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Experimental Plan Assessment

Laboratory Course	:	CHE 3110L
Experiment Title	:	Carrageenan Production
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Teacher's Name	:	Dr. Camilla Flor Y. Lobarbio
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Criteria	Grade
Preparation & Planning for Experiment (x 0.50)	
Ability to Answer Questions (x 0.50)	
Grade	

Assessed and Graded By: _____

(Signature over printed name)

Date and Time _____

University of San Carlos
Department of Chemical Engineering

CHE 3110L Laboratory Simulation of Industrial Product Manufacture

Experiment Plan

(Form CHE 3110L-2)

Prepared and submitted by:

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Experiment: **Carrageenan Production**

Objectives of the Experiment

1. Prepare a process flowsheet for the manufacture of carrageenan, complete with details in process conditions and stream specification;
2. Monitor overall and component mass and energy flows during the lab-scale implementation of the product manufacture;
3. Calculate component yields in every process step and for the entire process; and
4. Identify critical steps in the process based on laboratory data and the entire experience of generating the product.

Methodological Framework

Objective 1:

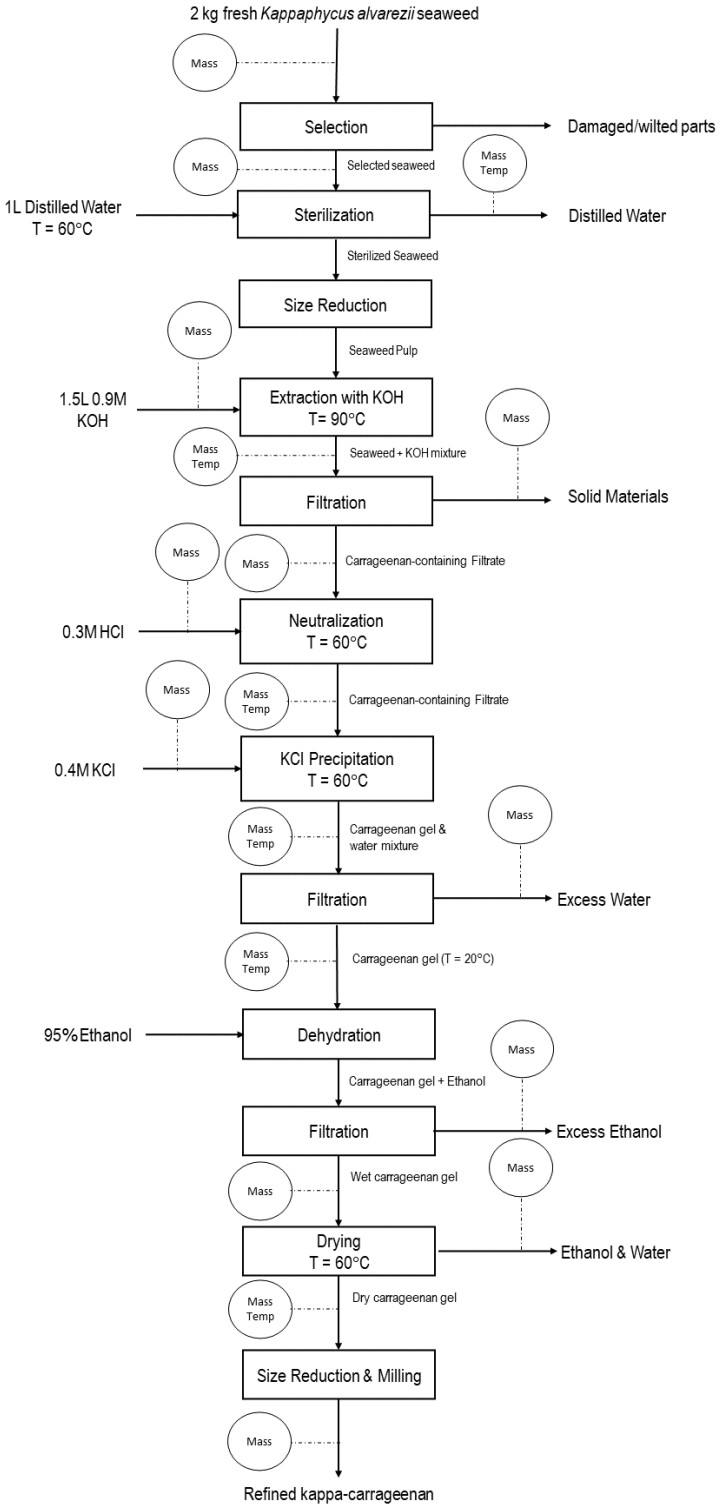
To prepare the process flowsheet of the production of carrageenan, the following are to be done:

