Hydrothermal Liquefaction of microalgae targeting bio-crude oil production

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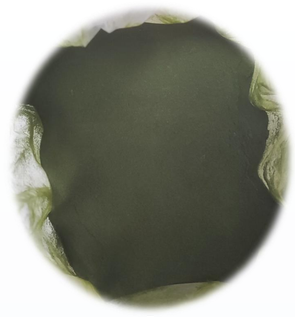
Chlorella Vulgaris

Structure	wt.%
Ash:	5.9
Lipids:	16.7
Proteins:	39.7
Carbohydrates:	26.6
Extractives:	11.7

Introduction

- **Microalgae contain valuable molecules**
  Lipids – Proteins - Carbohydrates
- **Hydrothermal Liquefaction**
  Production of liquid biofuel intermediates

Chlorella Sorokiniana



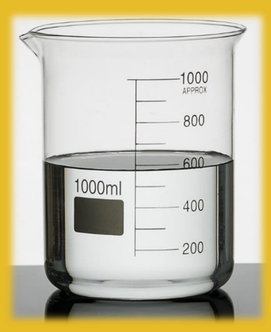
Structure	wt.%
Ash:	7.1
Lipids:	13.1
Proteins:	40.7
Carbohydrates:	13.1
Extractives:	25.1

Methodology

HTL Parameters

- **Solvent:** Deionized water
- **Biomass/solvent ratio:** 1/10
- **Temperature:** 280º – 360ºC
- **Residence time:** 5 – 60 min
- **Inert gas:** Nitrogen 30 bar

Deionized water




Batch autoclave reactor

Objectives

- **Hydrothermal Conversion**
  Microalgae → Bio-crude oil
- **Main parameters investigation**
  - Temperature
  - Residence Time

  Severity factor $R_0 = t \times exp\left[\frac{(T-100)}{14.75}\right]$
- **Comparative study**

Products separation

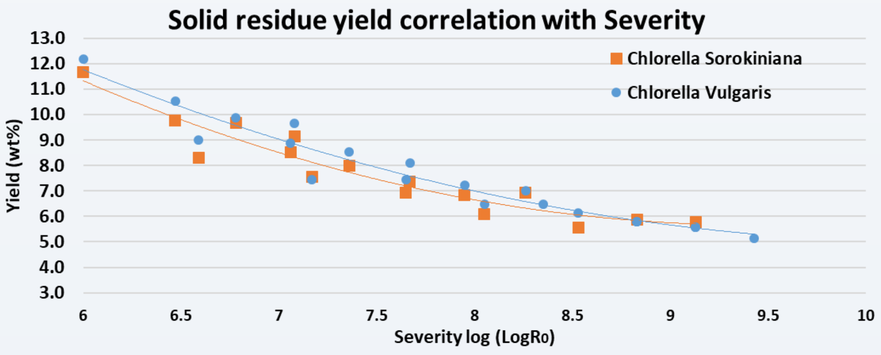
1. Gas sampling
2. Mixture filtration
3. Aqueous phase removal
4. Acetone extraction
5. Solvent evaporation
6. Solid residue drying

