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COMPUTER MODELING OF INDUSTRIAL EMISSIONS

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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, NO₂ and SO₂ 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 carcinogenicity. 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.

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Table of Contents

Abstract	iii
Acknowledgement	v
Table of Contents	vi
List of Figures	viii
List of Tables	x
List of Abbreviations	xii
List of Notations	xiii
CHAPTER 1 : INTRODUCTION	
1.1 Current air quality scenario in the country	1
1.2 Research objectives	5
CHAPTER 2: LITRATURE REWIEW	
2.1 Air quality modeling	6
2.2. Examples of air quality modeling systems	10
2.3 Atmospheric dispersion modeling- The Gaussian Model	18
2.4 Cement manufacturing industry <small>oratuwa, Sri Lanka.</small>	32
2.5 About the company- <small>Electronic Theses & Dissertations</small> Holcim Lanka Ltd	35
2.6 Air pollution potential from cement manufacturing	37
CHAPTER 3: APPLICATION OF A MODEL TO PREDICT AIR EMISSIONS	
3.1 Simulation title	40
3.2 Meteorological data file	41
3.3 Model parameters	49
3.4 Source information	50
3.5 Other parameters	54
CHAPTER 4: ANALYSIS OF THE FATE OF STACK EMISSION USING AUSPLUME	
4.1 Applicability of AUSPLUME in Environmental Impact Assessment	60
4.2 Application of AUSPLUME to Holcim stacks	69

CHAPTER 5 :	RESULTS AND DISCUSSION	
5.1	Applicability of AUSPLUME in Environmental Impact Assessment	86
5.2	Application of AUSPLUME to Holcim stacks	88
CHAPTER 6 :	CONCLUSION	94
CHAPTER 7 :	OPPORTUNITIES AVAILABLE FOR FUTURE WORK	95
REFERENCES		97
Annexure 1:	Sample meteorological file	99
Annexure 2:	Dispersion models used in the EIA processes	100
Annexure 3:	Sample output file	102
Annexure 4:	Sample emission data for the Puttlam cement plant stack	106
Annexure 5:	Specimen Calculation- Emission rate of NO₂ from the equivalent stack (considering both stacks as a single stack)	107
Annexure 6:	Ambient air quality standards in Sri Lanka	108
Annexure 7:	Pasquill- Gifford curves	112
Annexure 8:	Area map, monitoring locations and the area of highest damage	114
Annexure 9:	Output from SCREEN3	115



List of Figures

1.1: CO ₂ emission under baseline scenario through energy generation	3
2.1: Relationships among the major components of an air quality modeling system	7
2.2: Flow of information in RAINS ASIA 2	15
2.3: Flow of information in AUSPLUME	17
2.4: Gaussian (Normal) Distribution curve	18
2.5: Distribution of the plume around the centre line	20
2.6: Height of a stack	21
2.7: Fanning plume	23
2.8: Fumigation	24
2.9: Coning	24
2.10: Looping	25
2.11: Lofting	25
2.12: Downwash types	29
2.13: The creation of the wake	30
3.1: Variation of wind speed during the day	43
3.2: Variation of wind direction during the day	44
3.3: Variation of ambient temperature during the day	49
3.4: Cartesian receptor grid	52
3.5: Polar receptor grid	52
3.6: Plume rise options	55
4.1: Ground Level Maximum Concentration for an Emission from a Stack Height 80m and Wind Velocity 20m/s	61
4.2: Maximum Concentration at a 30m Elevation for an Emission from a Stack Height 80m and Wind Velocity 20m/s	63
4.3: Concentration at Ground Level for an Emission from a Stack Height 80m and Wind Velocity 25m/s	64
4.4: Effect of plume exit velocity on dispersion	65
4.5: Maximum concentration points at ground level for an emission from a stack height 50m and wind velocity 20m/s	66

4.6: Ground Level Maximum Concentration for an Emission from a Stack Height 50m and Wind Velocity 25m/s	67
4.7: Distribution of maximum ground level concentrations of particulate matter	71
4.8: Distribution of maximum CO ₂ concentrations	73
4.9: Distribution of maximum NO ₂ concentrations	74
4.10: Distribution of maximum SO ₂ concentrations	76
4.11: Distribution of maximum ground level concentrations of particulate matter	80
4.12: Distribution of maximum ground level concentrations of NO ₂	81
4.13: Distribution of maximum ground level concentrations of SO ₂	83
4.14: Distribution of maximum ground level concentrations of CO ₂	84
5.1: Estimated and real particulate concentrations before installing the baghouse	91
5.2: Estimated and real particulate concentrations after installing the baghouse	91
5.3: Predicted ground level concentration of particulate matter using AUSPLUME and SCREEN 3	93



List of Tables

1.1:	CO ₂ emission under baseline scenario through energy generation	2
2.1:	Stability class choices for day and nighttime (adapted from Turner 1994)	23
2.2:	Typical mixing heights in km	26
2.3:	Basic raw materials of Portland cement	32
2.4:	General compositions of basic raw materials	33
2.5:	General compositions of minor constituents	33
3.1:	Variation of wind speed during the day	42
3.2:	Variation of wind direction during the day	44
3.3:	Variation of the stability class during the day	46
3.4:	Variation of the mixing height during the day	47
3.5:	Variation of ambient temperature during the day	48
3.6:	The default wind speed categories	56
3.7:	The default wind profile exponents	57
4.1:	Emission Data for the Hypothetical Constituent in the Stack Emission	61
4.2:	Maximum ground level concentration for varying plume exit velocities	65
4.3:	Emission Data for the Hypothetical Constituent in the Stack Emission	67
4.4:	Emission data for Stack 1b mrt.ac.lk	70
4.5:	Maximum ground level concentrations of particulate matter calculated using AUSPLUME	71
4.6:	Maximum CO ₂ concentrations	72
4.7:	Maximum ground level concentrations of NO ₂	74
4.8:	Maximum ground level SO ₂ concentrations	75
4.9:	Variation of meteorological conditions on 07/ 04/ 2003	77
4.10:	Emission data for the Equivalent stack	78
4.11:	Maximum ground level particulate matter concentrations	79
4.12:	Maximum ground level NO ₂ concentrations	81
4.13:	Maximum ground level SO ₂ concentrations	82
4.14:	Maximum ground level CO ₂ concentrations	84
4.15:	Variation of meteorological conditions on 19/ 03/ 03	85
5.1:	Pollutant Dispersion Results using AUSPLUME	86
5.2:	Ambient air quality standards in Sri Lanka	88

5.3:	European standard guideline values	88
5.4:	Maximum 1 hr time weighted average values of NO ₂ , SO ₂ and particulate matter	89
5.5:	Measured ambient PM ₁₀ concentrations at different locations	90
5.6:	Downwind peak concentrations of particulate matter for a single stack using data observed after the installation of the bag house	92



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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 , $\mu\text{g}/\text{m}^3$
d _s	diameter of the stack
Fe	Iron
Fe ₂ O 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 ₂ O ₃ , Fe ₂ O 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