- Research on the procedures of carrageenan, taking note of inputs, transformation processes, and outputs.
- Determine the key process steps
- Determine the underlying reactions
- Identify process conditions such as temperature and pH levels
- Establish the flow of inputs and outputs of the different processes such as materials and products

- Present the overall process as a flow diagram specifying on the process and stream conditions

Objective 2:

To monitor the component mass and energy flows, recordings of the mass and temperatures from each process step when necessary throughout the manufacturing will be made. This is represented as a process flow diagram below:



Objective 3:

To calculate the component yield of each process step and for the entire process the following are to be done:

For each process step, identify the primary input material to be processed and desired output product. Measure their respective mass in grams and calculate the yield for each process step by:

$$Percent\ Yield,\ \% = \frac{Mass\ of\ Primary\ Input\ Material, g}{Mass\ of\ Desired\ Output\ Product, g} \times 100\%$$

- For the entire process yield, it is calculated by:

$$Percent\ Yield,\ \% = \frac{Mass\ of\ Carrageenan\ Final\ Product, g}{Mass\ of\ Fresh\ Seaweed, g} \times 100\%$$

Objective 4:

Critical Steps based on laboratory data and potential eventualities:

- Seaweed selection - The quality of seaweed may affect carrageenan quality. The quantity to be used is determined in order to obtain optimum yield of carrageenan with respect to cost.
- Chopping - Removes certain parts of the seaweeds that are deemed undesirable. It also makes alkali treatment easier, especially in conjunction with using a blender.
- Filtration - Used in various stages of the process, it helps discard certain parts that are no longer useful in further stages.
- Filtrate neutralization - Prepares the filtrate for KCl precipitation. Imbalances at this stage may affect the precipitation process.
- KCl Precipitation - The crux of the experiment. Any imbalances from previous steps or in this one will severely affect carrageenan quality.
- Air-drying - Removes excess water content. Can be a source of contamination due to contact with open air.
- Oven-drying - Further removes any water content. Also functions to sanitize the carrageenan from any contaminants it may have encountered during air-drying.
- Packing - Improperly sanitized containers can hasten the spoilage of the carrageenan. Container must be adequately sized with respect to the amount of product produced.

Materials, Measuring Apparatus & Equipment

Material	Quantity
Kapaphycus alvarezii seaweed ('guso'), fresh	2 kg
0.9M Potassium Hydroxide solution	1.5 L
0.3M Hydrochloric acid solution	250 mL
0.4M Potassium Chloride solution	1.5 L
95% v/v Ethanol	1 L
Distilled water	10 L

Tap Water	10 L	
Apparatus	**Size**	**Quantity**
PH strips	7x4.5 cm	10
Pot	10-in. in diameter	1
Wash basin	30 cm in diameter	3
Measuring cup	1 L	3
Wooden Spatula	-	1
Nylon Strainer Bag	-	2
Strainer	10 cm in diameter; KW-050 fine mesh	1
Kitchen Knife	-	2
Chopping board	-	1
Plastic containers	10 oz, round	2
Soft-bristled brush	-	1
Equipment	**Specifications**	
Gas stove	La Germania-Labelle; 3-burner	
Oven	La Germania-Labelle; 50x50cm; 280C maximum temperature	
Digital Weighing Scale	0.1-3000g weighing range	
Food Processor/Blender	Kyowa; 500-watt	
Digital Kitchen Thermometer	23.88 mm; battery-operated	

