1-14-2015

2015 AQ Summit: Research Update by Peter Van Walsum

Peter Van Walsum

What can chemical engineering do for aquaculture R&D?

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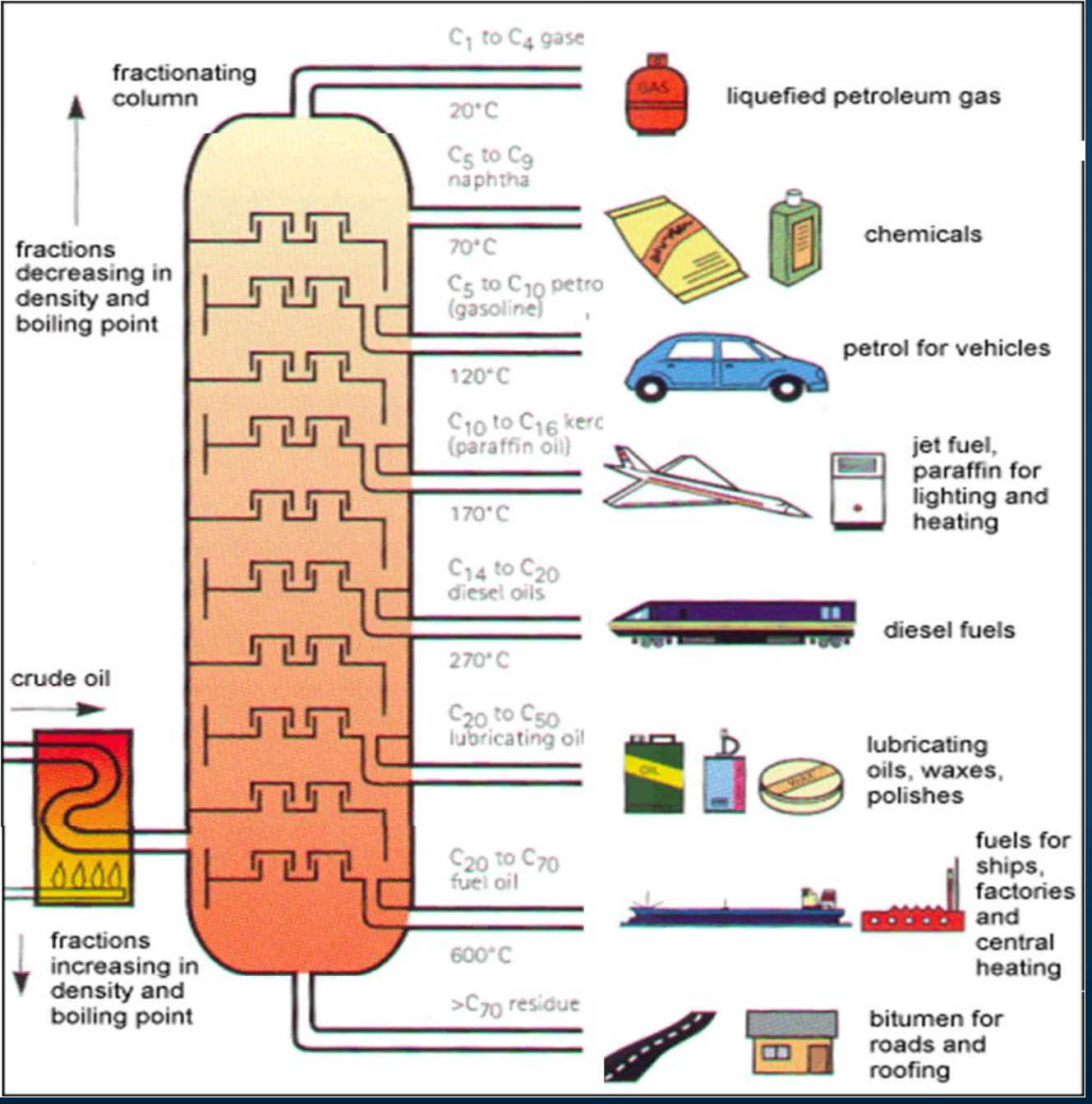
What is Chemical Engineering?

- Designing processes that:
  separate, convert and purify
  raw materials into more valuable products
  - Crude oil → fuels, lubricants, chemicals.
  - Corn → starch, corn oil, ethanol, feed
- Designing production of useful materials
  - Adhesives
  - Composites
  - Pharmaceuticals

