Department of Chemical and Biological Engineering

Single Cell Protein Production

Group B4: Alicia Cortez, Alun Bain, Arjun Venkat, Maddy Rivelis, Meredith Huber, Osbert Yu, Reid Sutherland, Sam Hahn

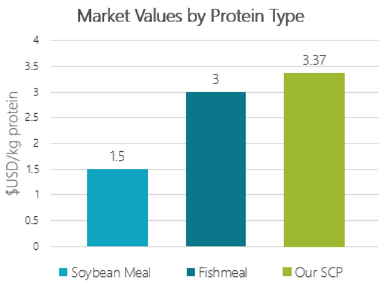
Introduction

From a 5:1 feed of cattle manure digestate pellets from biogas production and spent Coffee grounds this project uses Pyrolysis, and a syngas reactor to create methanol feed a culture of *Methylophylus methylotrophus*. This culture is utilized as a single-celled protein (SCP) and can be fed to livestock. This circular economy between cattle feed and their manure is core to the philosophy of this project.

The goal is to create a method to produce animal feed while processing waste products. Through thermo-catatalytic reforming of our pyrolysis stream we co-produce Bio-Char and Bio-oil, both value-added products in their own right, and our SCP avoids the need for using arable land to feed livestock

Considerations

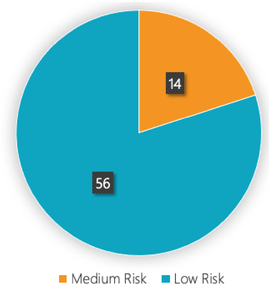
With the environment and efficient costing in mind, it is designed to maximize output with as small a footprint as possible.

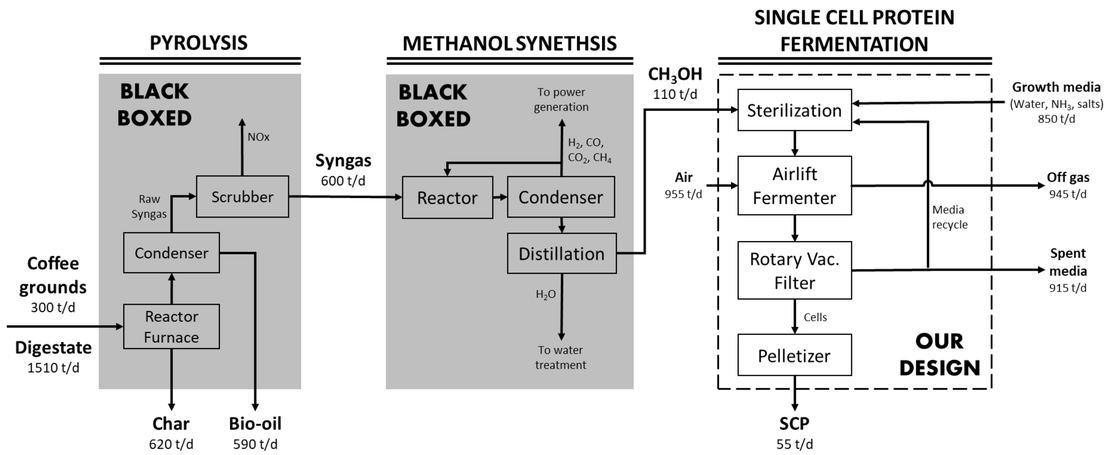


Waste Composition

Component	Units	Off gas	Wastewater
Carbon Dioxide	kg/hr	528	0
Methanol	kg/hr	Trace	Trace
Single Cell Protein	kg/hr	0	36
Salts	kg/hr	0	790
Water	kg/hr	0	37249

Risk Distribution





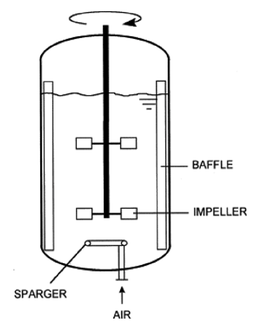
Equipment

Equipment costs can be reduced through use of an airlift fermenter, which has better oxygen transfer properties than traditional stirred-tank reactors.

