Sustainable production of fish protein hydrolysates: Overall system architecture and footprint

Prosjektarbeid – Høst 2021

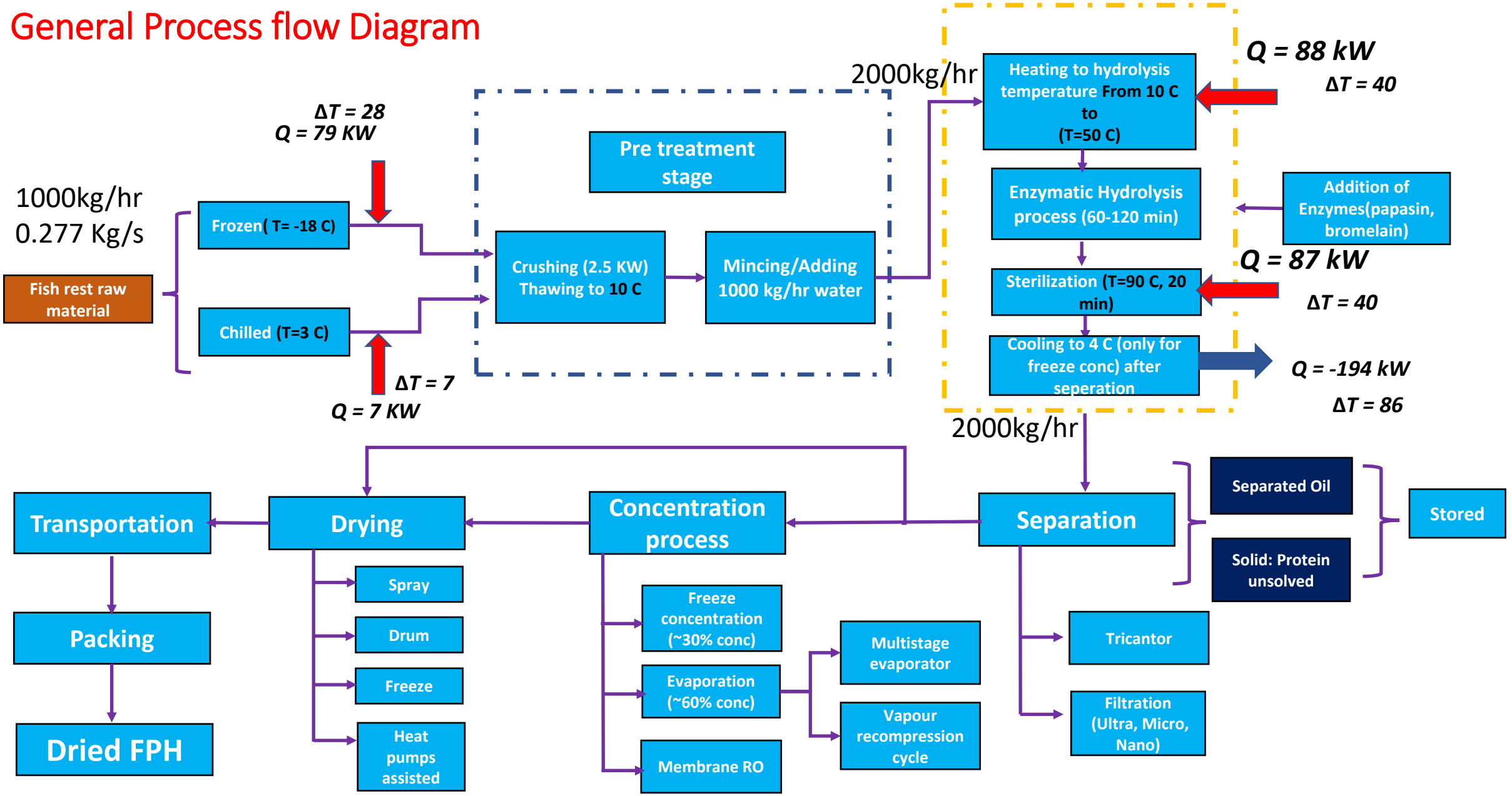
Prem Kumar Sherman

Sustainable production of fish protein hydrolysates: Overall system architecture and footprint

