

Rutgers University Coffee Fuel

Students run on coffee, now so does Rutgers!

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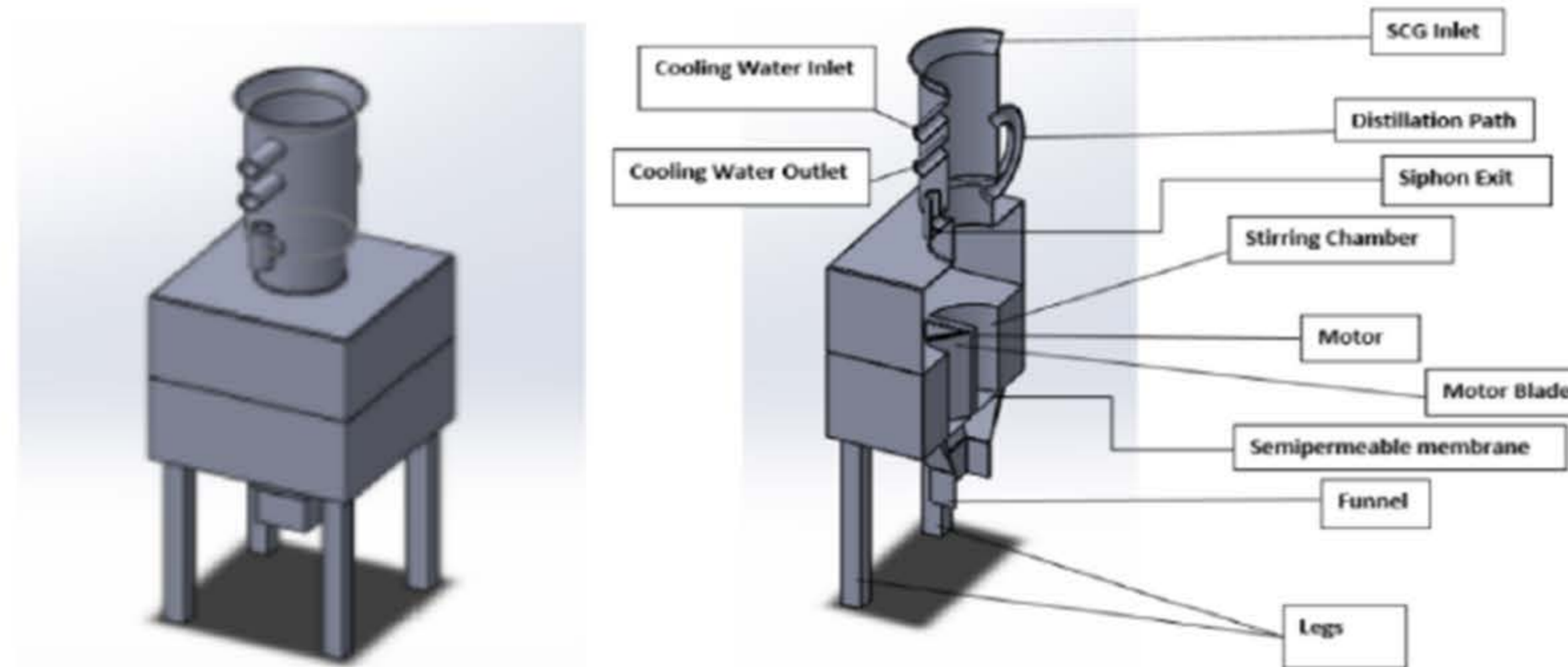
INTRODUCTION

Coffee is one of the largest agricultural commodities in the world. As such, spent coffee grains are one of the largest sources of agricultural waste. Rutgers dining halls use 22,460 pounds of coffee annually. We propose that Rutgers use a machine that implements existing techniques for extracting oils from these spent coffee grains and processes it into useful biodiesel.

This is done in a three step process, lipid extraction, trans-esterification, and separation.

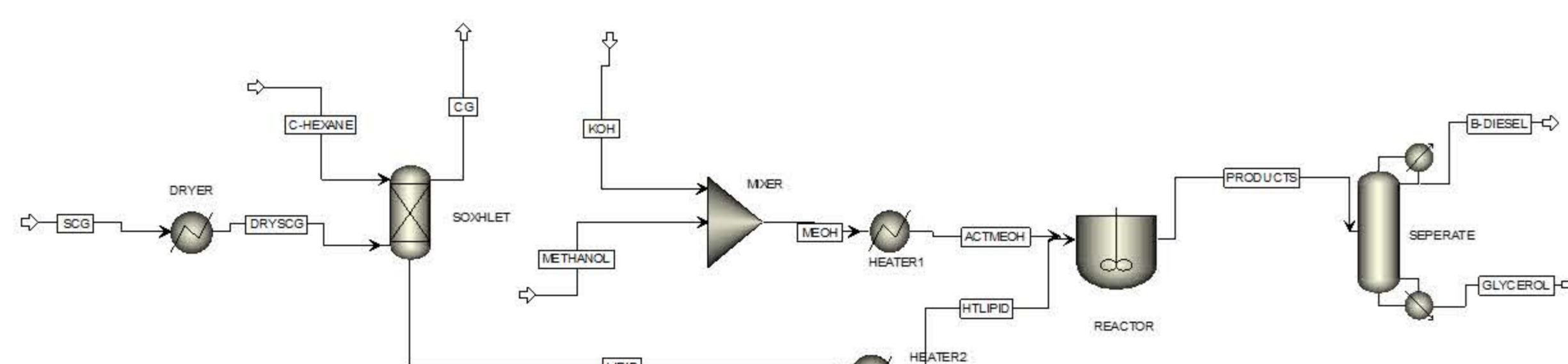


MATERIALS AND METHODS



(Entire Machine- Full View)

(Entire Machine- Sectioned View)



USES

Dining Hall Kitchens

- Burn as fuel if gasified.

