Comprehensive Evaluation of Char Production Technology from Traditional Chinese Medicine Residue Based on Life Cycle Analysis

Qian Deng, Aijun Li*

School of Energy & Power Engineering, Huazhong University of Science and Technology, Wuhan, China

Email address:

Dengqian37@163.com (Qian Deng), hust_laj@mail.hust.edu.cn (Aijun Li)

*Corresponding author

Abstract

With the rapid development of Chinese medicine industry and the extension of related resources chain, the problem of traditional Chinese medicine residue (TCMR) has become a growing concern for whole society. Char production from TCMR can realize the resource recycling of traditional Chinese medicine residue to a certain extent. Due to the diversity of char production technologies and overall development, there is an urgent need to conduct an evaluation related to char production technologies. In this study, the life cycle analysis method was employed to evaluate the technical schemes of char preparation from TCMR, including low-temperature pyrolysis, hydrothermal carbonization and chemical activation. The results showed that the greatest potential impact of low-temperature pyrolysis on the environment is eutrophication, and a greater impact on the environment during the heating and cooling stages of the process. The biggest potential impact of hydrothermal carbonization on the environment is abiotic depletion, with the hydrothermal carbonization stage of the process having a greater impact on the environment. The greatest potential impact of chemical activation on the environment is human toxicity, and the activation, washing and drying stages have a great impact on the environment. Moreover, low-temperature pyrolysis and hydrothermal carbonization show preferable GHG emission reduction effects. Compared with landfill, the GHG emission reduction of every ten tons of TCMR is 5.65E+04 kg CO_2 eq, 5.84E+04 kg CO_2 eq, respectively. Compared with incineration power generation, the GHG that can be reduced per ten tons of TCMR is 4.14E+03 kg CO_2 eq, 5.99E+03 kg CO_2 eq respectively. There will be an increase in GHG emissions from the chemical activation of TCMR. Besides, the environmental, economic and social benefits of the three char preparation technologies were compared and analyzed. The research shows that the hydrothermal carbonization exhibits the highest environmental and social benefits, but the cost of carbon preparation is high at present; The low-temperature pyrolysis shows the lowest cost. Moreover, it's environmental and social benefits are preferable, and biochar is widely used. The preparation of activated carbon by chemical activation has the highest cost and the lowest environmental and social benefits, but the product has special uses in environmental protection. This study establishes a relatively complete evaluation system for the char production system of TCMR, which lays a foundation for the comprehensive evaluation of the resource utilization of TCMR and provides guidance for the commercialization and industrial application of char production technology from TCMR.

Keywords

Char Production from TCMR, Life Cycle Assessment, Economic Benefits, Environmental Benefits, Social Benefits