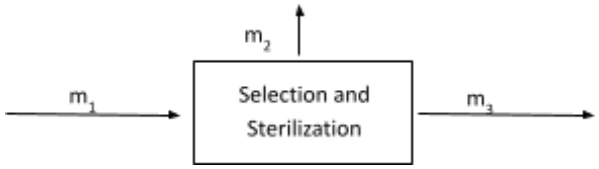
Task Plan

Time	Task	Person Responsible
	Preparation	
Day 1 8:30AM to 10:00AM	Weigh fresh seaweed. Record.	Villanueva
	Wash fresh seaweed with running water until all visible impurities are removed (e.g. sand)	
	Remove damaged/wilted parts. Discard.	
	Weigh cleaned and trimmed seaweed.	
	Chop the seaweed into 1-inch-long sticks. Place chopped sections aside.	
	Weigh and heat 1L of distilled water to 60°C. Record mass and temperature of distilled water.	
	Soak the chopped seaweed for an hour in the warm distilled water.	
	Let excess water drip by placing the cleaned seaweed strips in a sieve/colander.	
	Weigh soaked seaweed. Record.	
	Alkali Treatment	
Day 1 10:00AM to 2:00PM	Weigh cleaned and dried container for KOH solution. Record.	Villanueva
	Weigh ~75.74g of KOH flakes. Dissolve KOH flakes in 1L of distilled water then top it up to make 1.5L of 0.9M KOH solution.	
	Weigh container with KOH solution. Record.	
	Place the chopped seaweed in a blender and pules until coarse.	
	Strain the coarse seaweed blend using a sieve.	

	Use 1L of distilled water to transfer left over seaweed from the blender to the sieve completely.	
	Allow it to drain excess water	
	Weigh the cleaned and dried pot. Record.	
	Transfer the drained coarse seaweed into a pot.	
	Pour in the 1.5L 0.9M KOH solution into the pot.	
	Immerse the chopped seaweed in the KOH solution.	
	Gradually heat the mixture until the temperature reads 90°C.	
	Cook the seaweed for two hours, constantly stirring.	
	Strain the seaweed mixture into another pot using a sieve.	
	Neutralize the filtrate with 0.3M HCl solution. Use pH indicator strips to monitor the pH level of filtrate.	
	Weigh the pot with neutralized filtrate. Record.	
KCl Precipitation		
Day 1 2:00PM to 4:00PM	Weigh cleaned and dried container for KCl solution. Record.	Villanueva
	Weigh ~44.73g of KOH. Dissolve KOH in 1L of distilled water then top it up to make 1.5L of 0.4M KOH solution.	
	Weigh container with KCl solution. Record.	
	Heat the filtrate in the pot for 30 minutes until it reaches 60°C	
	Add the prepared KCl solution into the filtrate with a 1:1 filtrate to solution ratio. Record volume of KCl solution added.	
	Stir the mixture for 15 minutes.	
	Filter the mixture through a sieve with nylon cloth placed over.	
	Let excess water drip/drain out	
	Discard the filtrate.	
	Set aside the gel/residue in a pot and let it cool down to about 20°C.	
	Weigh the pot with the cooled gel. Record.	
Dehydration and Drying		
Day 1 Overnight	Pour 1L of 95% EtOH into the pot with the gel and let it soak for an hour stirring continuously.	Villanueva
	Filter the gel through a sieve with nylon cloth placed over.	
	Weigh a cleaned and dried baking tray. Record.	
	Lay out the gel on the tray.	
	Weigh the tray with the laid-out gel. Record.	
	Let the gel air-dry for 4 hours	
Day 2 7:00AM to 9:30AM	Weigh the tray with air-dried gel. Record.	
	Place the tray with air-dried gel in the pre-heated oven (~60°C) and let dry for 15 mins.	
	Take out the tray with dried gel and weigh. Record.	
	Repeat the drying process in the oven, taking it out every 15 mins and weighing, until sufficiently dry. Record time of oven drying.	
	Take out the dried carrageenan gel and let it cool to ~20^{O}C.	
	Weigh the tray with cooled dry carrageenan gel. Record.	
Milling and Packaging		