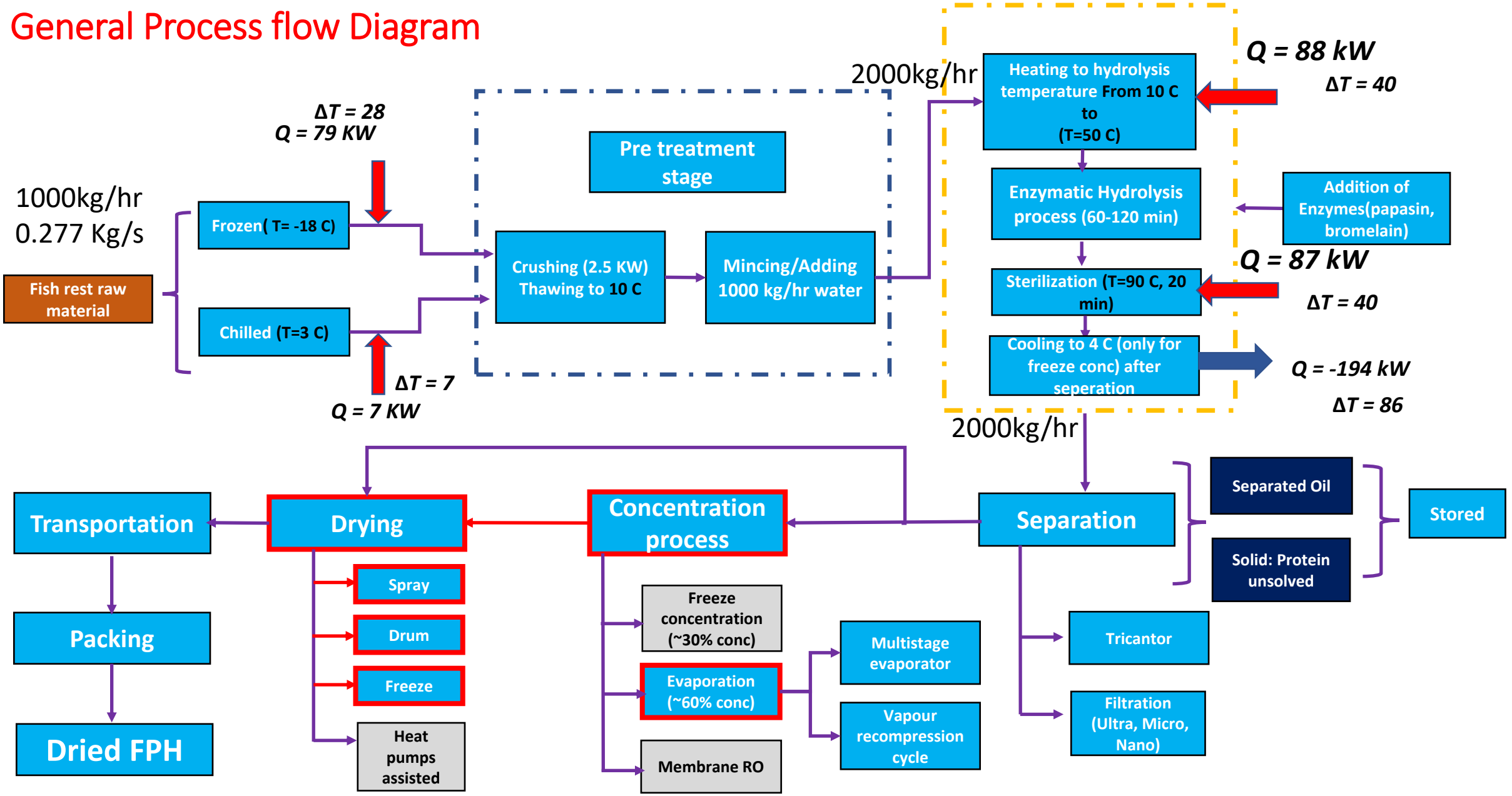
Aim

- *In this research project, the main objective is to understand and identify the **overall energy demands** involved in production of powdered FPH from RRM.*
- *The study involves investigation of **different alternatives** involved in the complete **production chain**.*
- *Also, Identifying the areas of **energy reduction** and **increasing the process efficiency** by heat pump application.*