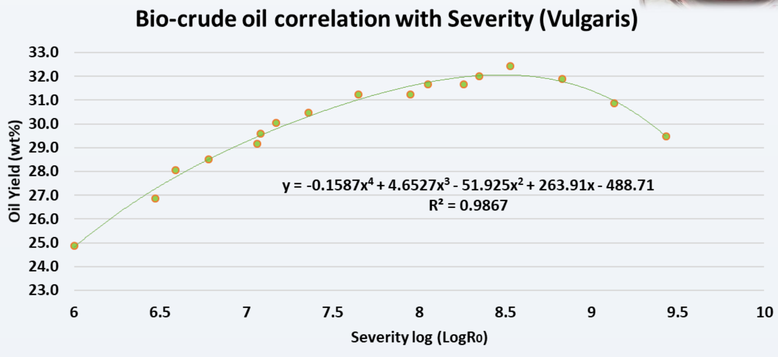
Gas Product

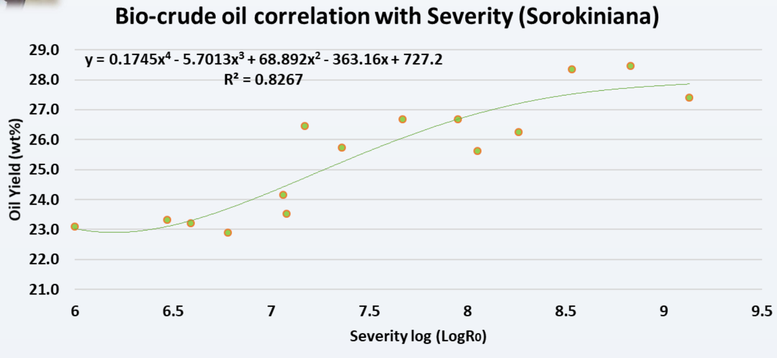
Solid residue

Bio-crude oil

Aqueous Phase

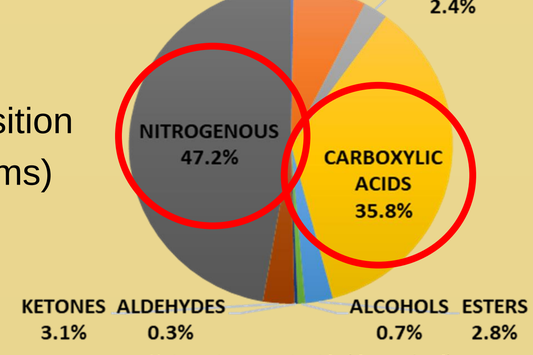


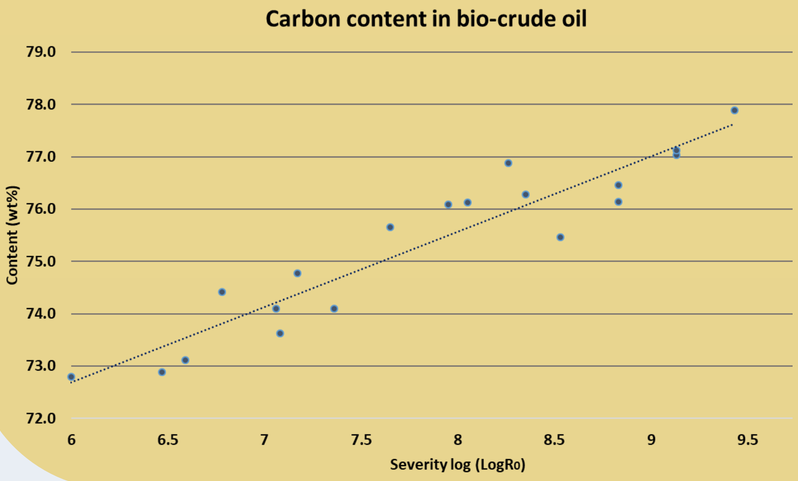


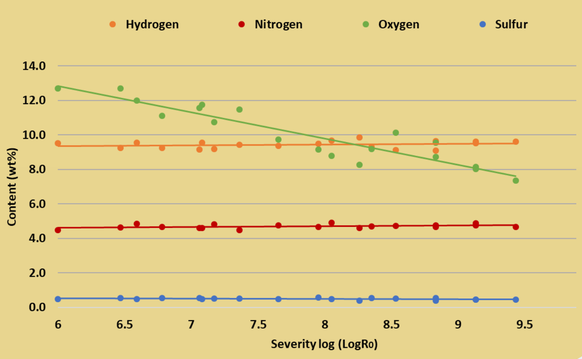


Quality of bio-crude oil

- High carbon content **(> 70 wt.%)**
- Low Oxygen content **(< 14 wt.%)**
- Higher severity → Enhanced elemental composition (**rich** in carbon – hydrogen, **poor** in heteroatoms)
- Bio-crude **rich** in carboxylic **acids** (from lipids)







Conditions impact on bio-crude oil:

- **Yield increase** up to Log(R_0) ~8,5 (350 ºC – 15 min)
- Log(R_0) > 8,5 → **Gasification** of biomass
- Maximum bio-crude oil yield: **32.5 wt.%**
- **Vulgaris yields more bio-crude** due to its favorable lipid and low extractives content

Conditions impact on solid residue:

- Higher severity → Greater decomposition

Conclusions

- **Successful production of bio-crude oil via HTL**
- **Temperature and structure - most decisive factors**
- **Bio-crude oil production yield > 30 wt.%**

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