Day 2 9:30AM to 10:30AM	Place dried carrageenan gel into a cleaned and dried food processor/blender.	Villanueva
	Pulse the dry carrageenan gel until fine.	
	Weigh the cleaned and dried plastic containers for packaging. Record.	
	Transfer all of the carrageenan powder into the microwave-oven safe container.	
	Weigh the container with carrageenan powder. Record.	
	Seal and label product.	
Post-Production Analytics		
Day 3 8:00AM to 5:00PM	Test for Gelling point of final carrageenan product. Record and Evaluate.	Villanueva
	Test for Melting point if final carrageenan product. Record and Evaluate.	
	Homemade fruit jam making using of the final carrageenan product	
Day 4	Data Processing and Analysis.	Amaba

Sample Calculation



$m_1 + m_2 = m_3$

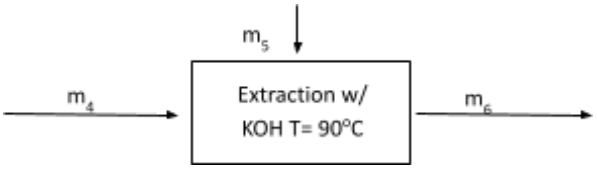
Feed Seaweed (m_1) = 2 kg = 2000g

Damaged Parts (m_2) = 0.05 m_1 = 0.1 kg = 100 g

Sterilized Seaweed (m_3) = $m_2 + m_3$ = 1.9 kg = 1900 g

$m_3 = m_4$

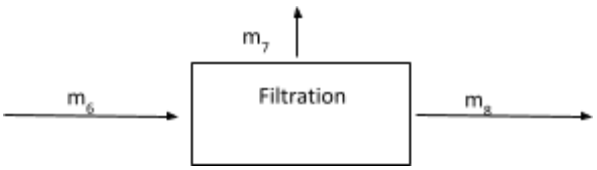
Seaweed Pulp (m_4) = 1900 g = 1.9 kg



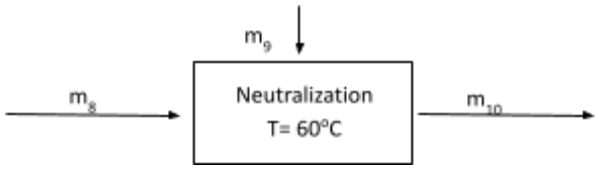
$m_4 + m_5 = m_6$

1.5 L of 0.9 M KOH = 0.9 M KOH x 1.5 L x 56.11 g/mol KOH = 75.75 g

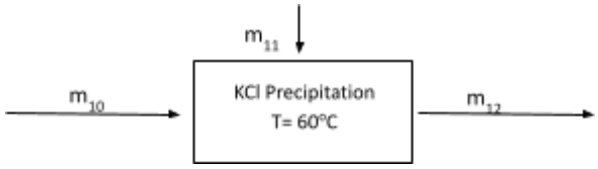
Seaweed + KOH Mixture (m_5) = $m_5 + m_4$ + 1500 g =3475.75 g



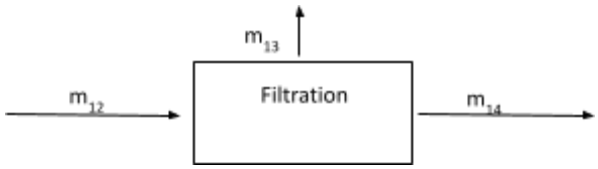
$m_6 = m_7 + m_8$
Solid Materials (m_7) = 0.096 (m_7) = 189.672 g
Carrageenan Containing Filter (m_8) = $m_6 - m_7$ = 3286.078 g



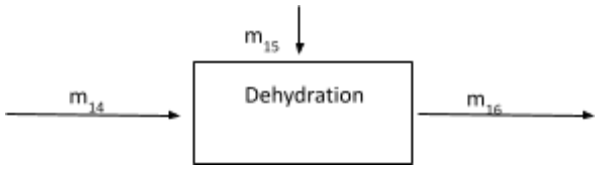
$m_8 + m_9 = m_{10}$
0.3 M HCl (m_9) = 0.3 M HCl x 36.46 g HCl x 0.100 L = 1.0938 g HCl
Carrageenan Containing Filtrate (m_{10}) = $m_8 + m_9$ + 100g = 3387.172 g