  Coatings
  Plastics
  Drug delivery

Diversity of Oil Refinery Products



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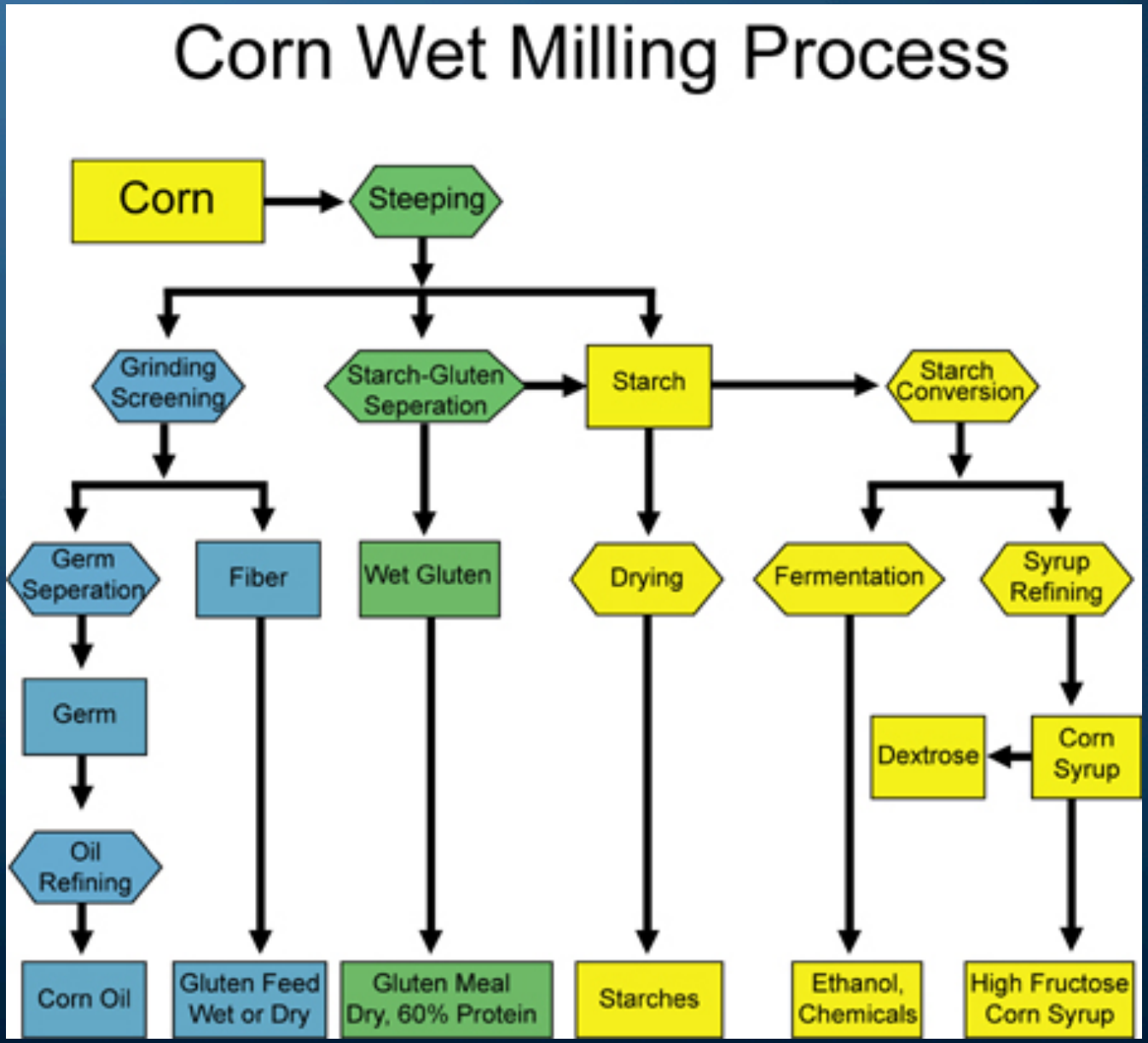
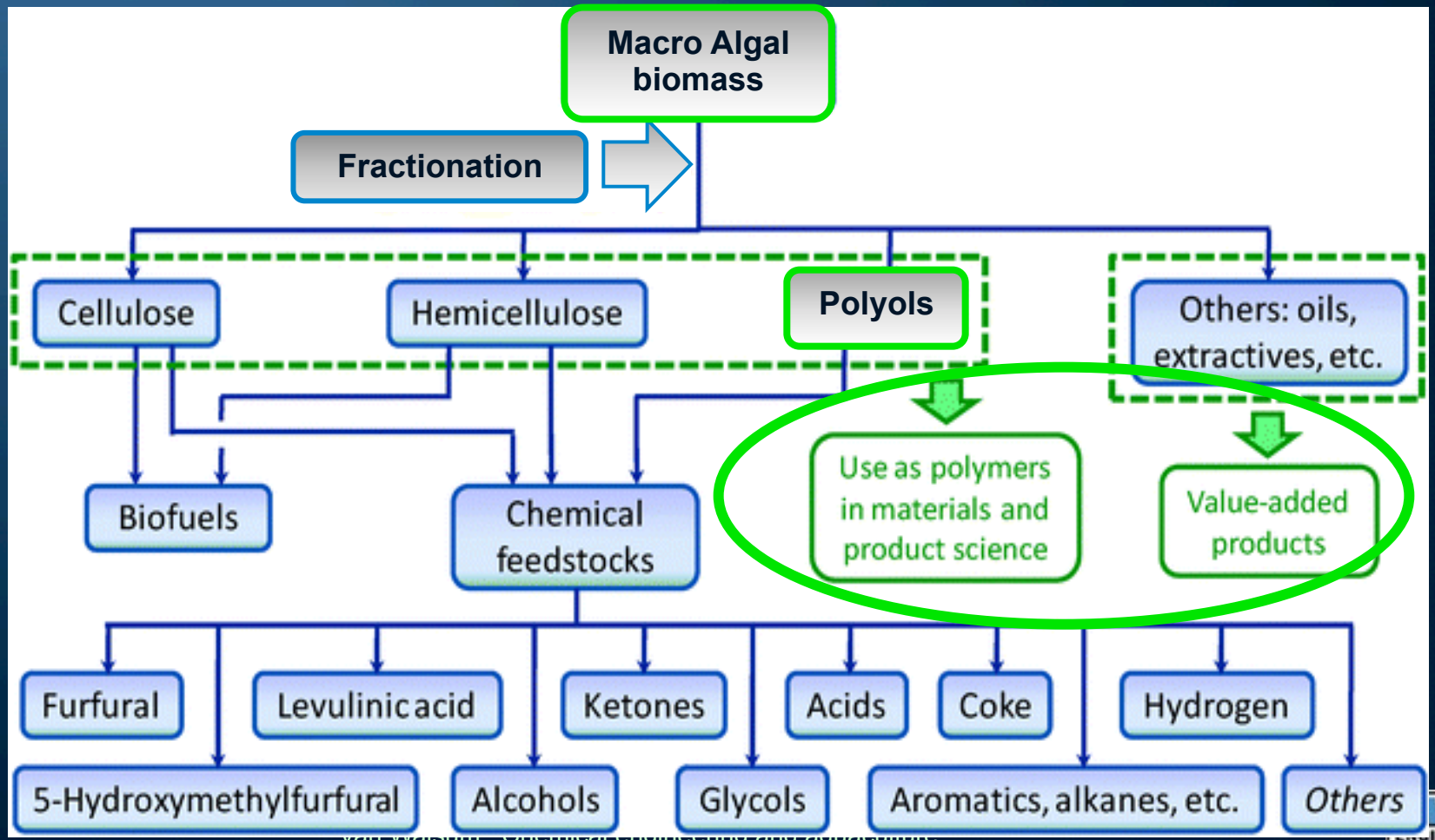
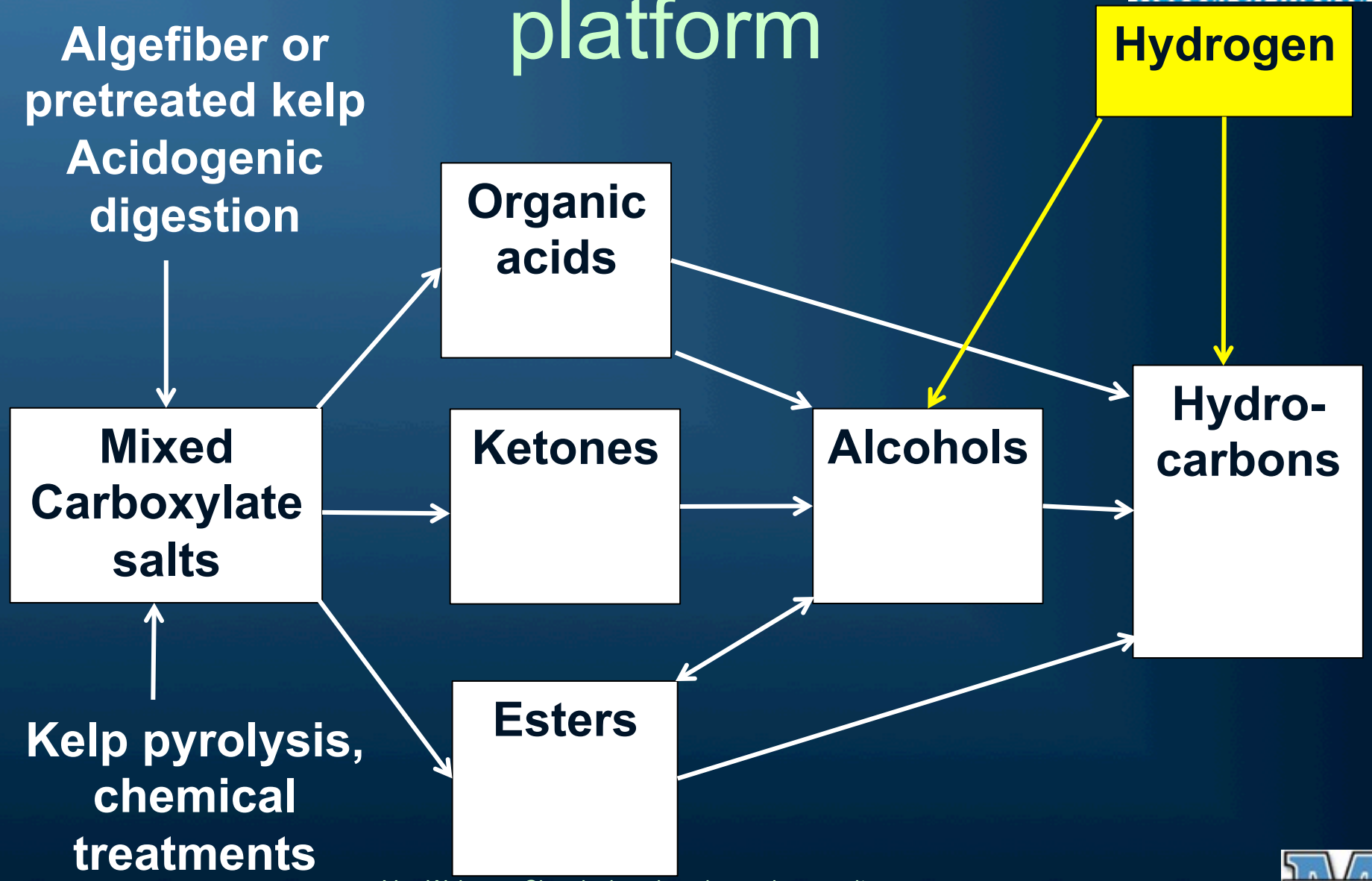


