Título: PYROLYSIS FOR BIOFUELS OR BIOCHAR? A THERMODYNAMIC, ENVIRONMENTAL AND ECONOMIC ASSESSMENT

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Resumen: This thesis assesses pyrolysis pathways for the production of second generation biofuels and for carbon storage in the form of biochar under thermodynamic, environmental and economic aspects. Process simulation is used for modelling the conversion plants and as principal data source for the assessments. For this purpose, both the pyrolysis plants and the biorefinery for upgrading the bio-oil are simulated in Aspen Plus. Focus is put on the pyrolysis plant, for which a predictive kinetic reaction model is developed. This permits the calculation of product yields and compositions for the pyrolysis of any lignocellulosic feedstock as a function of its biochemical composition and the reactor conditions. The reaction model is validated successfully against existing literature data and with a series of own experiments. Exergy analysis methodology is used for assessing the efficiencies of the processes and identifying improvement potentials on a component level of the plants. The environmental assessment

follows the life cycle assessment (LCA) methodology and evaluates the environmental impacts and benefits of the bioenergy products in comparison with fossil fuel alternatives and with alternative use options for the biomass feedstock. Finally, an economic assessment gives an idea of the competitiveness of the pyrolysis products with conventional fuels and therewith potential needs for subsidies.
The production of synthetic biofuels via fast pyrolysis and hydrotreatment shows exergetic efficiencies well above those published for alternative second generation biofuel processes. Under environmental aspects, it nearly reaches a 60% GHG reduction potential in comparison with fossil fuels while still showing significant improvement potential. The estimated final fuel cost can be competitive with fossil fuels if a continuous operation of the plants can be achieved. Processing the biomass in a slow pyrolysis plant to biochar and heat shows a higher exergetic efficiency and higher GHG saving potential than the production of synthetic fuels via fast pyrolysis. On the other hand, it leads to increased environmental impacts in other categories. Economic viability cannot be achieved for the slow pyrolysis biochar process at current fossil fuel prices. In any case, the use the biomass resource for other energetic purposes like co-firing or cogeneration shows potentially higher environmental benefits and could be the better alternative than its processing to biofuels or to biochar for soil application.