MACROFUELS

WP4 Thermochemical Fuel Production

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WP4

- Partners: ECN, AVT
- 41 PM, Month 1-48.
- Goals:
  - Developing thermochemical conversion routes of seaweed fractions and isolated sugars to furan-based fuels.
  - Upscaling to kg scale and production of fuel for engine tests.

Approach

- Research on furan-based fuels production from
  1. Alginate (uronic acids, brown seaweeds) → furfural
  2. Xylose (red & green seaweeds) → furfural
  3. Laminarin (glucose, brown seaweeds) → hydroxymethylfurfural (HMF)
  4. Rhamnose (green seaweeds) → 5-methyl furfural
- Production of sufficient fuel for characterisation (WP5)
- Production of one fuel for engine test (WP5)

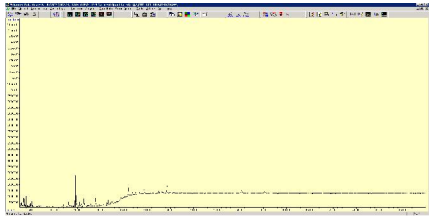
Deliverables

Deliverable	Title	Responsible partners	Due date
D4.1	Alginate furanic fuel	ECN	24
D4.2	Xylose based furanic fuel	AVT	30
D4.3	Laminarin (Glc) based furanic fuel	*AVT*	30
D4.4	Rhamnose based furanic fuel	*ECN*	30
D4.5	Fuels sample for WP5 for engine testing	ECN	36

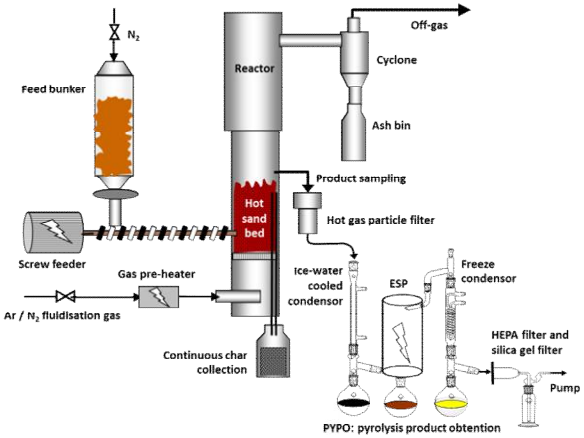
- Partner in italics: change to DoA.
- Swap of tasks 4.3 and 4.4 between ECN and AVT.

4.1 Alginate to furfural (ECN)

- Starting point:
  - Literature.
  - Analytical Py-GC/MS work in earlier project on alginic acid showing selective formation of furfural.



Analytical Py-GC/MS



Fluidized bed reactor

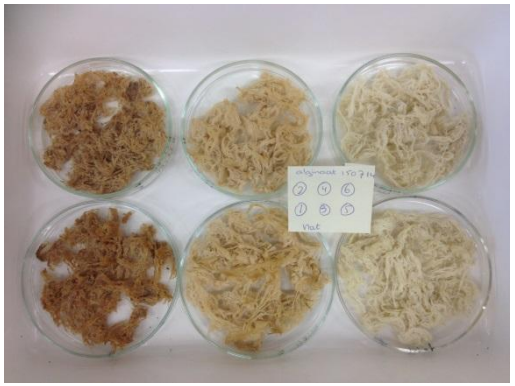
4.1 Alginate to furfural (ECN)

- Benefit:
  - Easier separation of furfural compared to current water-based processes (diluted streams, azeotrope).
- Viable route?
  - Not based on current pure and expensive alginate sources.
  - However, giant reduction of alginate price expected when large-scale seaweed biorefinery is implemented.
  - Research questions:
    - Can we use impure alginate streams (further cost reduction)?
    - Can we scale-up from mg-scale to kg-scale?

4.1: Alginate to furfural (ECN)

- Approach:
  - Commercial alginic acid conversion using analytical Py-GC/MS → optimum conditions.
  - Conversion of commercial alginic acid to furfural on kg-scale using bench-scale (fluidized bed) pyrolysis equipment.
  - Production of fuel for initial fuel analysis (WP5).
  - Verification of route using alignic acid isolated from seaweed (WP2).

Laminaria digitata



Isolated alginate

4.2: Xylose to furfural (AVT)

- Approach:
  - Benchmark condition xylose conversion to furfural: literature study and experimental verification.
  - Application of determined conditions for conversion of xylose-rich streams from WP2 to produce furfural-based fuel for WP5.

Palmaria palmata

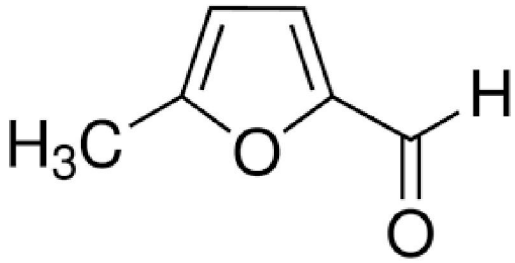
4.3: Glucose to furans (AVT)

- Approach:
  - Starting point: AVT process for production of furanics from starch / glucose.
  - Isomerisation of glucose in laminarin hydrolysates from WP2 to fructose
  - Application of AVT process for conversion to furans
  - Production of a suitable amount of fuel for tests in WP5.

4.4: Rhamnose to 5-methyl furfural

- Starting point: rhamnose from Ulva succesfully converted to 5-methyl furfural by ECN in 2015.
- Approach:
  - Yield optimisation of process using commercial rhamnose.
  - Application optimum conditions for rhamnose (-rich streams) from Ulva in WP2.
  - Production of fuel for WP5.

Ulva sp.



4.5: Fuel batch for engine testing

- Assessment together with WP5 on fuel properties determined in tasks 4.1-4.4.
- Selection of most promising fuel.
- Production of large fuel batch for engine tests in WP5.

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