Diversity of Corn Milling Products

Biorefinery: processing structural biomass material



Carboxylate platform



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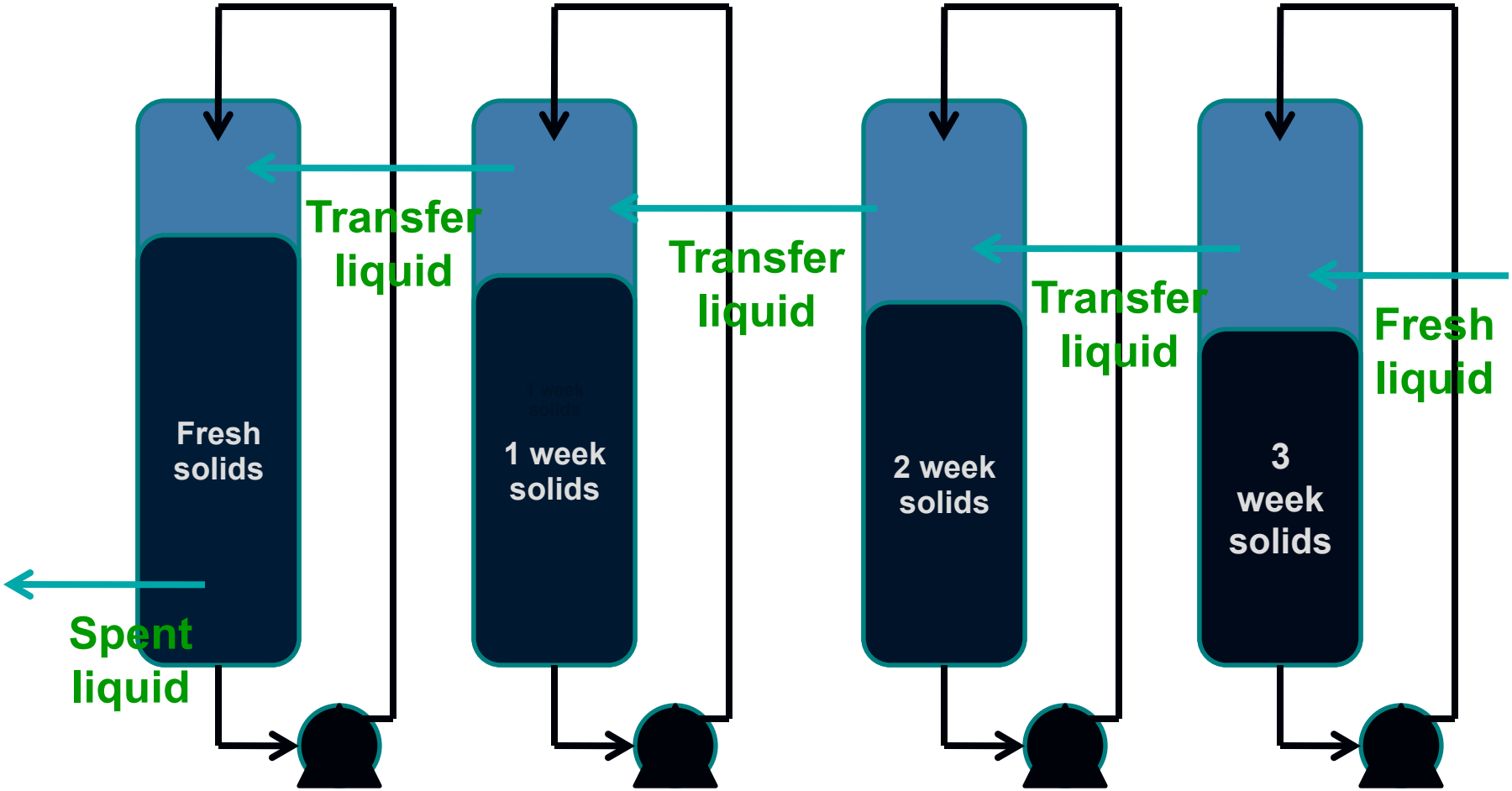
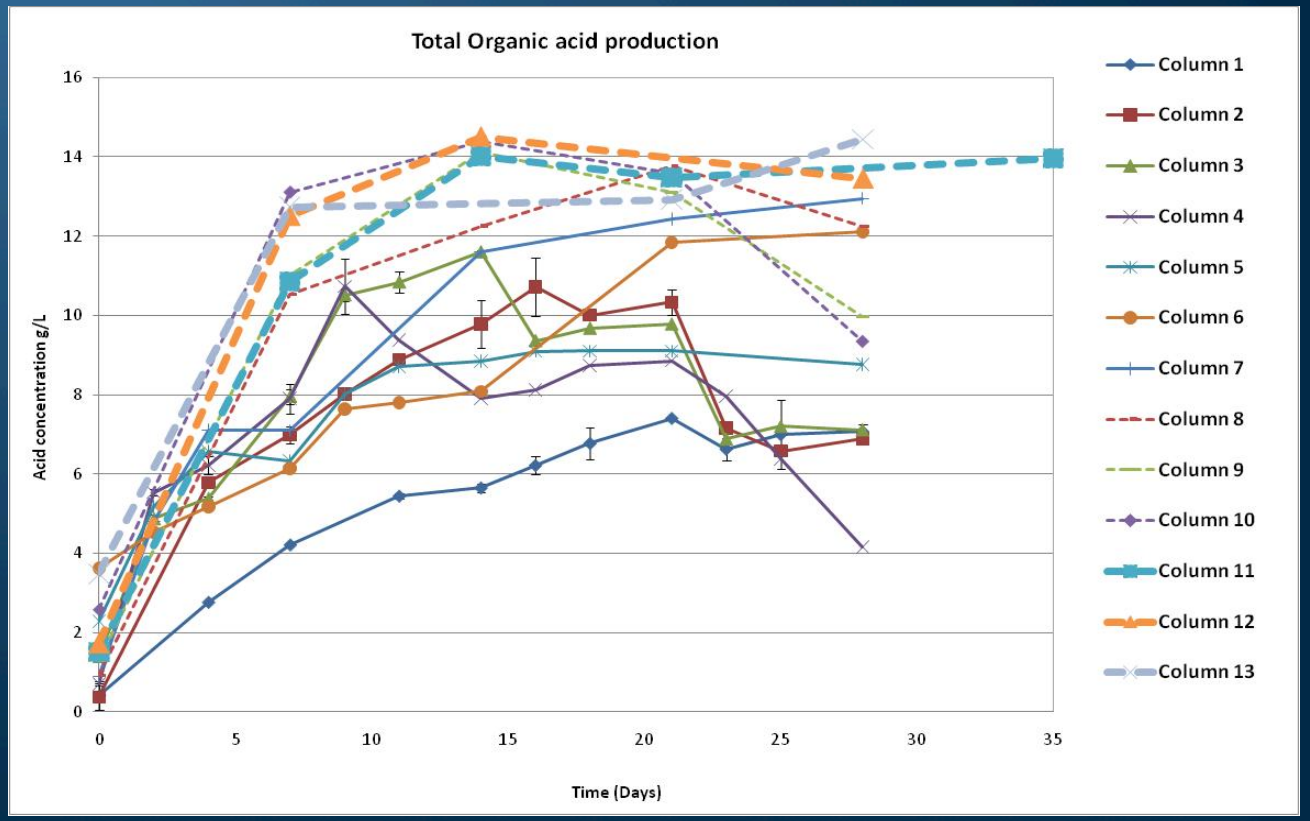
Algefiber: Mixed culture fermentation in Percolation columns

Four columns contained within one temperature controlled box box.

