Geophysical Research Abstracts
Vol. 17, EGU2015-12350, 2015
EGU General Assembly 2015

A methodology of the assessment of environmental and human health risks from amine emissions from post combustion CO_2 capture technology

Anna Korre, Saba Manzoor, and Alexandra Simperler
Imperial College London, SW7 2AZ, United Kingdom (a.korre@imperial.ac.uk)

Post combustion CO_2 capture (PCCC) technology in power plants using amines as solvent for CO_2 capture, is one of the reduction technologies employed to combat escalating levels of CO_2 in the atmosphere. However, amine solvents used for capturing CO_2 produce negative emissions such as, nitrosamines and nitramines, which are suspected to be potent carcinogens. It is therefore essential to assess the atmospheric fate of these amine emissions in the atmosphere by studying their atmospheric chemistry, dispersion and transport pathways away from the source and deposition in the environment, so as to be able to assess accurately the risk posed to human health and the natural environment.

An important knowledge gap until recently has been the consideration of the atmospheric chemistry of these amine emissions simultaneously with dispersion and deposition studies so as to perform reliable human health and environmental risk assessments. The authors have developed a methodology to assess the distribution of such emissions away from a post-combustion facility by studying the atmospheric chemistry of monoethanolamine, the most commonly used solvent for CO_2 capture, and those of the resulting degradation amines, methylamine and dimethylamine. This was coupled with dispersion modeling calculations (Manzoor, et al., 2014; Manzoor et al,2015). Rate coefficients describing the entire atmospheric chemistry schemes of the amines studied were evaluated employing quantum chemical theoretical and kinetic modeling calculations. These coefficients were used to solve the advection-dispersion-chemical equation using an atmospheric dispersion model, ADMS 5. This methodology is applicable to any size of a power plant and at any geographical location.

In this paper, the humman health risk assessment is integrated in the modelling study. The methodology is demonstrated on a case study on the UK's largest capture pilot plant, Ferrybridge CCPilot 100+, to estimate the dispersion, chemical transformation and transport pathways of the amines and their degradation products away from the emitting facilities for the worst case scenario. The obtained results are used in calculating the cancer risks centred on oral cancer slope factor (CSF), risk-specific dose (RSD) and tolerant risk level of these chemical discharges. According to the CSF and RSD relationship (WQSA, 2011), at high CSF the RSD is small i.e. resulting in a high potent carcinogen risk. The health risk assessment is performed by following the US EPA method (USEPA, 1992) which considers atmospheric concentrations of these pollutants (mg m-3, evaluated by the dispersion model), daily intake through inhalation (mg kg-1 d-1), inhalation rate (m3 d-1), body weight (kg), average time (d), exposure time (d), exposure frequency (d), absorption factor and retention factor. Deterministic and probabilistic risk estimation of human health risks caused by exposure to these chemical pollutant discharges are conducted as well.

From the findings of this study, it is suggested that the developed methodology is reliable in determining the risk these amine emissions from PCCC technology pose to human health. With this reliable and a universal approach it is possible to assess the fate of the amine emissions which remains a key area to address for the large scale CCS implementation.