

KINETIC OF BIOBASED BITUMEN SYNTHESIS FROM MICROALGAE BIOMASS BY HYDROTHERMAL LIQUEFACTION

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The current worldwide consumption of bitumen is about 100 million tons. A remarkable combination of properties (adhesion, impermeability to water, specific thermo-rheological behavior) makes it a key material in road construction. Today's bitumen is mostly obtained from petroleum refining, so bioabased alternatives have to be explored for the future. The ALGOROUTE project funded by the French National Agency for Research (ANR) focuses on the use of hydrothermal liquefaction (HTL) process for the production of bitumen mimicking binders from microalgae biomass. HTL applied to microalgae is inspired by the geological process of petroleum formation, but on a very short time scale: For conditions around 260 °C / 50 bar, bitumen like products have been obtained by our consortium for residence times of about 1 hour [1] [2]. Beside temperature and pressure, the key parameters are the reaction time, algae/water ratio and loading level of reactor.

In order to study the kinetics of bitumen formation, an experimental setup allowing fast heating and cooling rates has been developed. It consists of stirred pressure reactor (300mL) combined with an induction heating system and a water/air spray quenching. The cavity or the reactor is instrumented with a pressure sensor and 9 thermocouples for monitoring of the temperature field (Figure 1), with the objective of understanding the physical and chemical phenomena taking place during the process.

Beside, the origin of the bitumen like behavior needs to be clarified. Using biomass from Spirulina microalgae, controlled HTL leads to an hydrophobic product composed of an oil phase and solid residues. The oil phase has a rheological behavior similar to that of a classical bitumen (Figure 2), while the whole hydrophobic product behaves like bitumens formulated with elastomer additives (Figure 2).

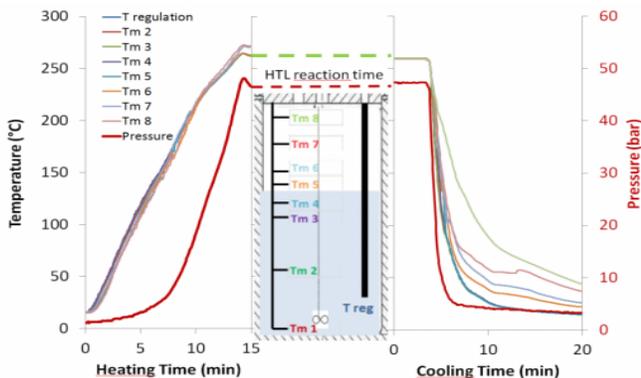


FIGURE 1
Temperature control of the instrumented stirred pressure reactor

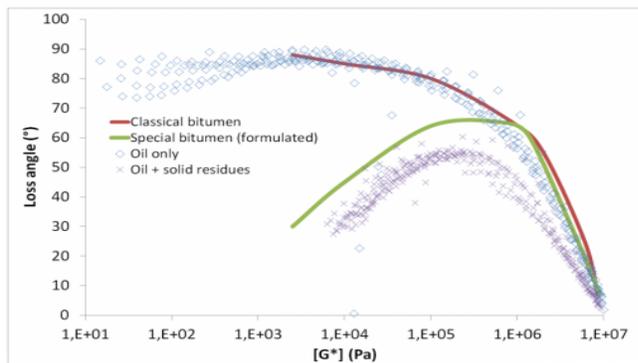


FIGURE 2
Rheological behaviour of oil and oil/solid residues mixture obtained after 60 min at 260 Celsius degree

References

- [1]: I. Borghol et al. Biosourced analogs of elastomer-containing bitumen through hydrothermal liquefaction of Spirulina sp. microalgae residues. Green Chem., 2018,20, 2337-2344
- [2]: M. Audo et al., Subcritical Hydrothermal Liquefaction of Microalgae Residues as a Green Route to Alternative Road Binders. ACS Sustainable Chemistry & Engineering 2015 3 (4), 583-590