Columns in series: counter-current



Counter current percolation fermentation



Columns 10, 11, 12 achieved max titer of 14 g/L in two weeks

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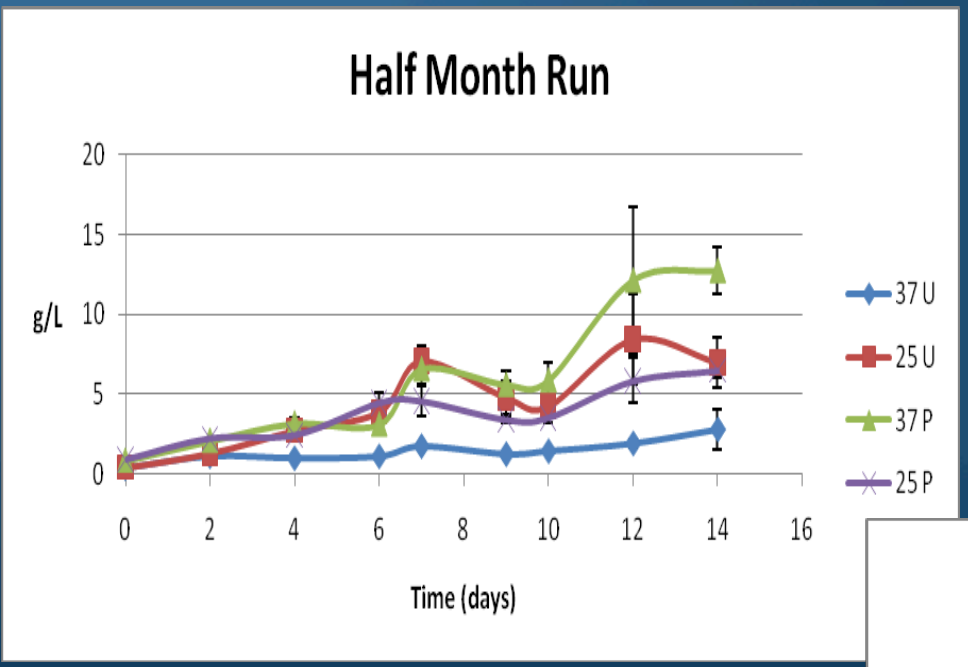
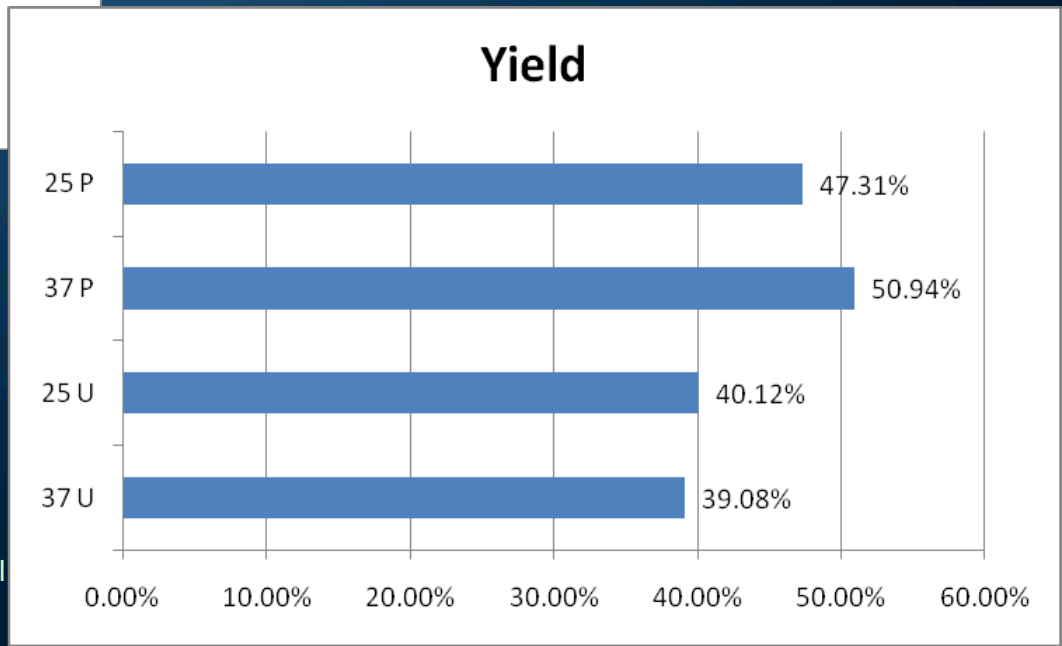
Kelp

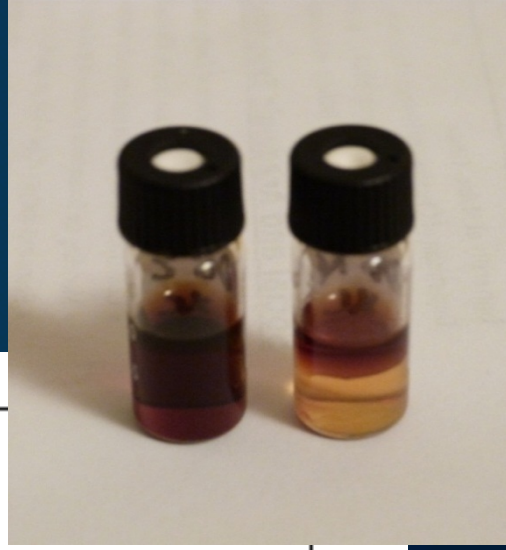
- One of the most abundant biomass sources in the world
- Does not require land and freshwater resources
- Grows faster than other biomass feedstocks
- Easily harvested
- Almost zero lignin
- Long coast and cool water in Maine