General Process flow Diagram

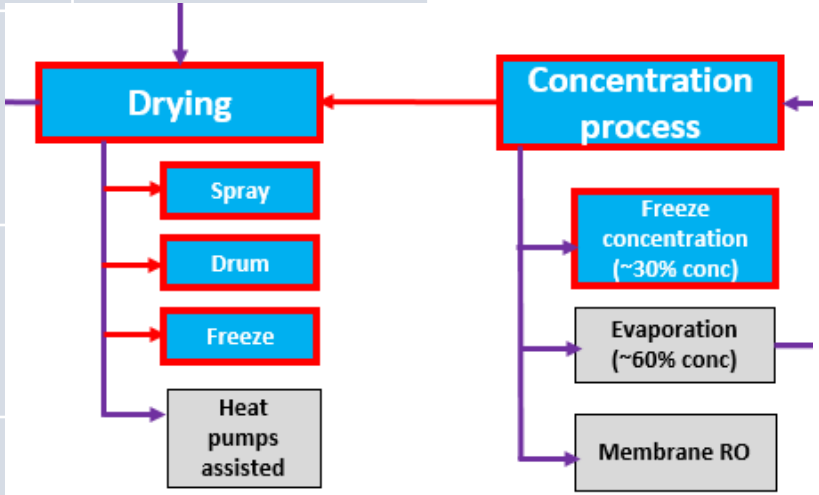


General Process flow Diagram



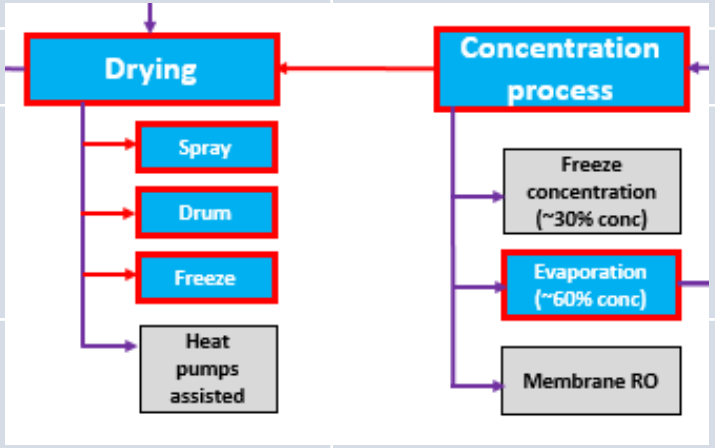
Freeze concentration with different drying methods

Process	Energy Required		Additional work	Comments
	Heating loads	Cooling loads		
Concentration Techniques				
Freeze concentration		Q=-135 kW	W_c= 30 kW, COP= 4.46	30 %
	Q=134kW			*Melting of ice*
Drying methods				
1. Spray drying, 150-200 °C	Q=6040 kJ/kg of water **Q= 500 kW**			
2. Drum drying, 150-200 °C	Q=5522 kJ/kg of water **Q= 458 kW**			
3. Vacuum freeze drying. 0°/-50 °C	Q=2838 kJ/kg Q= 233 kW	Q=-2875kJ/kg Q= -236 kW	W_c= 85 kW, COP= 2.78 Vacuum pump, Wp= 85 kW	



Evaporation alternatives vs Drying methods

Process	Energy Required		Additional work	Comments
	Heating loads	Cooling loads		
Evaporation Techniques				
1. Multi stage evaporation (100-50 °C)	Q=767 kJ/kg **Q= 347 KW**	Q= - 374 kW		Vapor condensing at 0.2 bar, 30 C
2. Vapor recompression evaporator (100 °C)	Q= 250.4 kJ/Kg **Q= 113 kW**			
Cooling to Storage temperature (0°C)		Q=-10		Mass= 215 Kg/hr(60 % conc)
Drying methods				
1. Spray drying 150-200 °C	Q= 6823 kJ/kg of water,**Q= 158 kW**			
2. Drum drying 150-200 °C	Q=6053.1 kJ/kg of water, **Q= 140 kW**			
3. Vacuum freeze drying 0°/-50 °C	Q=2838 kJ/kg Q= 66 kW	Q=-2875 kJ/kg Q= -66 kW	W_{car}= 24 kW, COP= 2.78 Vacuum pump, Wp= 41 kW	



Design av kjølesystem for produksjon av hydrolysat

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Jomar Mandal Leth-Olsen & Zakaria Hajjem

