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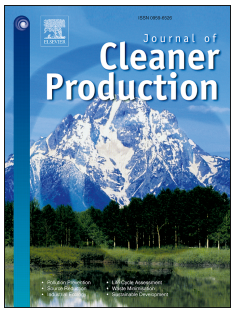

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Mitigation of carbon dioxide emission using liquefied natural gas cold energy in small scale power generation systems

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Abstract

Capturing carbon dioxide under the cryogenic conditions has attracted more attention in the industrial applications. Despite of several large scale studies, the cryogenic carbon dioxide capture has not been well studied for the small scale power generation systems. In this study, a cryogenic carbon dioxide system is proposed for the small scale applications. The liquid carbon dioxide is collected in the liquefied natural gas vaporizer during the regasification process. The proposed design is simulated for the 30, 65, and 200 kW microturbines. In addition to the liquid carbon dioxide, the condensed water and the gas mixture of nitrogen-oxygen are collected as the byproducts of the system. The best carbon dioxide capture ratio is aimed with the minimum energy losses since the generated power rate is a key criterion. The proposed systems are evaluated according to the thermodynamic, environmental, and enviroeconomic perspectives. From the viewpoint of thermodynamics, the systems are found feasible with the low power decrement rates which are 1.81, 3.15, and 3.17% for the 30, 65, and 200 kW models, respectively. The integration of the life cycle-based parameters increases the emitted carbon dioxide rate and the environmental payback periods. The 200 kW model is found infeasible for the applications. A case study is performed for Singapore, and the annual money savings are achieved as 242.57, 726.75, and 1678.56 Singapore Dollars by means of the liquid carbon dioxide capture. The water production annually saves 906.33, 1735.29, and 4535.08 Singapore Dollars for the 30, 65, and 200 kW models, respectively.

Keywords: Carbon dioxide capture, life cycle assessment, liquefied natural gas cold energy, environmental analysis, thermodynamic analysis, polygeneration.

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