

BioMates

PRODUCING SINGLE PHASE FAST PYROLYSIS CONDENSATES FROM STRAW BY STAGED CONDENSATION

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ISSUE

Fast pyrolysis crude bio-oils from straw spontaneously decompose into two phases: a tarry-like phase at the bottom and an aqueous phase on top (Figure 1). In this phase separation process water content in the bio-oil plays a vital role. This investigation focuses on the influence of staged condensation temperature on the water content of the condensates, with the aim of finding the minimum temperature at which the resulting bio-oils collected in the 1st stage will have single phase.

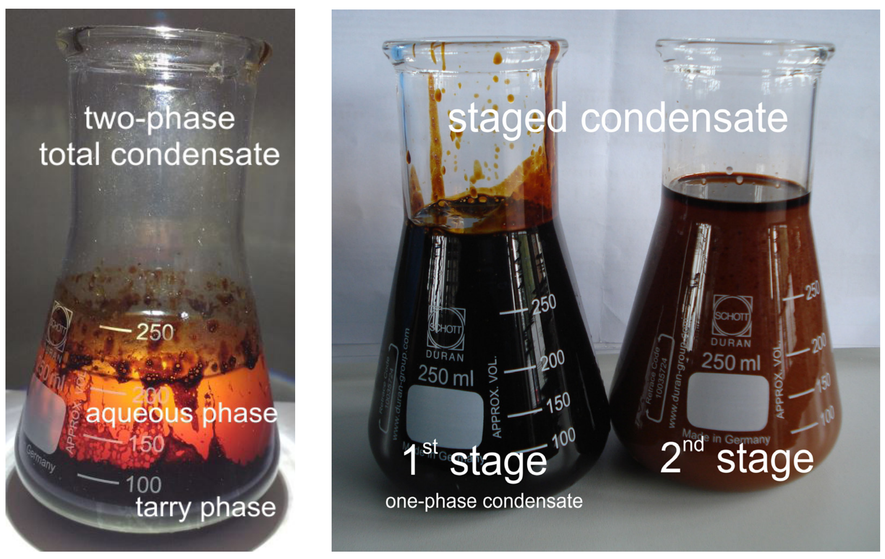


Fig. 1: Two-phase total condensate (left) and single-phase staged condensate (right).

METHODS

The experimental part was carried out in an ablative fast pyrolysis lab-scale reactor (550 °C pyrolysis temperature, 4.2 kg/h biomass and 4.9 kg/h nitrogen input) in combination with a two-stage condensation chain installed in a side-stream (internally cooled condenser and an electrostatic aerosol precipitator at each stage). The condensation temperature of the 1st stage was varied by changing the cooling medium temperature from 60 °C to 80 °C and the temperature of the cooling medium in the 2nd stage was kept constant at 4 °C.

RESULTS

The total condensate (4 °C) had a calculated water content (19.6 wt.% tarry phase, 72.3 wt.% aqueous phase) of 48.6 wt.%. The bio-oil produced in the 1st fraction showed a phase separation above a critical water content, which lies between 25.1 wt.% and 35.9 wt.% at condensation temperature at and below 62.8 °C and no phase separation above 65.8 °C (Figure 2).

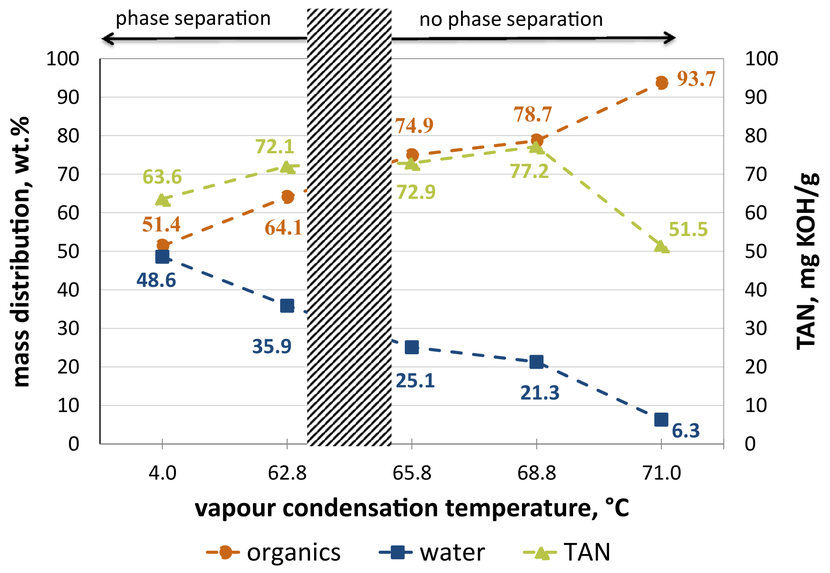


Fig. 2: Relationship between phase separation and water content of the whole 1st stage bio-oil depending on the condensation temperature.

The organics but also water in the 1st stage tarry phase increase at the transition between two-phase condensate (62.8 °C) and single-phase condensate (65.8 °C). With increased condensation temperature more and more water but also organics (including organic acids) will be lost to the 2nd stage (Figure 3).

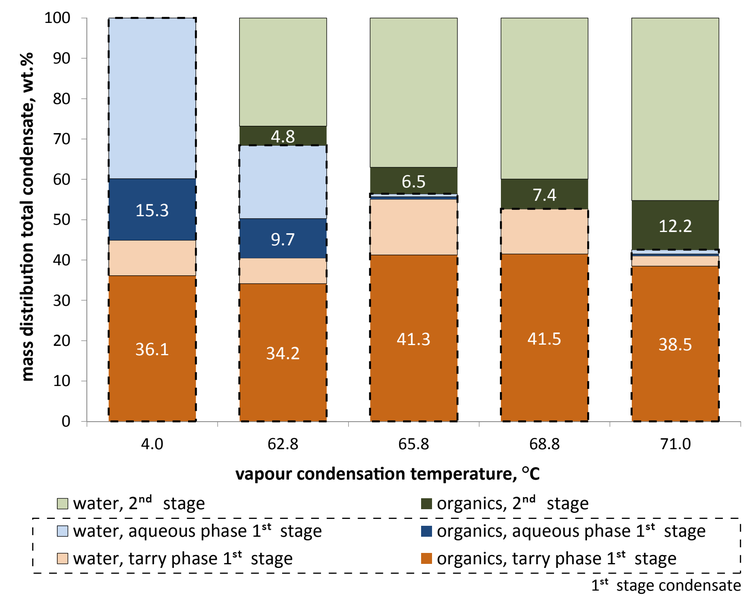


Fig. 3: Distribution of water and organics on the tarry and aqueous phase form 1st and 2nd stage condensates.

The minimum vapour temperature at which the 1st stage condensates will be single-phase bio-oils was found to be 65.8 °C. At higher temperature, the water content and TAN decrease significantly at moderate loss of organics.

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