COMPUTER MODELING OF INDUSTRIAL EMISSIONS

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This thesis was submitted to the Department of Civil Engineering

Of the University of Moratuwa in partial fulfillment of the requirements

for the degree of

Master of Science

In Environmental Engineering and Management

Department of Civil Engineering
University of Moratuwa
Sri Lanka

November 2006

The work included in this dissertation in whole or part has not been submitted for any other academic qualification at any institution.

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Abstract

Air being an important part of the environment is always required to be in a satisfactory condition for the proper functioning of the entire eco system. Air quality is being affected adversely due to several reasons such as increasing number of industries without having proper emission handling systems and increasing number of vehicles.

Many industrial stacks observed in Sri Lanka today are not constructed according to the proper stack design requirements. The quality of stack emissions or the dispersion of pollutants from a specific stack is seldom analyzed mainly because of the high costs involved. Even analysis is done on the dispersion from a specific stack it is difficult to get good representative results because the meteorological conditions vary frequently.

In this study a stack emission dispersion model named AUSPLUME which is developed by the Victorian Environmental Protection Authority and recommended by several organizations for regulatory purpose was studied. This work mainly looks at the following:

i. The applicability of the model in the Environmental Impact Assessment (EIA)
ii. Model emissions from the stacks at Holcim Lanka cement plant at Puttlam with the use of AUSPLUME before and after installing a new dust handling system

The purpose of the EIA is to predict and identify potentially significant environmental impacts of development projects and to suggest mitigation measures to minimize the negative impacts and maximize the positive impacts. Main stages in the EIA process are,

i. Screening (find out whether an EIA is required)
ii. Scoping (identification of main issues)
iii. Collection and analysis of information
iv. Public involvement
v. Communicating the findings

In the process of analyzing the information AUSPLUME can be used. With available information about the stack, emissions and the meteorological data of the area of concern, the model can predict the concentrations of selected constituents at ground level or elevated levels in the down wind direction. The areas of worst impact, limit of the buffer zone, effects to the high rise buildings or effects to the selected areas of important like high bio diversity, archeology, and residences can be identified using the results obtained with AUSPLUME.

For the analysis of the stack emission dispersion from the Holcim Lanka cement plant at Puttlam, the meteorological data obtained at the Palavi weather monitoring station of the Meteorological Department were used. There are two similar stacks at the factory which are placed close by and therefore both of them were considered as a single point source with an equivalent diameter. The area was considered to be a flat terrain since there were no disturbances in the vicinity.

The analysis results on the dispersion of particulate matter, NO_2 and SO_2 emissions from the stack were compared with ambient air quantity standards for Sri Lanka and European Guideline values which were established by considering human health hazards other than carcinogenity. Certain values were found to be above the limits and the rest below the limit. Anyway in this analysis raw emission data were used and in the real life the raw emissions are mixed with clean air before released to the atmosphere. Therefore due to the dilution the real values can be expected to be much lower.

Predicted values were compared with field measurement values available and with predicted values from SCREEN3 model.

The results obtained can be used for decision making purposes with a good understanding about their inaccuracy.

Acknowledgement

I acknowledge with gratitude General Management of Ecolcim, Mr George Nicole, in giving me the opportunity to carry out this study focusing the operations in the Holcim Lanka cement plant at Puttlam.

I am grateful to Prof. Ajith De Alwis and Dr Manisha Y. Gunasekara my co supervisors whom very generously spared their precious time and provided every guidance and assistance to carry out this task.

I am also thankful to Mr Chalaka Fernando- Environmental Manager, Ms Vijitha Jayawardena- Electrical Engineer and the other staff members at the Puttlam cement plant for providing their kind assistance and sparing their precious time.

I extend my gratitude to Prof. Arjuna De Soyza and Mr Shantha Fernando at the Department of Mathematics and Philosophy of Engineering, Open University, Nawala for giving me the opportunity to continue this study.

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List of Abbreviations

ADOM	Acid deposition oxidant model
CIT	California institute of technology
DWM	Diagnostic wind model
EIA	Environmental impact assessment
ID	Identity
ISC	Industrial Source Complex
ISCLT	Industrial Source Complex Long Term
ISCST	Industrial Source Complex Short Term
ppm	Particles per million
PM10	Particulate matter less the 10 μm in diameter
POP	Persistent Organic Pollutants
RADM	Regional acid deposition model
ROM	Regional oxidant model
SPM	Suspended particulate matter
SAARC	South Asian Association for Regional Corporation
UAM	Urban airshed model
USEPA	United States environmental protection agency

List of Notations

Al	Aluminum
Ca	Calcium
$CaCO_3$	Limestone
CO_2	carbon dioxide
C(x,y,z)	the downwind concentration at a point x,y,z , $\mu g/m^3$
d_s	diameter of the stack
Fe	Iron
Fe_2O_3	Iron Ore/Mill Scale
H	the effective stack height, m
h_s	physical stack height
NO_2	nitrogen dioxide
P	wind profile exponent, varies with the type of ambient weather conditions; ranges from 0.1 for calm conditions to 0.4 for turbulent weather conditions
Q	emission rate of the pollutants, g/s
Si	Silicon
SiO_2	Sand
SiO_2, Al_2O_3, Fe_2O_3	Shale, Clay
SO_2	sulphur dioxide
u	the mean vertical wind speed across the plume height, m/s
u_s	wind speed at stack height (m/s)
U_1, Z_1	wind speed, vertical height of the wind station
U_2, Z_2	wind speed, height of the plume
v_s	emission velocity (m/s)
$\bar{x}$	mean
y	the lateral distance, m
z	the vertical distance, m
ΔH	plume rise
σ	standard deviation
σ_y, σ_z	plume standard deviations, m