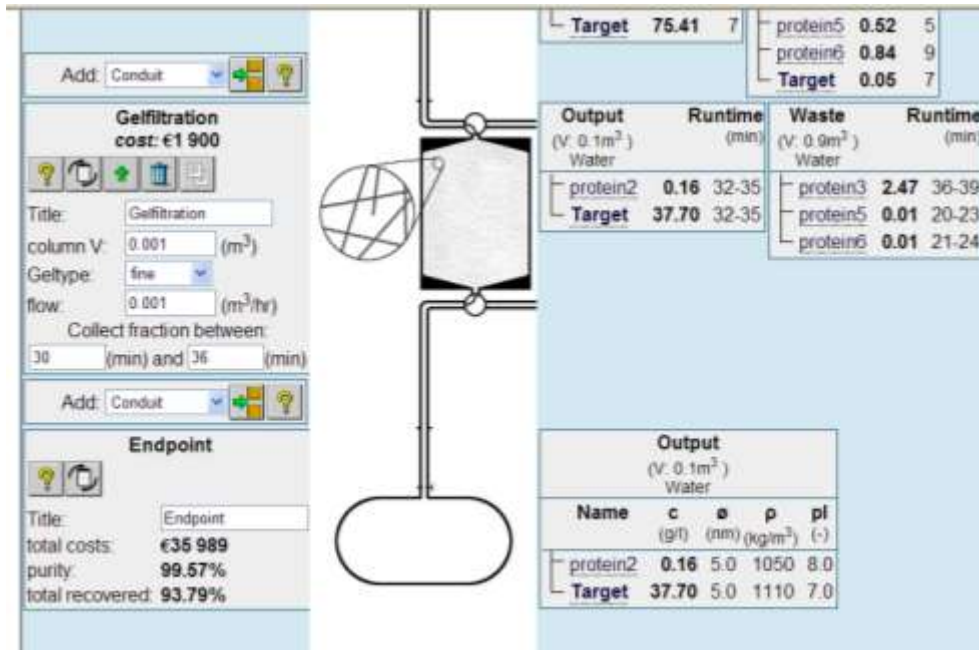
Ion-exchange
cost: €2 781

Title: Ion-exchange
Type: Kation
Eluent: 0.05 (m³)
pH On: 6.7
pH Off: 7.5



Output (V: 3.0m ³) Water		Waste (V: 2.0m ³) Water	
+ions	0.66	+ions	0.02
-ions	0.66	-ions	0.02
protein1	0.04	protein2	0.01
protein2	0.38	protein8	0.01
protein7	0.06	<i>E. coli</i> 912	0.59
protein8	0.21	protein3	0.02
protein3	0.78	protein5	0.02
protein4	0.13	protein6	0.03
protein5	0.52	Target	0.04
protein6	0.85	Debris	100.00
Target	1.31		

Output (V: 0.1m ³) Water	pI (-)	Waste (V: 3.0m ³) Water	pI (-)		
protein1	0.08	6.5	+ions	0.66	-
protein2	0.33	8	-ions	0.66	-
protein7	0.02	5.5	protein1	0.04	6.5
protein8	0.07	8.8	protein2	0.37	8
protein3	45.25	7	protein7	0.06	5.5
protein4	0.02	4	protein8	0.21	8.8
protein5	0.14	5	protein3	0.03	7



Here is the end result of your downstream process:

Output					
(V: 0.1m ³) Water					
Name	c	ø	ρ	pl	
	(g/l)	(nm)	(kg/m ³)	(-)	
protein2	0.16	5.0	1050	8.0	
Target	37.70	5.0	1110	7.0	

Results per Unit						
unit		purity	yield	waste (m ³)	costs (€)	
Reactor			0.91	1.00	0.00	0
Centrifuge			1.84	1.00	10.00	20 200
Disruptor			1.84	1.00	0.00	5 908
Filter			23.32	0.97	2.00	5 200
Ion-exchange			62.03	0.96	3.00	2 781
Gelfiltration			99.57	1.00	0.92	1 900
Endpoint			99.57	1.00	0.00	0

End Results	
Concentration Target Protein:	37.70kg/m³
Total recovered:	3.77kg (93.8%)
Concentration pollutants:	0.16kg/m³
Purity:	99.6%
Waste:	15.9m³
Costs:	€35 989

Komentar

Ekstracelularni protein

Zaporedje procesov je v obeh primerih enako, razlike se nahajajo le v finih nastavitvah parametrov. Ker se protein nahaja v bioproceni brozgi, je potrebno najprej odstraniti celice. Izkazalo se je, da je filtracija cenejša od centrifugiranja. V drugem koraku sledi ionsko izmenjevalna kromatografija, s katero se znebimo ionov in večjega dela proteinov. V večji meri nam ostane še protein 2, ker ima pI le malo nižjo od 7 (tarčni protein). Ker se ta dva proteina razlikujeta v velikosti, je smiselno

uporabiti gelsko filtracijo. Zadnji korak je ponovno ionsko izmenjevalna kromatografija, služi pa dodatnemu čiščenju proteina. Razlike med obema primeroma so opazne pri gelski filtraciji, kjer je ločba boljša ob večjem pretoku, in pri zadnjem koraku, saj je v prvem primeru premalo eluenta, kar pomeni slabo izpiranje proteina iz kolone in s tem slab izkoristek. Cena in volumen odpadne vode sta zelo blizu skupaj.

Intracelularni protein

Če želimo med samim procesom delati s čim manjšim volumnom (nižja cena procesov in manj odpadkov), je prvi korak centrifugiranje, da odstranimo bioproceno brozgo, obdržimo pa celice. Če želimo pridobiti produkt znotraj celic, je te potrebno najprej razbiti. Sledi filtracija, da odstranimo delce celic. Nato je postopek podoben zaključnim procesom pri ekstracelularnih proteinih. Z ionsko izmenjevalno kromatografijo odstranimo proteine z različnim nabojem v primerjavi s tarčnim proteinom, z gelsko filtracijo pa ločimo proteine na podlagi velikosti. V prvem primeru je na koncu uporabljena še dodatna ionsko izmenjevalna kromatografija, kar sicer očisti protein do 99,99 %, ampak je izkoristek nekoliko manjši. Pri tem moramo upoštevati, za kakšno uporabo je protein namenjen. Za humano uporabo potrebujemo visoko čistost, sicer pa ne, in je zadnji korak v prvem primeru nepotreben. Cena in volumen odpadkov sta približno enaki.