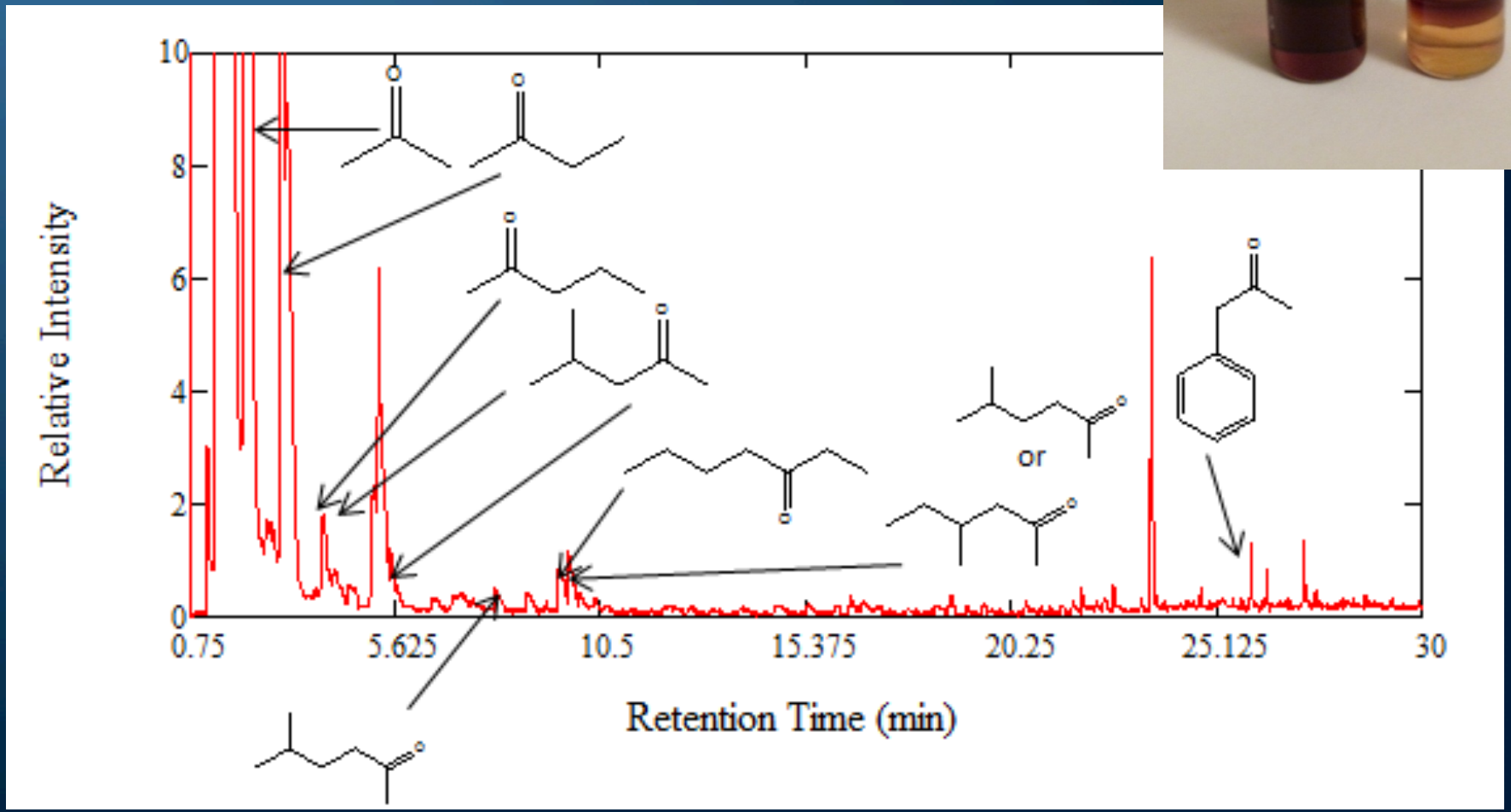
Kelp fermentation results





Ketonization of Fermentation salts





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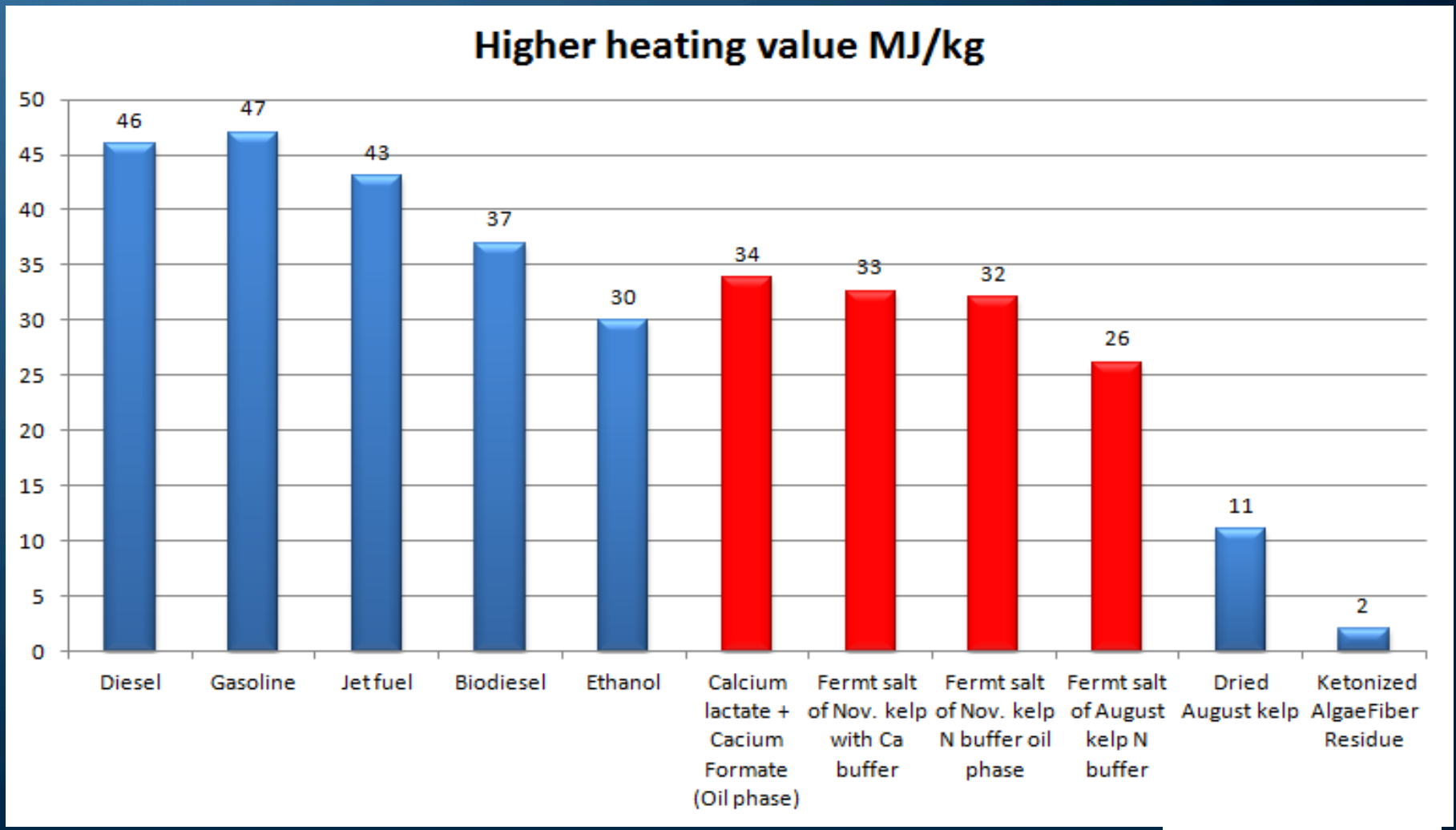
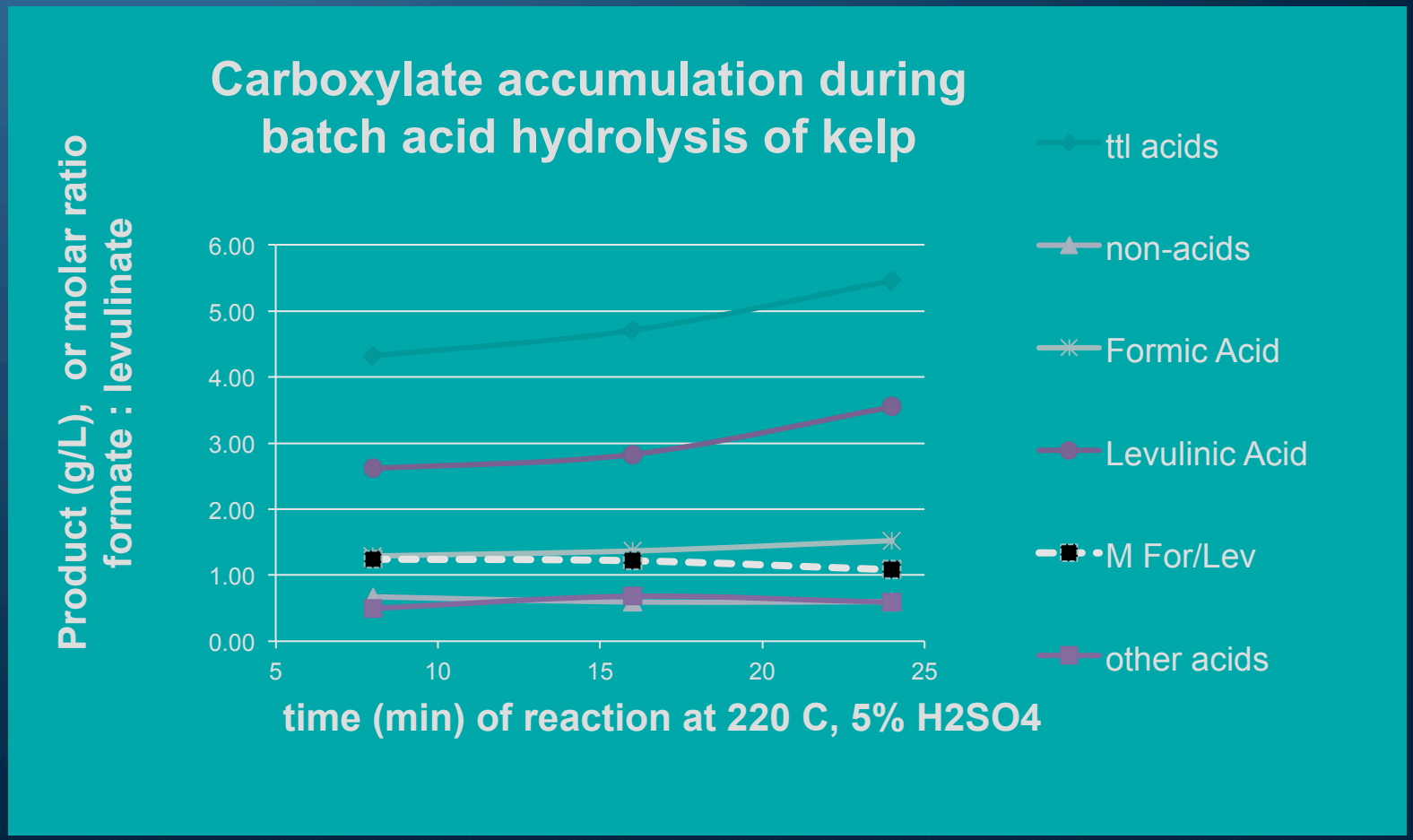

Higher heating value MJ/kg
50
45
40
35
30
25
20
15
10
5
0
46
47
43
37
30
34
33
32
26
11
2
Diesel
Gasoline
Jet fuel
Biodiesel
Ethanol
Calcium lactate + Cacium Formate (Oil phase)
Fermt salt of Nov. kelp with Ca buffer
Fermt salt of Nov. kelp N buffer oil phase
Fermt salt of August kelp N buffer
Dried August kelp
Ketonized AlgaeFiber Residue