Oversikt

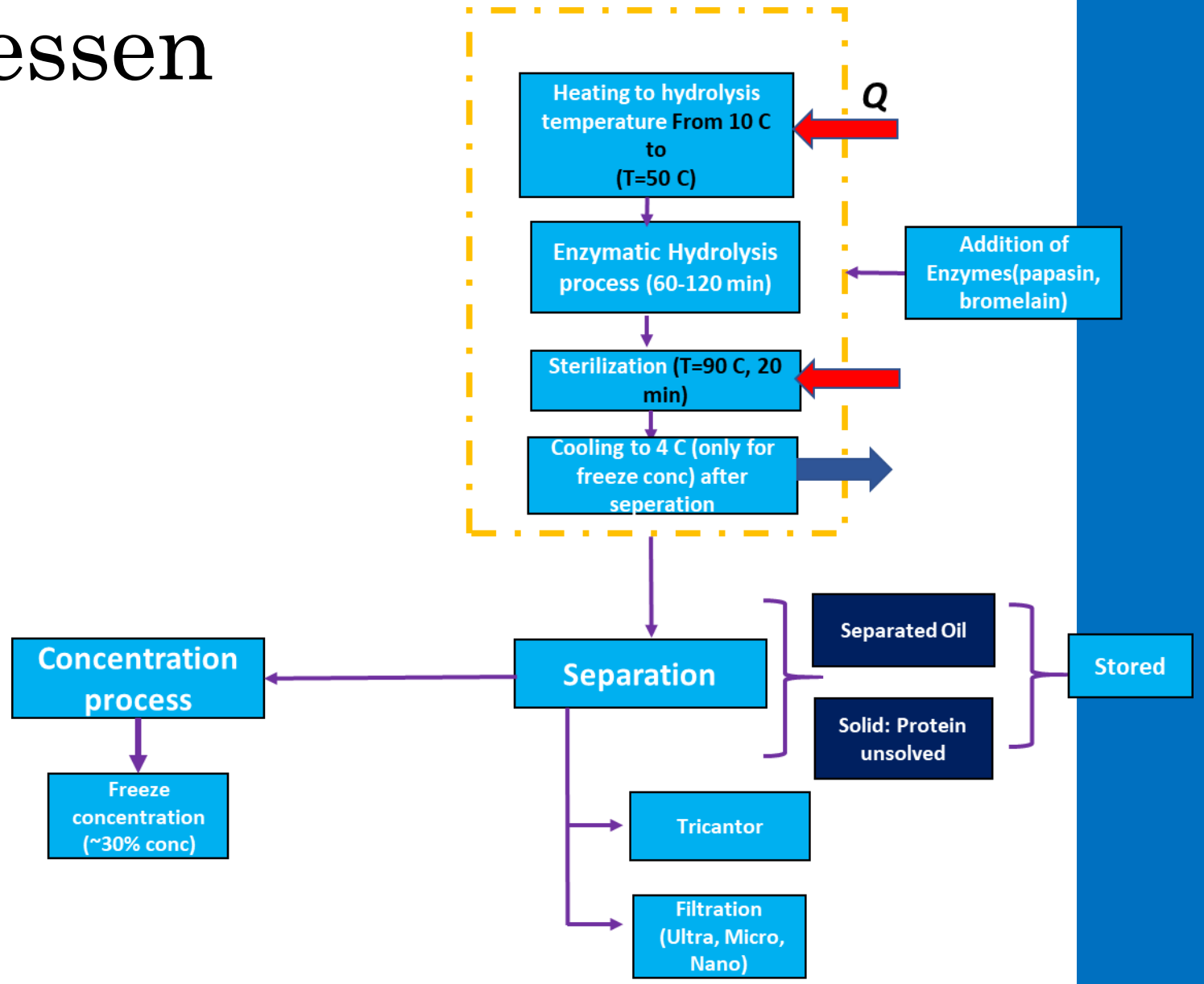
- Litteraturstudie
  - Skaffet generell oversikt
- Arbeid i gruppe
  - Bestemte komposisjon og temperaturnivå basert på litteratur
  - Brainstorming
- Design av system
  - Varmegjenvinning
  - Transkritisk
  - Temperaturer

Temaer

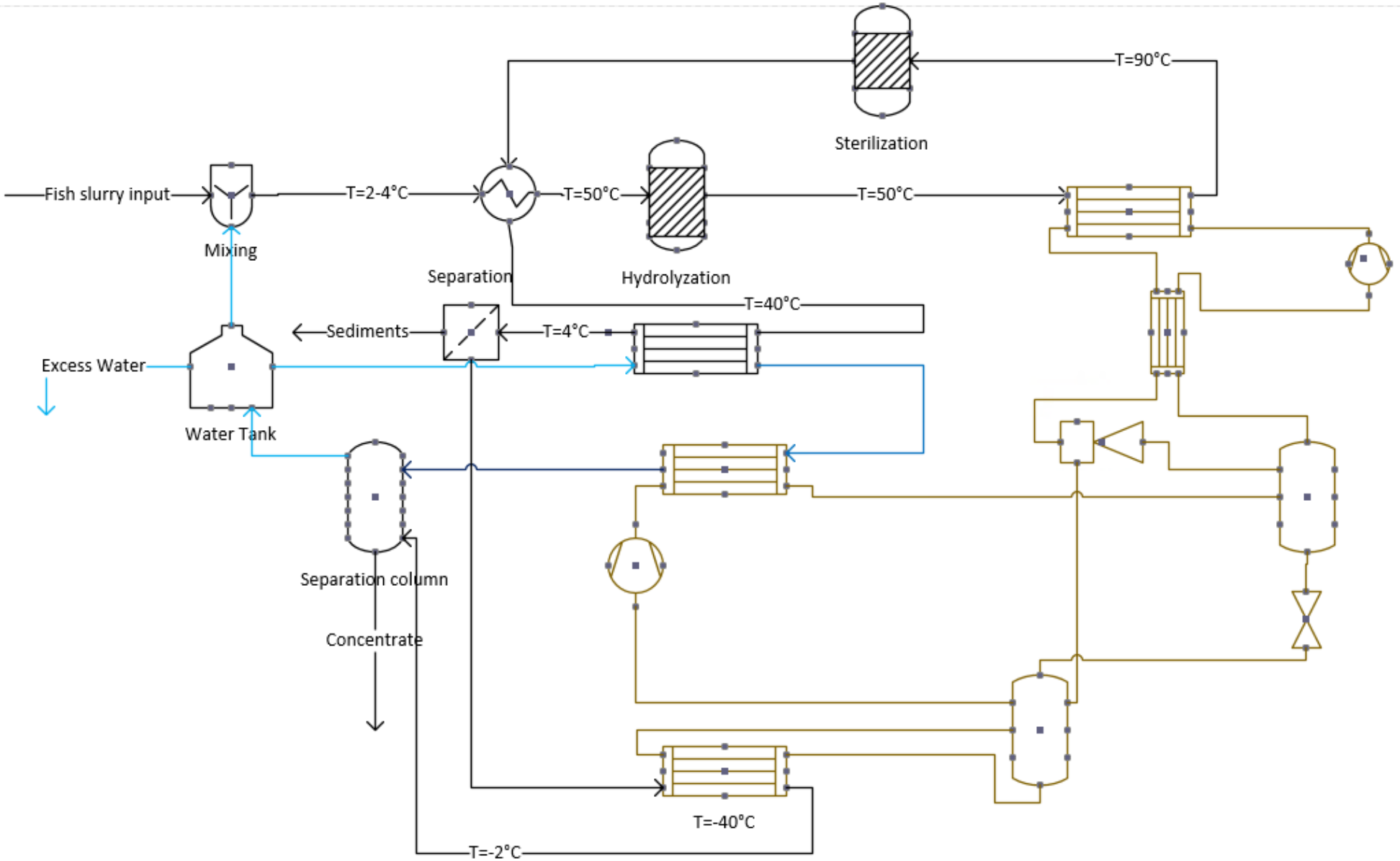
- FPH hydrolyse produksjon
  - Egenskaper og sammensetning
  - Filtrering
  - Temperaturnivå
  - Fysisk utforming og utfordringer
- CO_2 kjøleanlegg
  - Utforming
  - Tilpassing til prosess
  - Begrensninger og varmestrømmer
- Frysekonsentrering (Muhammad Omar)
  - Temperaturnivå
  - Konsentrasjon på produkt (30%)
- Modelica
  - Modellere prosessen

