conferenceseries.com SciTechnol
J Nucl Ene Sci Power Generat Technol 2017, 6:3(Suppl)
DOI: 10.4172/2325-9809-C1-003

Theoretical assessment of the atmospheric fate and human health impact of amine emissions from post-combustion CO_2 capture

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Emissions from post combustion CO_2 capture plants using amine solvents are of concern due to their adverse impacts on the human health and environment. Potent carcinogens such as nitrosamines and nitramines resulting from the degradation of the amine emissions in the atmosphere have not been fully investigated. It is, therefore, imperative to determine the atmospheric fate of these amine emissions, such as their chemical transformation, deposition and transport pathways away from the emitting facility to perform essential human health risk assessments. In this study an in-depth analysis of the complex atmospheric chemistry mechanisms of monoethanolamine, methylamine and dimethylamine are considered. Rate constants describing the atmospheric chemistry reactions of the amines are obtained within experimental accuracy using theoretical quantum chemistry methods and kinetic modelling. Their dispersion away from the emitting PCCC facility in the atmosphere is quantified using an atmospheric dispersion model, ADMS 5. The cancer incident probability for humans living in vicinity of the plant is also predicted. The implementation of the developed methodology is illustrated by conducting worst-case scenarios on three emitting facilities at different geographical locations. In conclusion, the established method is independent from experimental parameters, which can assess the fate of any generic amine emission and its environmental impact regardless of the size and geographical location of the emitting facility. Since PCCC technology is yet to be widely implemented at a commercial scale in operation; the developed method can ensure if a proposed facility complies with the air quality regulatory limits, essential for its chemical discharge permit.

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Thermoelectric energy harvesting for fuel economy improvement and sustainable development

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Waste heat recovery using thermoelectric energy conversion has garnered an increasing attention as a strong candidate for leading sustainable development and alleviating global warming and environmental problems. Despite importance on industrial fields and human life, the extent of most thermoelectric generation (TEG) research has been fallen into material science and module-level characteristics. In this study, we address energy harvesting performance of TEG from the system-level performance point of view to evaluate its potential on energy saving and fuel economy improvement. For optimal waste heat recovery, a thermal optimization method that includes design of internally finned exhaust gas channel was introduced to induce a proper level of temperature difference across thermoelectric modules while maintaining the pressure drop across the TEG below 3 kPa. The waste heat recovery performance of the TEG fabricated based on thermal optimization analysis was examined on a diesel engine while changing its operating conditions. The output power and conversion efficiency of the TEG are presented as a function of engine load and rotation speed. The maximum output power and conversion efficiency are ~119W and ~2.8%, respectively, using customized thermoelectric modules.

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