Kelp conversion to Levulinic and Formic acids



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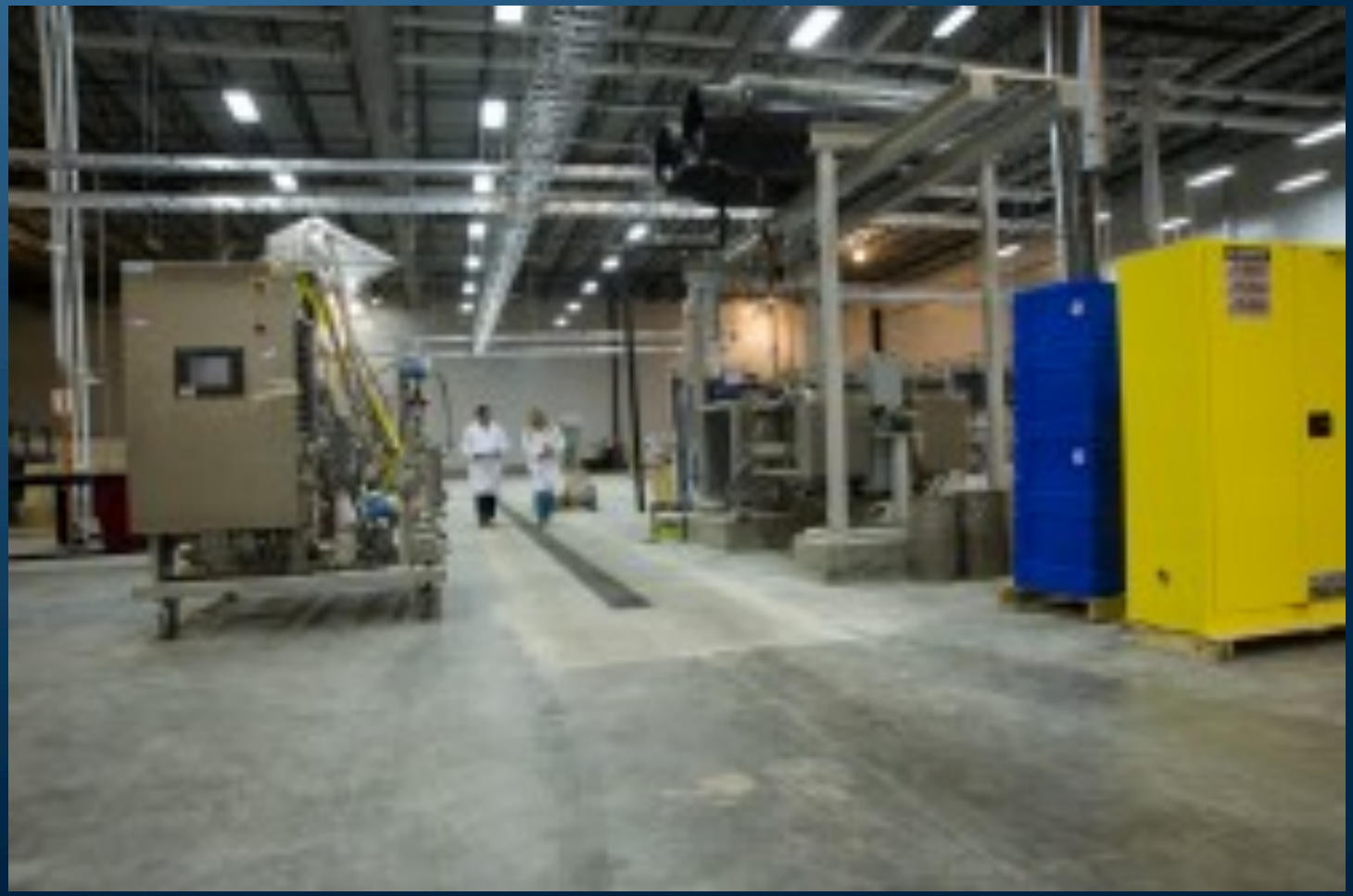
FBRI Pilot plant and analytical capabilites



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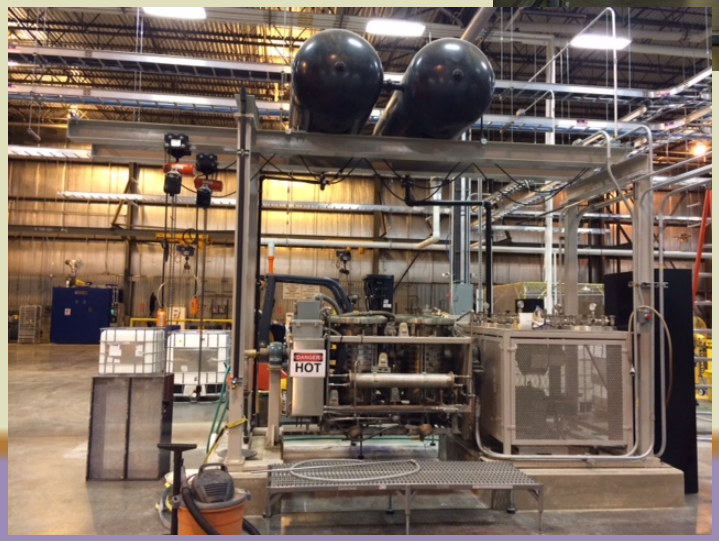
Chemical Reactors



- TDO reactor, atmospheric pressure, high temperature (900 F), 50 L
- Hodgins Reactor for extraction and pulping, 14 dry kg per run, up to 180 psig

Parr Chemical Reactors

- 20 L Parr stirred reactor, up to 1800 psi, hastelloy C, acid hydrolysis, pulping
- Parr Tubular Reactor, 2” OD. trickle bed reactor, Max temp.: 600°C - Max pressure: 6000 psi - Flowrate: 40 mL/min.

Fermenters

- SIP fermenter, 20L total volume, 15L working volume, automatic sterilization, temperature, agitation, D.O./pH and 4 fixed speed pumps.
- 3 – 50 gallon anaerobic fermenters
- One 40 L stainless steel fermenter
- 4 – Bioflo 110, shaker flasks

Concentration/Distillation

- The CONVAP/ CONTHERM functions as a compact, scraped-surface evaporator. Model: 6 x 4. Heating surface area: 4 sq. ft.
- Rotovap System has 20 liter evaporating flask and two 10 liter receiving flasks.
- Semi Automatic ASTM Fractional Batch Still, 2L batch

Separation Operations

- Niro Automated Microfiltration Pilot Plant. A ceramic membrane microfiltration pilot plant designed for scale-up to full production, broth clarification, biomass clarification, and recovery.
- CEPA Centrifuge, for harvesting biomass, clarifying process liquids, separating liquid products, processing of granular, crystalline and fibrous suspensions, and separation of filterable and non-filterable sludges.
- Mixer-Settler for liquid liquid extraction
- Liquid-liquid extraction column

FBRI Analytical Capability

- Chemical and Physical Testing - Large/μ-Scale
- Fully Equipped/Staffed Analytical Laboratory
- Gas & Liquid Chromatography
- Atomic & Molecular Spectroscopy
- Wet Chemical Characterization
- Analytical Method Development
- On-line FTIR capability
- Ion Chromatography
- Carbohydrate Analysis
- In-process & Final Product Material Characterization

Fuels Chemicals Advanced Materials

Summary of macro algae derived products to date

- Fermented algefiber and pretreated kelp to mixed carboxylates→ketones, mixed alcohols
- Acid hydrolysis of kelp to levulinic acid and formic acid.

Questions?

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