Hovedtrekk i prosessen

- Oppvarming fra 5-50˚C
- Hydrolysering
- Oppvarming 50-90˚C
- Sterilisering v/90˚C
- Filtrering
- Kjøling til frysepunkt
- Frysekonsentrering
- Separasjon i Wash Column
- Produkt med 30% fast stoff



P&ID 2-trinn CO_2 anlegg for hydrolysatproduksjon



- Utfordringer:
  - Filtreringsgrad basert på antagelse
    - Venter på forsøksdata fra riggen i Lofoten
    - Kan endre kjølelasten
  - Tilstrekkelig temperatur ut gasskjøler
- Videre arbeid:
  - Beregne massestrøm og energibruk for CO_2 prosessen
  - Fullføre modelicamodellen
  - Skrive prosjektrapport

Freeze-concentration of fish protein hydrolysat

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Muhammad Umar Khan

Freeze-consentration

Scope:

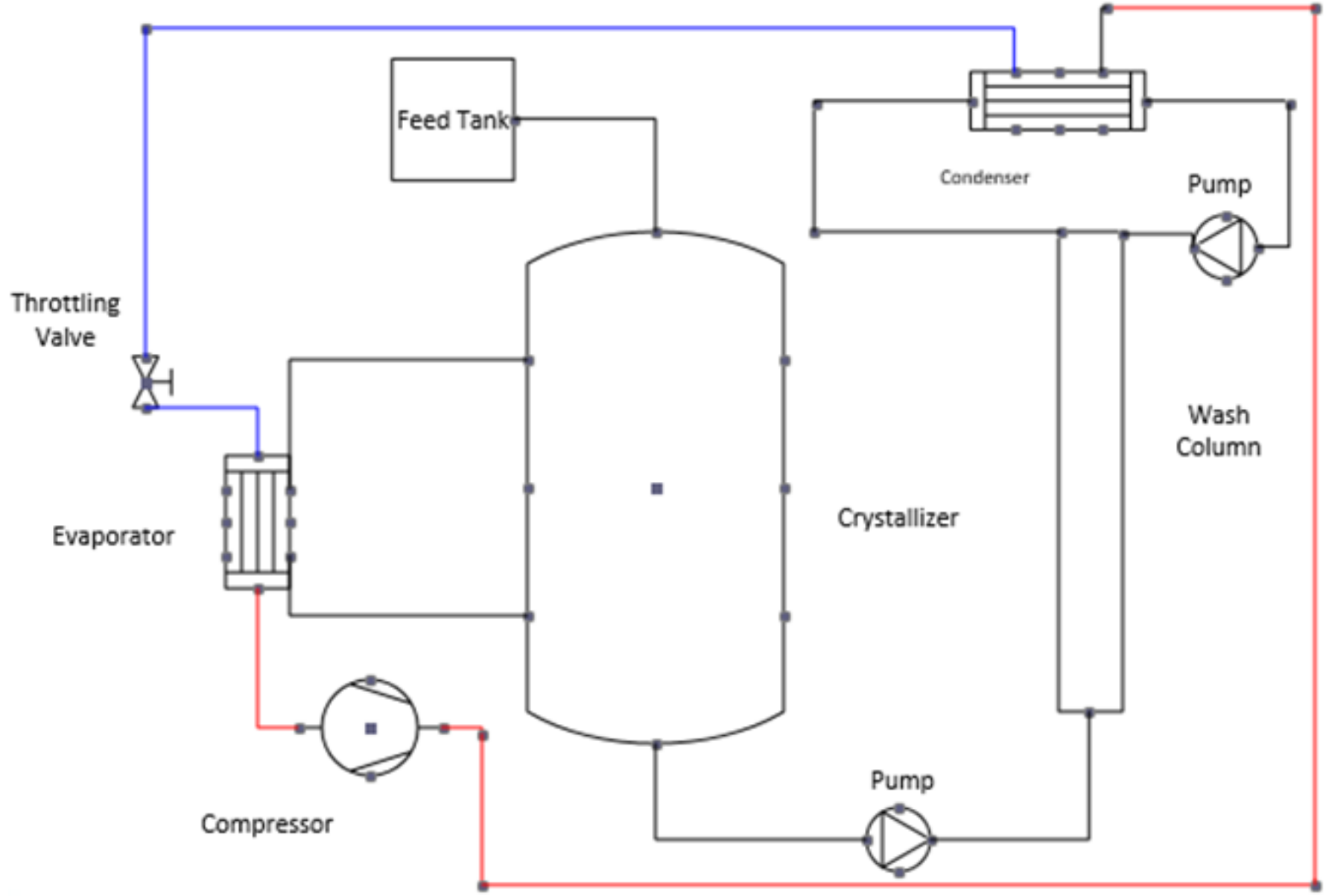
- **design a crystallizer**, **wash column** and **refrigeration system**
- validate simulations from literature and experiment.

