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Production of Omega-3 rich oil from Herring Oil Feedstock

Introduction

Motivation

- Scotia Gardens Seafood Inc. has identified molecular distillation as a possible recovery method of omega-3 rich oil from their herring oil feedstock.
- Omega-3 rich oil has higher market demand than crude herring oil.

Table 1: Fats Content % in Herring Oil

SFA	MUFA	PUFA	Omega-3 (n-3)
16.81	33.23	24.51	18.42

Objectives

- Produce omega-3 rich oil (50%) from herring oil feedstock.
- Product must meet CFA requirements and quality guidelines for human consumption.

Scope

- Research process design options for molecular distillation of fish oil.
- Perform detailed equipment design for the proposed processing plant expansion.
- Perform an economic feasibility assessment.

Design Process

Research Phase
- Research process design options for molecular distillation and any process needed to recover an enriched omega-3 rich oil
- Research regulatory requirements to produce CFIA-approved molecularly distilled fish oil.

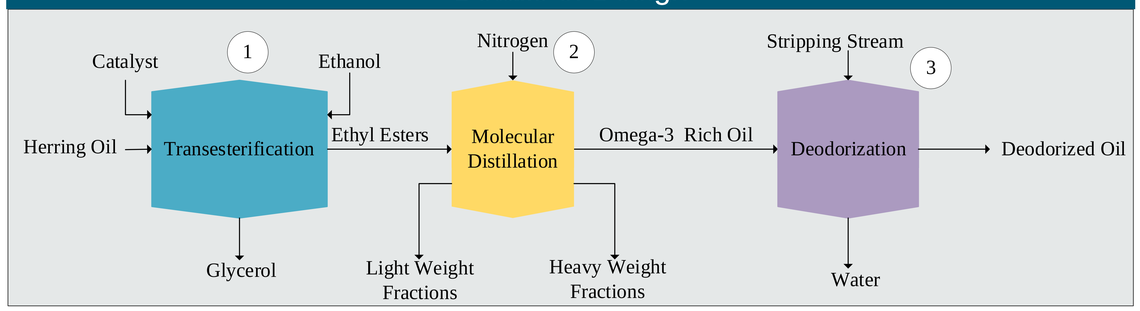
Preliminary Design
- Identify a design to produce an omega-3 rich product at the specified capacity.

Detailed Design
- Perform a detailed equipment design for the process including auxiliary equipment.

Economic Analysis
- Identify vendors to provide equipment costs and determine level of success.

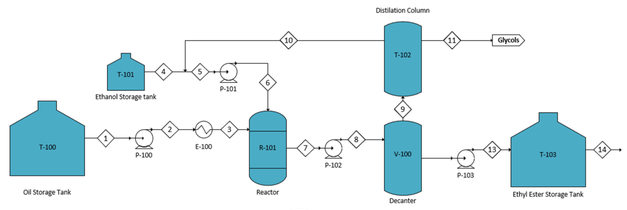
Evaluation
- Assess the remaining oil and impurities to determine possible uses.

Details of Design

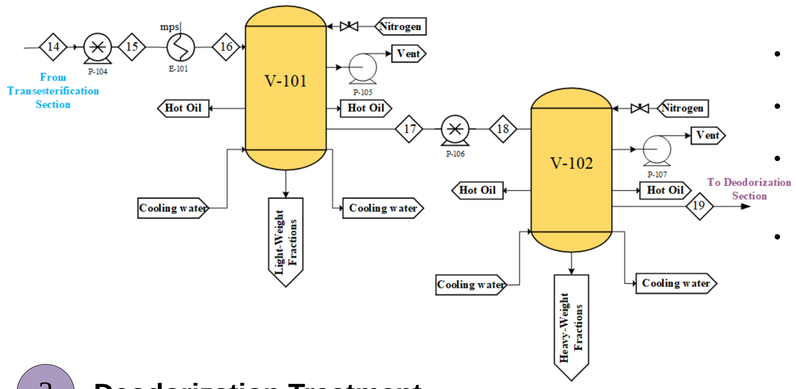


1 Transesterification

- This reaction converts tri, di, and monoglycerides into ethyl esters.
- Feed containing herring oil, ethanol and Lipozyme 435 catalyst.
- Reactor operation temperature is 45 °C
- Ethyl ester conversion needed for molecular distillation.



