Converting coffee by-products to a promising renewable fuel for the coffee processing sector

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Problem statements

- About ten million tons of green coffee beans are produced worldwide annually in processing facilities from coffee berries, leaving behind approximately the same amount of by-products in dry matter.
- Coffee consumption or processing to instant coffee produces spent coffee grounds as a waste.

Main research questions

- Can hydrothermal carbonization (HTC) improve the energetic properties of coffee by-products?
- Is it possible to substitute fossil fuels by using the carbon-rich product (hydrochar) from coffee by-products? Does hydrochar fulfill quality criteria in common fuel standards (e.g. DIN, RAL)?

Research methods

Spent coffee ground (SCG) → HTC reactor 18.6 L → Hydrochar (HC) → Characterization and evaluation → Combustion

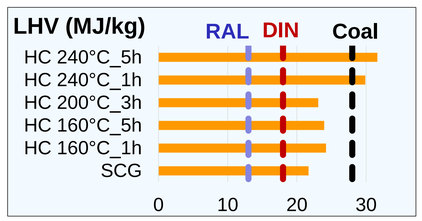
Calorific values: **LHV**, **Ash**.
Inorganic elements: **Cu**
(others are under detection limit, Hg was not analysed)

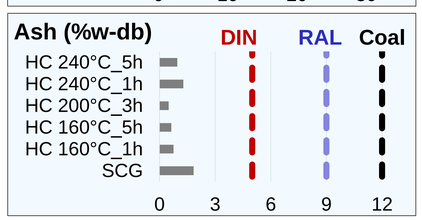
DIN EN ISO 17225
Thermally treated non-woody biomass fuel
As, Cd, Cr, Cu, Pb, Hg, Ni, Se, Zn

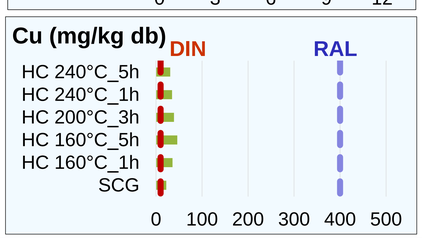
RAL-GZ 724
Solid recovered fuel
As, Cd, Cr, Co, Cu, Pb, Hg, Ni, Se, Zn, Tl

Experimental results

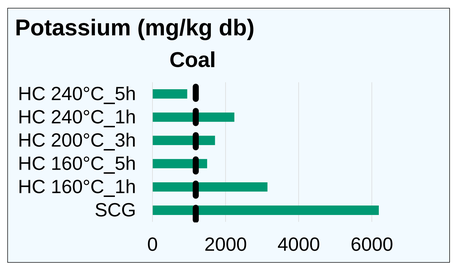
- ***Effect of HTC on calorific value and inorganic elements in SCG hydrochars***
  - LHV: increased app. 30% at 240ºC, exceeded LHV of coal. Both SCG and its HC achieved the criteria of DIN and RAL.
  - Ash: decreased 72% during HTC and met both fuel requirements easily, especially much less than coal.
  - Cu: did not decrease during HTC and exceeded the limit value in DIN.







- ***Reduction of potassium (K) in SCG to avoid the potential of slagging and corrosion during combustion***



- HTC reduced 50 - 85% of K concentration in hydrochars;
- HC at 240ºC in 5 hours showed the highest reduction in K concentration, and was less than that of fossil coal.

Conclusions

- SCG and its hydrochars meet the requirements for solid recovered fuel **RAL** for industrial uses. But both do not meet the stricter regulations **DIN** for thermally treated non-woody biomass pellets.
- HTC is a highly promising treatment for SCG. It produced a carbon-neutral fuel with a high LHV, low ash and potassium content that can be used to substitute fossil coal in coffee processing.

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