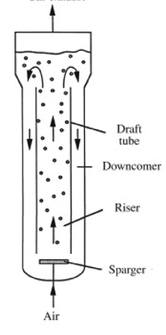
Equipment List

1 Bioreactor
1 Compressor
2 Drum Filters
2 Heat Exchanger
2 Pump, Positive Displacement
2 Pump, Centrifugal
4 Tanks
1 Pelletizer

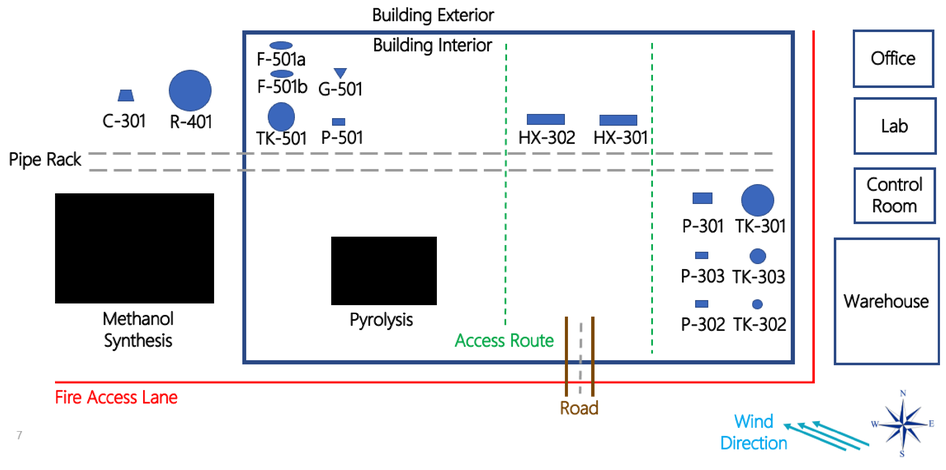
Option A
4 x 150 m³ Stir Tank Fermenters



Option B
1 x 650 m³ Airlift Fermenter

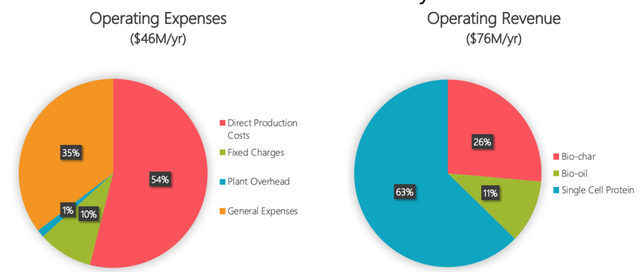


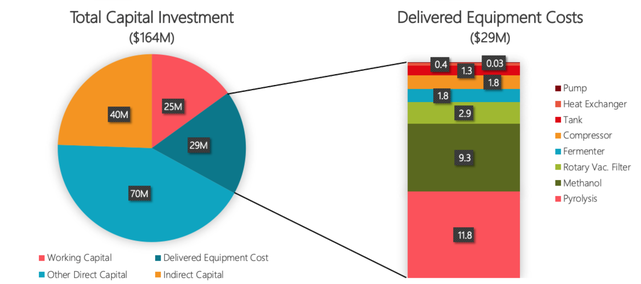
Plant Layout



Economic Assessment

This Project offers very reasonable economics, even though the CAPEX is high for a project of this kind. The internal rate of return is 15% with a full return on investment in 7.5 years





Products	Annual Production (tonnes/year)	Cost ($CAD/tonne)	Sales Value ($CAD/tonne)	Profit Margin ($CAD/tonne)	Annual Profits ($CAD/year)
SCP	18,200	1,598	2,629	1031	18,744,600
Bio-Oil	193,400	25	43	18	7,151,053
Bio-Char	203,800	62	99	37	3,685,720
				Total	29,581,374

Conclusions and Recommendations

This design promises a method to dramatically value-add both biogas digestate pellets and spent coffee grounds while creating a circular economy within a dairy farm, allowing them to produce feed from their waste products. While the Capital expenditure is not inconsiderable, costs are quickly recovered, and the project ends up being highly profitable, as well as eco-friendly.

Conclusions	Recommendations
• Hazard and Operability analysis indicates moderate-low safety risk	• Full process analysis, for accurate pyrolysis and methanol synthesis values
• Environmental assessment supports desired environmental benefits	• Explore additional feedstock options
• Primary source of uncertainty is market fluctuations for feedstocks and products	• Carbon capture on off-gas can improve environmental benefit
• Market projections positive for business	• Do it!