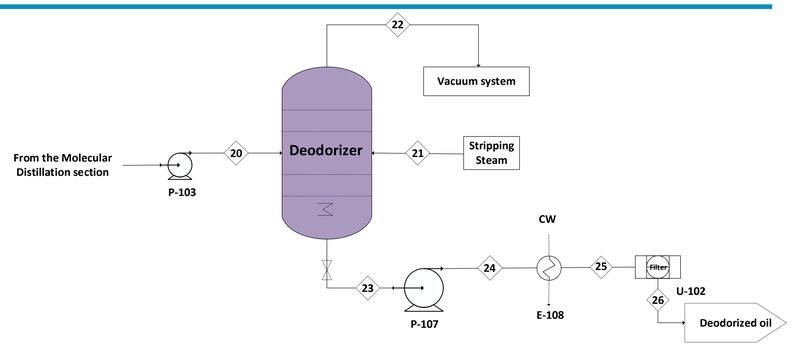
2 Molecular Distillation



- Two stages of molecular distillation under vacuum pressure.
- First stage: The evaporator (V-101) removes lighter weight fatty acids
- Second Stage: The evaporator (V-102) removes the heavier-weight fatty acids.
- Omega-3 enriched oil from the second stage contained 21.9% EPA and 38% DHA.

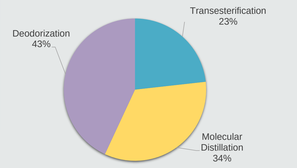
3 Deodorization Treatment

- Batch steam stripping procedure carried out under vacuum; 4 mbar at elevated temperatures of 180°C.
- Deodorization treatment aims to remove volatile compounds such as aldehydes and ketones
- Reduce peroxide values by removing free fatty acids.
- Creates a bland and odourless taste in the final product.

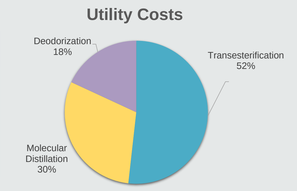


Economic Analysis

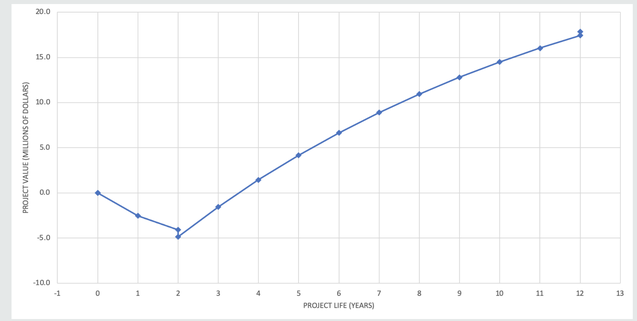
Component	Equipment cost
Transesterification	$ 600,610.00
Molecular Distillation	$ 871,424.50
Deodorization	$ 1,113,000.00



Component	Annual utility cost
Transesterification	$ 17,280.00
Molecular Distillation	$ 10,050.21
Deodorization	$ 6,042.50



Payback Period



Conclusions & Recommendations

- It is possible to produce an enriched omega-3 oil from herring oil with the composition shown below. The process is also economically feasible
- Table 1: Final Composition of Fatty Acids in Herring Oil

SFA	MUFA	PUFA	Omega-3 (n-3)
3.4	36.7	59.9	59.9

- Table 2: Economic Feasibility Results

Net Present Value (millions)	17.87
Discounted Cash Flow Rate of Return	59.97%
Discounted Payback Period (years)	1.3

References

- Kim, Y.-G., Lee, J.-H., Raorane, C. J., Oh, S. T., Park, J. G., & Lee, J. (2018). Herring oil and omega fatty acids inhibit Staphylococcus aureus biofilm formation and virulence. *Frontiers in Microbiology*, *9*. https://doi.org/10.3389/fmicb.2018.01241