ASSESSMENT OF ENVIRONMENTAL IMPACT FOR ACCIDENTAL RELEASE OF HEAVY GAS

Yasanthi Nadun Gunawardena

Index No: 119257A

Thesis/Dissertation submitted in partial fulfillment of the requirements for the degree Master of Science

Department of Chemical and Process Engineering

University of Moratuwa
Sri Lanka

June 2016

Declaration, copyright statement and the statement of the supervisor

I declare that this is my own work and without acknowledgement this thesis/dissertation does not incorporate any material previously submitted for a Degree or Diploma in any other University or institute of higher learning and to the best of my knowledge and belief it does not contain any material previously published or written by another person except where the acknowledgement is made in the text.

Also, I hereby grant to University of Moratuwa the non-exclusive right to reproduce and distribute my thesis/dissertation, in whole or in part in print, electronic or other medium. I retain the right to use this content in whole or part in future works (such as articles or books).

…….. …...……..

Y. N. Gunawardena Date

The above candidate has carried out research for the Masters Dissertation under my supervision.

…… ……

Supervisor: Date

Dr. (Ms) M.Y. Gunasekera

…… ……

Supervisor: Date

Dr. M. Narayana

Abstract

An air dispersion model can be used to mathematically simulate air pollutants dispersion in the ambient atmosphere. These dispersion results can be used to predict their environmental impact, concentrations and movement. Such predicted data of hazardous gases released after a chemical accident are valuable since it can be used to provide timely information to emergency response providers as well as to make decisions on siting chemical plants at safe distances from settlements during plant development stages.

Dense gas dispersion is the focus of this research as several pressurized dense gas release accidents have happened during the last few years in this country. These gases form clouds heavier than air when released to the atmospheric environment. In this study a mathematical model for the dispersion of heavy gas due to an accidental release is presented in order to determine the environmental impact.

The heavy gas model was then used to simulate the dispersion of negatively buoyant and highly toxic chlorine gas to illustrate the use of heavy gas dispersion modeling in hazard analysis. A worst case scenario study with stability class A, was used for an accidental release of 900kg of chlorine from a location in Kaluthara district in Sri Lanka. To determine the impact of the release probit analysis, safe distance and hazardous time period calculations were done. From the model results, for a 900kg chlorine release, safe Immediately Dangerous to Life or Health (IDLH) distance was above 490m. Within this hazardous zone the safe time period starts after 5.44 minutes from the release. Further, this model can be used to predict information, such as concentration variation of the substance released with time and, cloud dimensions such as height and radius. For validation, experimental data in literature were collected and a sensitivity analysis was done to identify the best values for the model parameters.

Key-words: Dense gas dispersion, environmental impact, chlorine, accidental release, safe distance

Acknowledgement

I would like to extend my sincere gratitude to my supervisors, Dr. M. Y. Gunasekera for her valuable guidance, advice and support extended in this study, and Dr. M. Narayana for the kind supervision given while assisting as the M.Sc. coordinator of the Post Graduate Division of the Chemical and Process Engineering department.

Also I would like to thank the administrative officers of M.Sc./PGD in Sustainable Process Development, University of Moratuwa for the timely information given regarding the research work.

In addition, I am grateful to my colleagues who helped me in many ways such as collecting and analyzing data. Special appreciation is given to my family for their immense support.

Finally, I would like to thank each and every one who came across this research for making this study a success.

Table of Content

List of Figures

List of Tables

List of Appendices