The aim of the modelling is to predict how the **ice crystals** and **bulk temperature** will vary with respect to **evaporation temperature** and surface area of heat exchanger and how much **filtration** and wash section length we need to separate ice from solution.

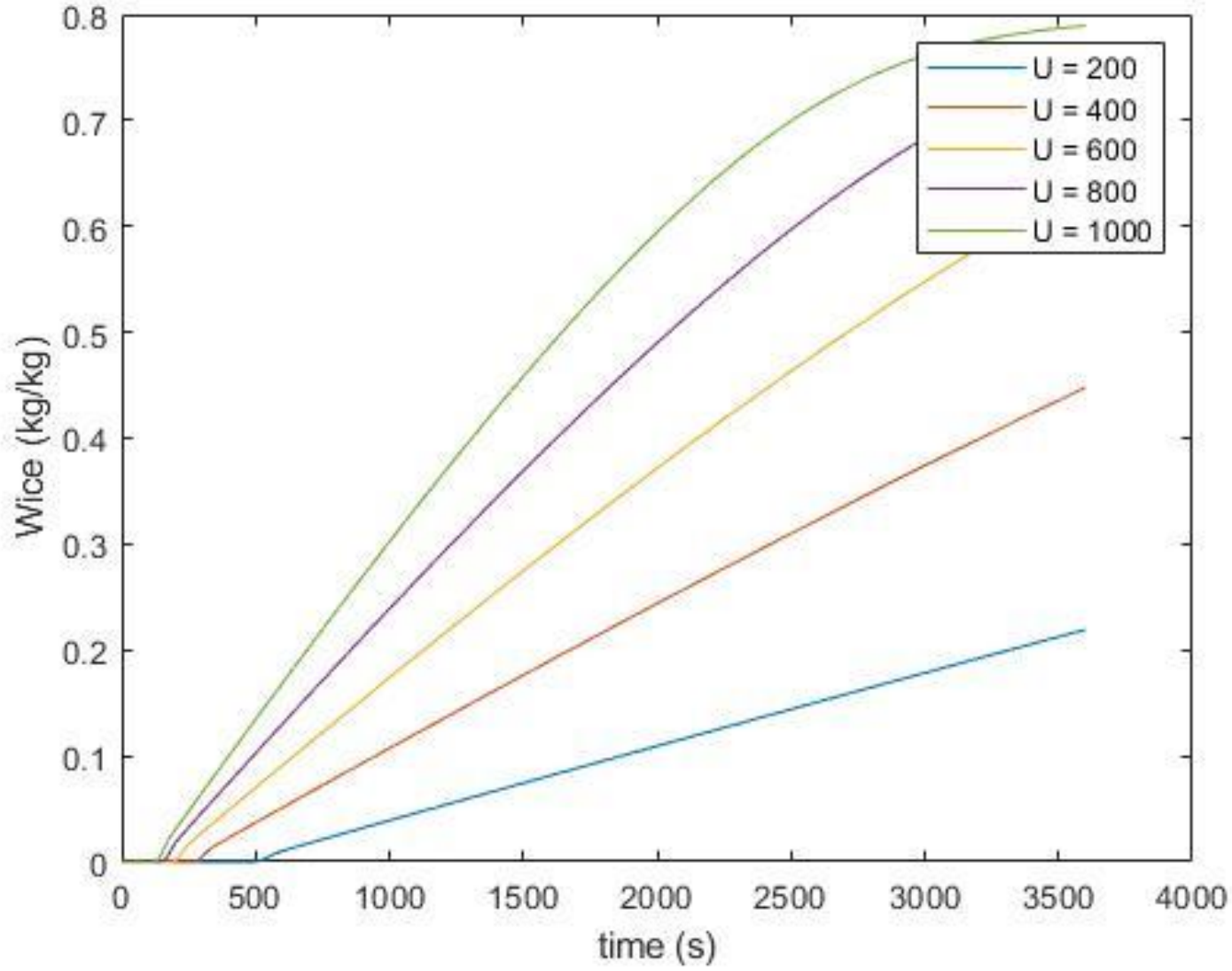
Outlet:

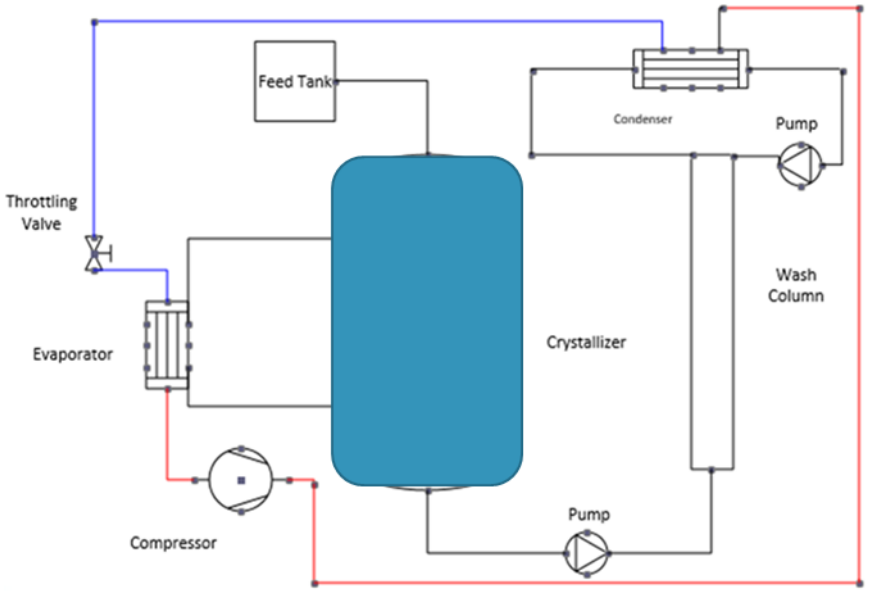
- Matlab model
- Design of lab freeze-consentrator
- Validation