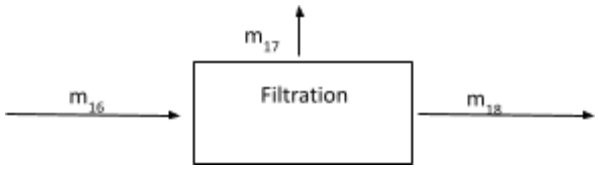
$m_{10} + m_{11} = m_{12}$
0.4 M KCl (m_{11}) = 0.4 M KCl x 74.55 g KCl x 1.500 L = 44.73 g HCl
Carrageenan Containing Filtrate (m_{10}) = $m_{10} + m_{11}$ + 1500g = 4831.902 g



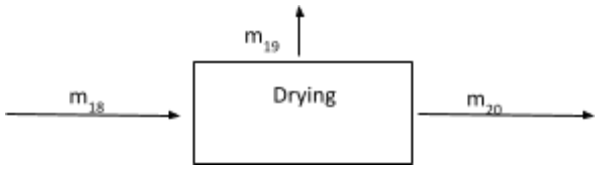
$m_{12} = m_{13} + m_{14}$
Excess H_2O (m_{13}) = 0.40(m_{12}) = 1932.76g
Carrageenan Gel (m_{14}) = $m_{12} - m_{13}$ = 2899.142 g



$m_{14} + m_{15} = m_{16}$
95% EtOH (m_{15}) = 1.627 M EtOH x 1L x 46.07 g/mol EtOH = 74.96 g EtOH
Carrageenan Gel + EtOH (m_{14}) = $m_{14} + m_{15}$ + 1000 g = 3974.102 g



$m_{16} = m_{17} + m_{18}$
Removed 95% EtOH (m_{17}) = 74.96 g EtOH + 1000 g = 1074.96 g
Carrageenan Gel (m_{18}) = $m_{16} - m_{17}$ = 2899.142 g



$m_{18} = m_{19} + m_{20}$
Removed Excess H_2O (m_{19}) = 1500 g + 1500 g + 100g – m_{13} = 1167.24 g
Dry Carrageenan Gel (m_{20}) = $m_{18} - m_{19}$ = 1731.902 g

$m_{20} = m_{21}$
Final gel (m_{21}) = 1731.902 g

% Yield =

Raw Data Sheets

Table 1. Raw data from *Preparation Process*

	Quantity	Unit
Mass of fresh seaweed		g
Mass of cleaned and trimmed seaweed		g
Mass of 1L distilled water		g
Temperature of heated distilled water		^{O}C
Mass of soaked seaweed		g

Table 2. Raw data from *Alkali Treatment Process*

	Quantity	Unit
Mass of cleaned and dried container for KOH sol'n		g
Mass of KOH flakes		g
Mass of container with KOH sol'n		g
Mass of cleaned and dried pot		g
Temperature of mixture while cooking		^{O}C
pH level of mixture before neutralization		
pH level of mixture after neutralization		
Mass of pot with neutralized filtrate		g

Table 3. Raw data from *KCl Precipitation Process*

	Quantity	Unit
Mass of cleaned and dried container for KCl sol'n		g
Mass of KCl flakes		g
Mass of container with KCl sol'n		g
Temperature of filtrate		^{O}C
Volume of KCl sol'n added		L
Mass of pot with cooled gel		g

Table 4. Raw data from *Dehydration and Drying Process*

	Quantity	Unit
Volume of 95% EtOH added		L
Mass of cleaned and dried baking tray		g
Mass of tray with laid-out gel		g
Mass of tray with air-dried gel		g
Temperature of pre-heated oven		^{O}C
Mass of tray with dried gel from oven-drying (May have several attempts)		g
		g
		g
		g
Time of oven-drying process		min
Mass of tray with cooled dry carrageenan		m

Table 5. Raw data from *Milling and Packaging Process*

	Quantity	Unit
Mass of cleaned and dried plastic containers for packaging		g

Mass of of container with carrageenan powder		g

Table 6. Raw data from *Post-Production Analytics Process*

	Quantity	Unit
Gelling point test results		^{O}C
		^{O}C
		^{O}C
Melting point test results		^{O}C
		^{O}C
		^{O}C
Homemade fruit jam product – Observations (consistency, color, smell, etc.)		