Backup Generators

- Mix with diesel to operate diesel powered backup generators.



Rutgers Buses

- Use as fuel to operate campus buses, either directly or mixed with conventional diesel.



EQUATIONS

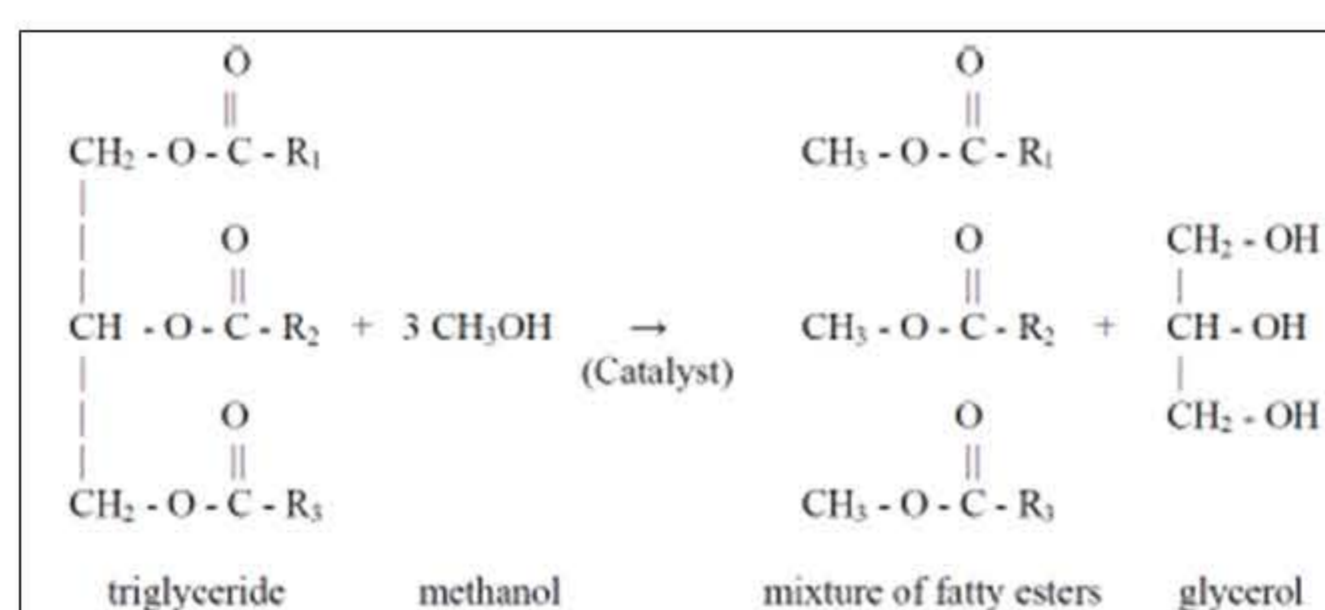


Figure 1. Main Conversion Reaction from coffee oil to biodiesel (fatty esters)

Biodiesel is composed of fatty acid alkyl esters and can be made via transesterification of triglycerides using alcohol. Vegetable oil is composed of mainly triglycerides. Ethanol and methanol will be used in the transesterification reaction. A mix of fatty acid alkyl esters and glycerol will be produced via transesterification using KOH as a catalyst.

$$N_{A0} * \frac{dX}{dT} = -r_A * V$$

Batch Reactor Design Equation

IMPLEMENTATION

Phase 1	Phase 2	Phase 3	Phase 4
Obtain approval and support from the Rutgers Department of Risk Management and Insurance and from the Rutgers Administration where applicable.	Order and assemble the parts necessary for the SCG soxhlet extraction apparatus from a manufacturer. Please see the appendix for our suggested design of this apparatus.	Provide the dining halls with the SCG soxhlet extraction machines. Design and execute a comprehensive training program to teach the dining hall staff how to use this machine properly.	Provide a means of contact for supervisors to request maintenance for this machine when needed. Also provide a survey for user feedback to obtain relevant information regarding user experience with this device.
Phase 1 3-6 Months	Phase 2 3-6 Months	Phase 3 1-2 Months	Phase 4 Ongoing

ECONOMIC ANALYSIS

Costs				
Name	Unit	Quantity	\$/Unit	Total Price \$
Soxhlet		4	200	800
Cyclohexane	gal	1100	0.26	286
methanol	gal	36	1.5	54
Revenue				
Name	Unit	Quantity	\$/unit	Total
Biodiesel	kWh	16100	0.1	1610
Annual				
Costs				340
Revenue				1610
Savings				1270

REFERENCES

1. Ahangari, B., & Sargolzaei, J. (2013). Extraction of Lipids from Spent Coffee Grounds using Organic Solvents and Supercritical Carbon Dioxide. *Journal of Food Processing and Preservation*.
2. "Factors Affecting Electricity Prices." *Factors Affecting Electricity Prices - Energy Explained, Your Guide To Understanding Energy - Energy Information Administration*.
3. "Understanding Backup Power System Fuel Choices." | *Consulting-Specifying Engineer*, www.csemag.com/single-article/understanding-backup-power-system-fuel-choices.
4. "Welcome to University Facilities & Capital Planning." *University Facilities & Capital Planning*, facilities.rutgers.edu/.

On Campus Power Plant

- Supplement power plant and raise temperatures and thus energy recovered in turbines.

