A CIRCULAR ECONOMY APPROACH BY CO-GASIFICATION OF WATER HYACINTH AND ALGAE BLOOM FOR HIGH-QUALITY BIO-CHAR PRODUCTION

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Water hyacinth is of interest for biochar production due to its high biomass yields, high carbon content and environmental benefits of carbon sequestration and pollutants removal. Gasification technology has attracted considerable attention to design a renewable biochar production process to be performed on a larger scale for both separation and immobilization of contaminants from water hyacinth and the production of energy and multifunctional materials. The concept of the circular economy has become popular since it is a solution that will allow countries, firms and consumers to reduce harm to the environment and to close the loop of the product lifecycle through three main approaches of reusing, reducing and recycling materials, energy and waste. This study is focused on the sustainable management of water hyacinth biomass via gasification (300-900˚C) to high-value products of biochar, bio-oil and syngas, from the perspective of energy consumption, heat reduction and recycling, emissions to the air and residues in the biochar based on circular economy towards environmental sustainability. The objective is to compare two different types of processes of mono-gasification and co-gasification for environmental, economic and social benefits. The environment, economy and society are inter-related to highlight the new insights for the biochar utilization and resonate with phytobioremediation strategy. The process is based on lab-scale gasifiers/pyrolyzers and a functional unit of a 20KW downdraft gasifier. In our previous experience, we have successfully converted waste biomass from horse manure in Singapore Turf Club to syngas and biochar in the downdraft gasifier. In this study, an equipment level of optimization is implemented for best-operating conditions to improve energy efficiency. In the first process of mono-gasification, biochar is produced from water hyacinth. The alternative to this method is co-gasification, where biochar is now produced with addition of algae bloom. The cost-benefit analysis and life cycle analysis demonstrate the difference in sustainability between these two processes, which offers a higher understanding of biochar production and hence determine which method would be the preferable sustainable practice. It is expected that the co-gasification process could increase the syngas, heat and energy production with high-quality biochar production. One of the major challenges is to guarantee the water hyacinth resources are conserved and used efficiently and affordably.