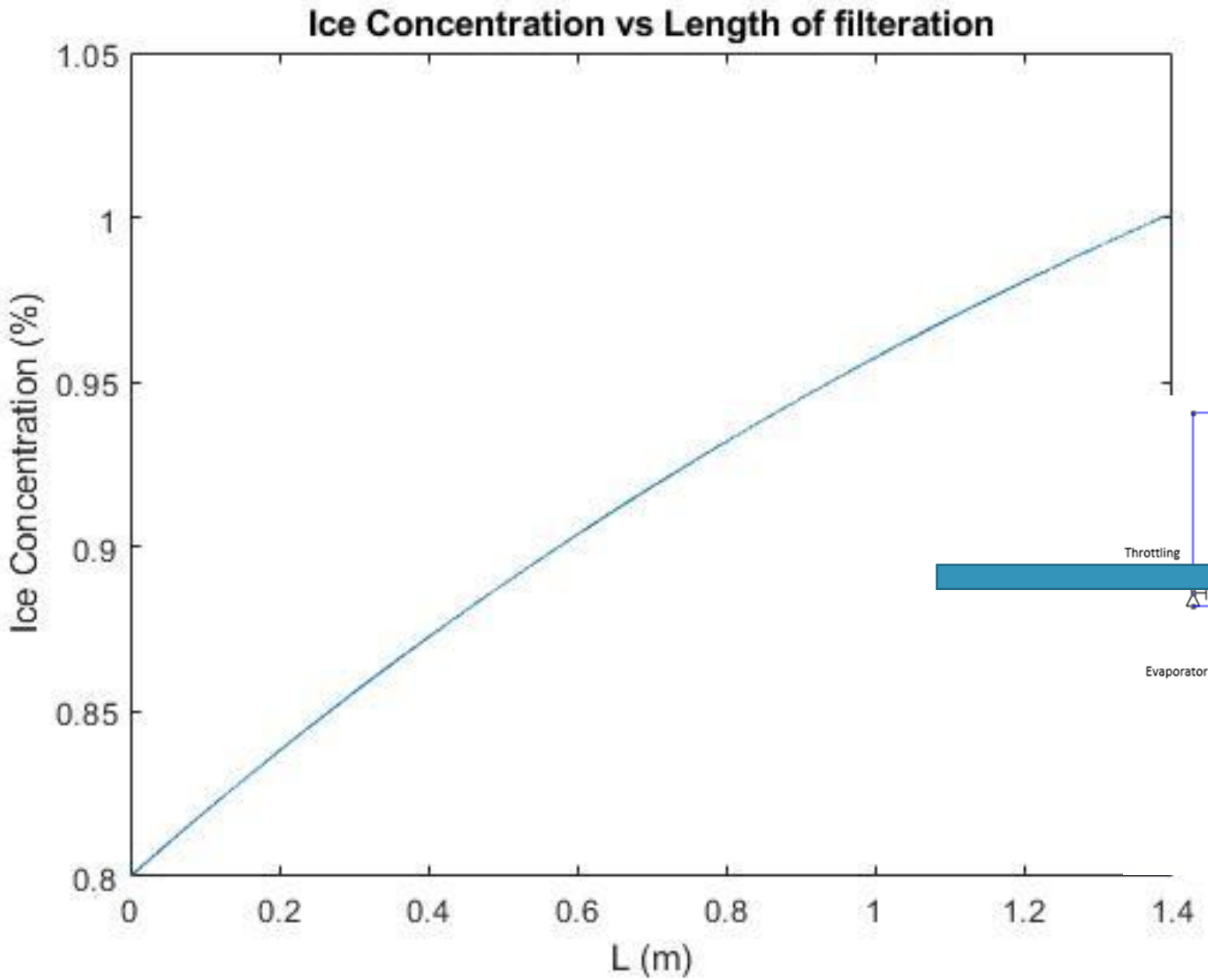
System design

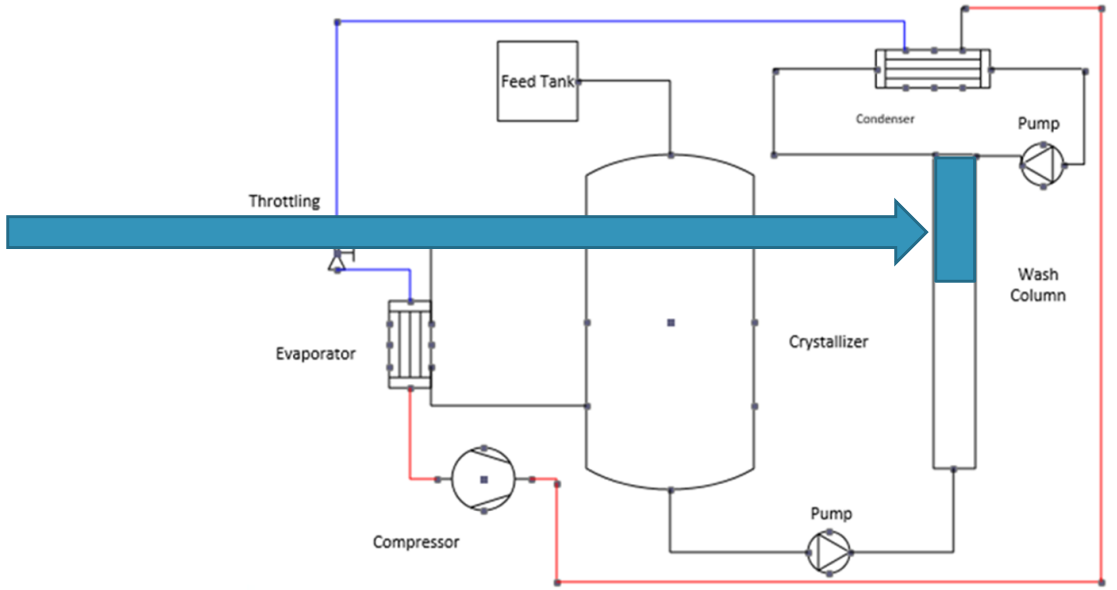


Ice content vs time and heat transfer






Ice Concentration vs Length of filteration
Ice Concentration (%)
L (m)
1.05
1
0.95
0.9
0.85
0.8
0
0.2
0.4
0.6
0.8
1
1.2
1.4


Feed Tank
Condenser
Pump
Throttling
Wash
Column
Evaporator
Crystallizer
Pump
Compressor

Sammendrag:

- Energibruk oversikt til produksjon av hydrolysat fra rå material til tørr pulver
- Utkast til CO_2 anlegg som blir energienhet til hydrolysat prosessen inkludert frysekonsentrering
- Model av frysekonsentrering: formering av iskrystaller og separering av is fra konsentrat