Food as fuel:

How to determine amount of biogenic component in liquid fuels

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Crops can be used for **food**, feed, fiber or **fuel**. In order to reduce the greenhouse gas (GHG) emissions, one of the solution is to produce biofuels which can substitute fossil fuels and are in theory carbon neutral. The production of crops for biofuel competes with production for food at arable land. In order to work together with food production, the 2nd and 3rd generations of biofuels use crop residue after food farming, such as stems and lignocelluloses, and algae.

Biofuels

Liquid

Bioethanol
from sugars, starch and cellulose

Biodiesel
from oils – transesterification

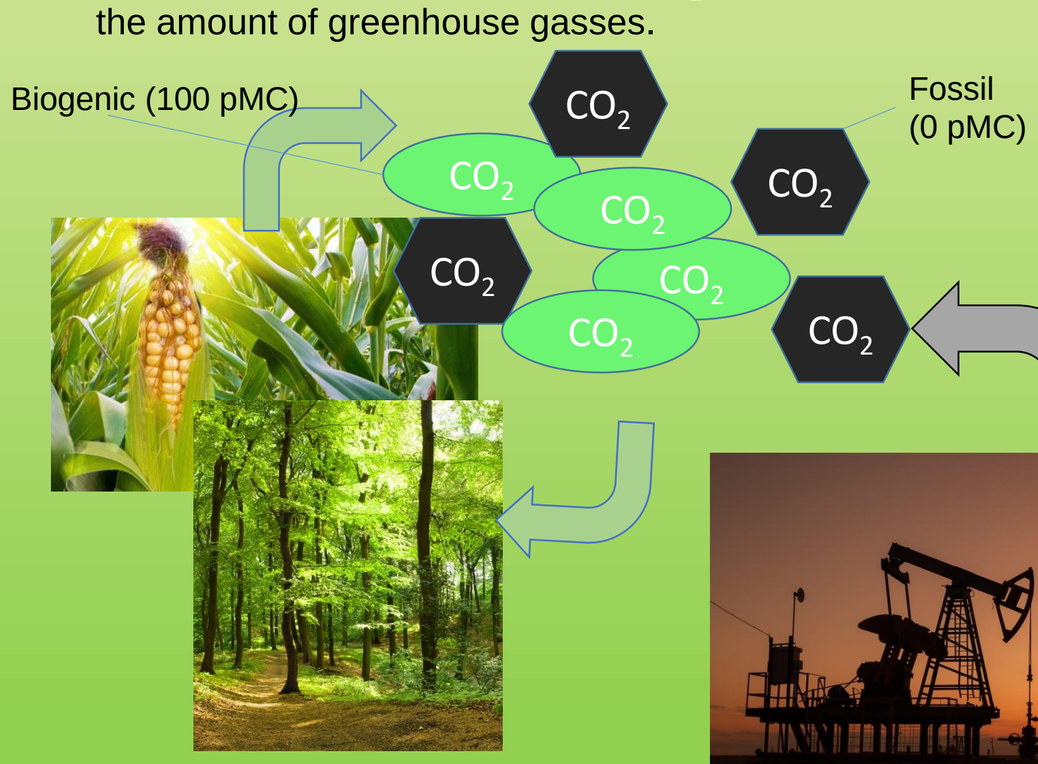
1st generation: sugar, starch, vegetable oil and animal fat (sugar cane, corn, sunflower…)

2nd generation: from sustainable feedstock in form of waste material (e.g. rice straw, wood waste from paper industry, municipal bio-waste, used vegetable oil…)

3rd generation: microalgae that produce oils

Why are biofuels carbon-neutral?

The plant that grows on fields takes up CO_2 from the air and when the plant gets used for fuel, it releases the same amount of CO_2.
When fossil fuels are used, extra CO_2 is introduced to the atmosphere raising the amount of greenhouse gasses.



The biogenic carbon reflects ^{14}C activity ($a^{14}C$) of the atmosphere (100 % Modern Carbon = 100 pMC). Fossil carbon practically does not have any ^{14}C due to its decay half-life of 5730 years (0 pMC). This is how we can distinguish fossil from biogenic carbon.

There are subsidies for introduction of bio-component in fuels and thus the bio-component fraction should be accurately known.

However, measurement of ^{14}C activity is often expensive and time consuming!

^{14}C activity measurement techniques

LSC
Liquid Scintillation Counting
Requires 2 – 4 gC

- $-C_6H_6$ synthesis
- $-CO_2$ absorption

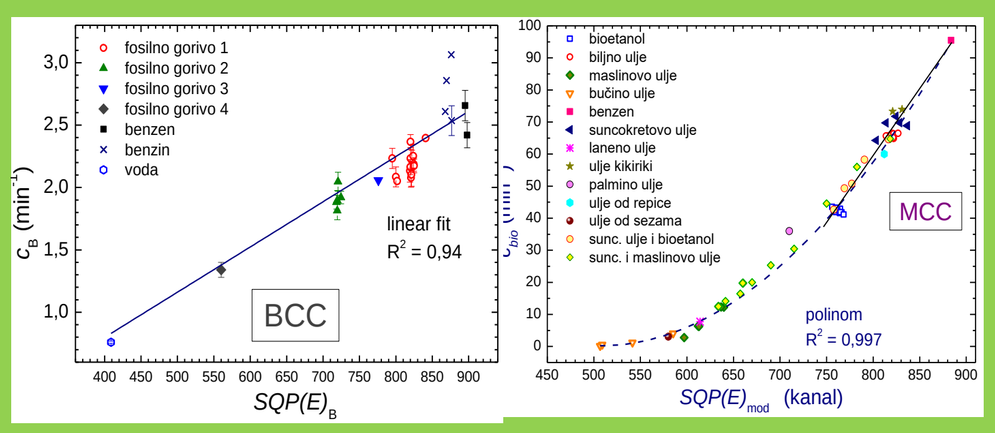
(time consuming and expensive)

AMS
Accelerator mass spectrometry
Requires 1.5 mgC
(time consuming and expensive)

Direct LSC

A direct measurement of the ^{14}C activity in liquid fuel by liquid scintillation counter (LSC) is a **simple** and fast technique for determination of the bio-component fraction in the liquid fuel.

The IRB direct method is based on calibration curves for modern (MCC) and fossil/background (BCC) samples of different color intensity (i.e. quenching parameter, *SQP(E)*).
It does not depend on the exact chemical composition of the liquid and gives reliable results for **not-highly quenched** samples. For highly quenched samples (dark colored) the accelerator mass spectrometry can be successfully used.



Bio-pyrolytic oils – dark, not dissolvable in custom organic solvents – application of AMS